PACIFICUS

ENVIRONMENTAL IMPACT STATEMENT

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ES1 Project Location

The proposal is to construct Pacificus Tourism Project (PTP), a high quality tourism destination for local and International visitors, on Hummock Hill Island (HHI) 30 km south east of Gladstone (see Figure ES.1).

HHI is approximately 13 km long, 3 km wide, with a total area of 3,000 ha. HHI is separated from the mainland by Boyne Creek, a shallow tidal estuary that flows into the deeper waters of Colosseum Inlet and Seven Mile Creek. Gladstone City is approximately a 35 minute drive from PTP, with Tannum Sands and Boyne Island located 20 minutes to the north-west and the town of 1770 approximately 90 minute drive to the south-east.

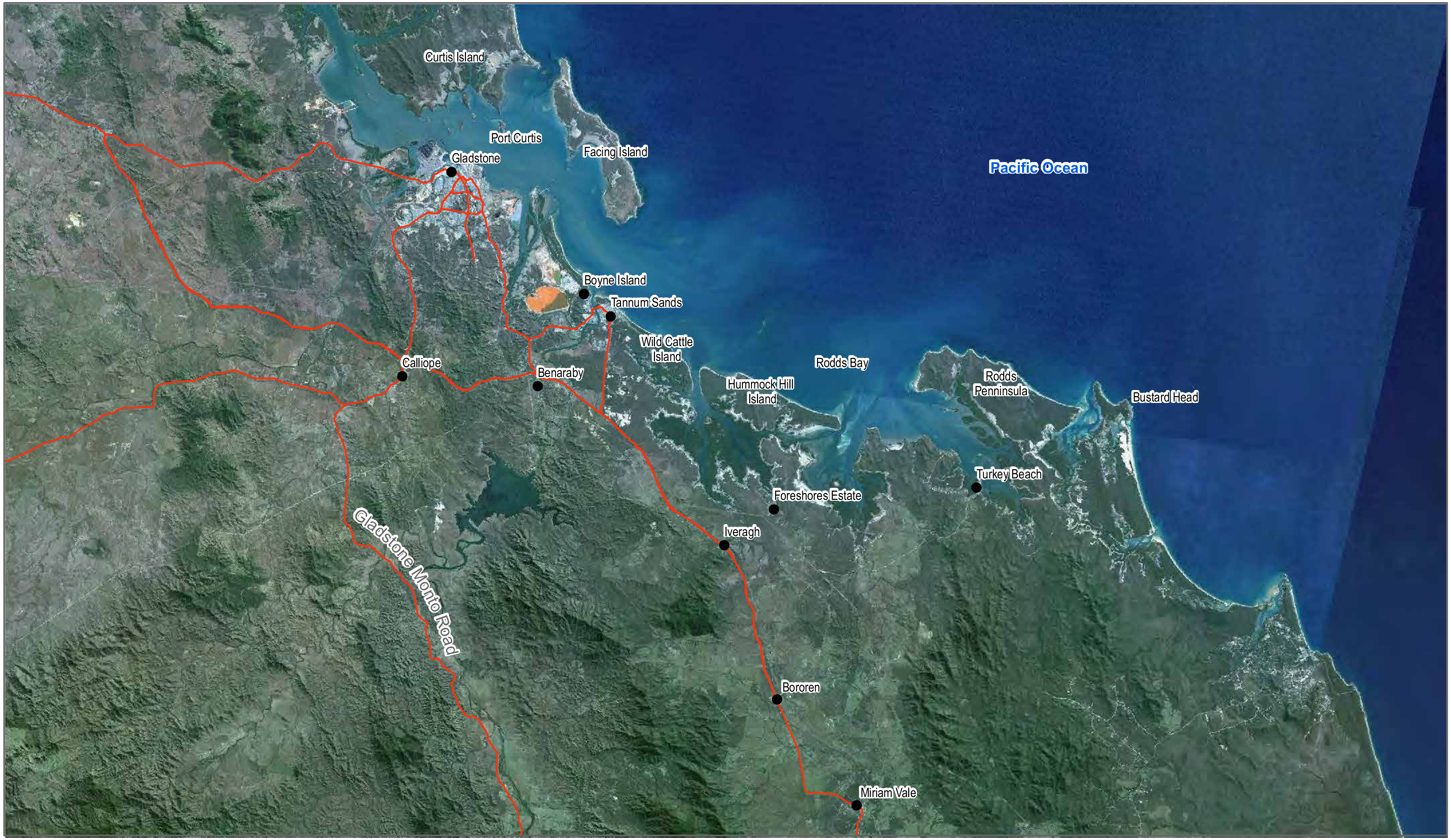
ES2 Overview

Eaton Place Pty Ltd, the Proponent for PTP, holds a Special Lease (SL) (SL 19/52155) over the entirety of Lot 3 on FD841442 (1,163 ha) on HHI which gives the Proponent the right to develop the land for business, industrial, commercial, residential, tourism and recreational purposes. The SL requires an environmental impact assessment study be undertaken (SL Condition C369) by the proponent for assessment prior to any development taking place on the land and consent to be obtained from the Queensland Government and the Gladstone Regional Council. The lease area has historically been used for cattle grazing and timber harvesting.

HHI and adjacent estuaries are within the Great Barrier Reef World Heritage Area (GBRWHA) and National Heritage Place (NHP). The Mackay/Capricorn Section of the Great Barrier Reef Marine Park (GBRMP) borders the seaward shore of HHI and the State Great Barrier Reef Coastal Marine Park (GBRCMP) surrounds the Island. Directly east of HHI is the Eurimbula National Park which is situated on Rodds Peninsula and to the north-west is Wild Cattle Island National Park (refer to Figure ES.2).

The Proponent recognises the importance of the contribution that HHI and surrounding waters makes to the outstanding universal value (OUV) of the GBRWHA and NHP and also the importance of other matters of national environmental significance (MNES) present on and adjacent to HHI. The Proponent has strategically, rigorously and iteratively designed PTP to ensure minimal disturbance to the physical, ecological and biological processes on HHI and within the surrounding marine environment that underpin the MNES values present, including the OUV of the GBRWHA. In addition to the design criteria, the Environmental Management Plan (EMP) will incorporate mitigation measures developed through the environmental impact assessment to avoid where possible, minimise, manage and compensate for potential impacts during the construction, operation and decommissioning phases of the development.

Only 10% of HHI will be developed. As agreed with the Queensland Government the undeveloped areas of will be given conservation status by the Queensland Government and managed for conservation values and compatible recreational usage. The Master Plan for the PTP is presented in Figure ES.6.



LEGEND

- Towns
- Main Roads

Figure ES.1 - Site Location - Hummock Hill Island

This figure must be read in conjunction with the data disclaimers located at the front of this report . The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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PACIFICUS TOURISM PROJECT

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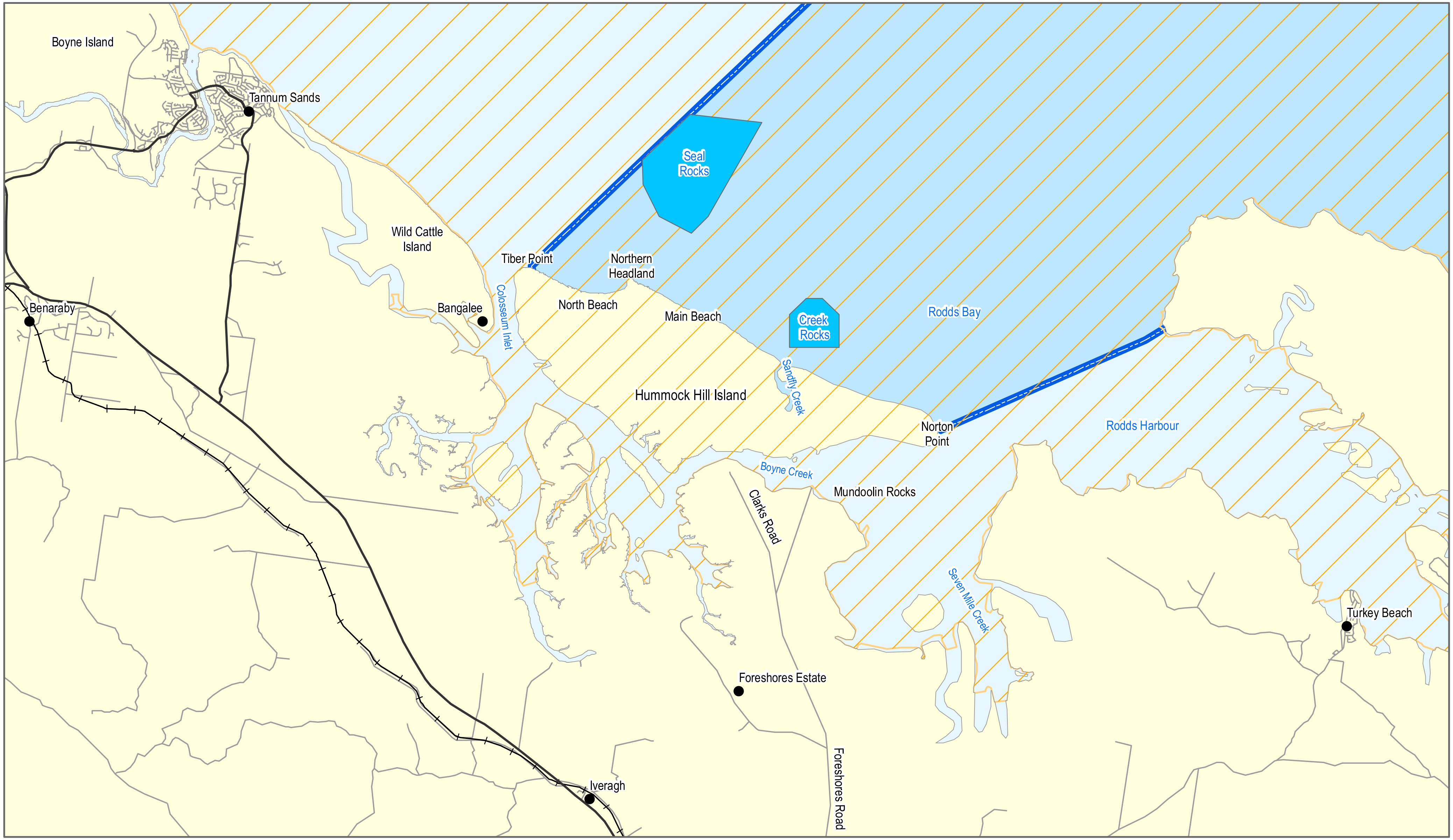

LEGEND

- Towns
- Main Roads
- Roads
- Railway
- Great Barrier Reef World Heritage Area
- Habitat Protection Zone
- Great Barrier Reef Marine Park Mackay/Capricorn

This figure must be read in conjunction with the data disclaimers located at the front of this report . The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Figure ES.2 - Study Area For The Pacificus Tourism Project

PACIFICUS TOURISM PROJECT

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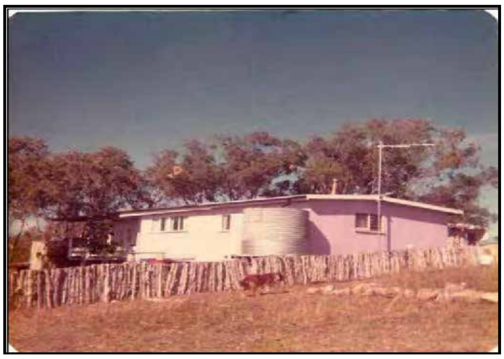
ES3 Project History

HHI has a long history of human use; firstly by the local Indigenous population and subsequently for pastoral activities, with the grant of a pastoral lease in 1870 that saw the Island used for raising beef cattle and as a source of timber. Vegetation clearing on the Island was required as a condition of the pastoral lease renewal (see Figure ES.3).

Figure ES.3 - Typical Vegetation within the Centre of the Lease Area

The various leaseholders constructed houses (see Figure ES.4), shearing stalls, milking yards, calf pens, a cattle dip, fences, roads, dams, wells and an airstrip. No activity has occurred on HHI since the pastoral lease was rescinded in 1980.



The Homestead in 1973

Looking north toward the homestead

Figure ES.4 - Former Homestead Buildings on HHI

Special Lease (SL) 19/52155 was created in 1991 following land use negotiations between mineral sand mining interests and State agencies that created national and environmental parks in areas of high conservation value, such as Byfield, Curtis Island, Wild Cattle Island, Rodds Peninsula, Eurimbula and Deepwater National Parks and Bustard Head Conservation Park. Remaining areas such as HHI and Middle Island were considered to have lower conservation values and also considered to have potential for either mining or tourism-related development.

A number of proposals for the Island have been put forward since the lease was issued. Plans were proposed for a tourism based development in the early 1990s; the subject of the 1993 Impact Assessment Study by AGC Woodward-Clyde (1993). Miriam Vale Shire Council issued a development approval for 5,000 lots, a marina, two golf courses and a hotel/convention centre in the mid 1990s. Another tourism and residential development was proposed in 1999 consisting of a hotel resort, caravan park, two golf courses, low and medium density residential, commercial science/technological precincts and a rocket launching facility.

A previous project of similar size and design to PTP was the subject of a full environmental impact assessment in 2007. The project (Hummock Hill Island Development (HHID)) was declared a "Controlled Action" by the Commonwealth Minister for the Environment and Heritage (DEH)[1] on 13 January 2006. On 17 November 2006, The Project was declared by the Queensland Government to be a 'significant project for which an environmental impact statement (EIS) is required' pursuant to section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act). Under a bilateral agreement with the Australian Government, the Coordinator-General's Report was to be used by the Australian Government to make an assessment of the controlled action for the purposes of the EPBC Act. The EIS for HHID was advertised for public comment from 10 December 2007 until 4 February 2008. The Proponent conducted a public information and consultation program throughout the EIS process including face-to-face meetings with 'affected' and 'interested' parties, newsletter/fact sheets, online information and feedback tools, free call 1800 number and reply paid mail service, as well as public displays and meetings. Following these extensive consultations with the public and all levels of government in Queensland, the Coordinator-General recommended that HHID should go ahead, subject to a range of conditions and recommendations and a Coordinator-General's Report was issued in February 2011. Following unsuccessful negotiations with the then Department of SEWPaC, the referral under the EPBC Act was withdrawn by the Proponent in July 2011. This did not affect the validity of the Coordinator-General's report in relation to Queensland government approvals.

Subsequently the Proponent and its key advisors met with SEWPaC staff to formulate a new referral with a reduction in the overall project area, and changes to the master plan including further refinements to reduce impacts on MNES and address concerns raised by SEWPaC officers. The PTP was declared a controlled action by the Australian Government on 14 December 2012 (2012/6643).

The Queensland Coordinator-General has been briefed on the changes made in response to discussions with SEWPaC/DotE and regularly updated on progress of the PTP proposal and its assessment under the EPBC Act. Changes made from the HHID to the PTP are of a nature that can be dealt with as a change to the HHID project under Part 4, Division 3A, Subdivision 1 of the SDPWO Act which, among other things requires an assessment of any changes in the type, scale and

[1] Re-named Department of Sustainability Environment Water Population and Communities (SEWPaC) and now known as Department of the Environment (DotE)

significance of impacts associated with the PTP. The Queensland Coordinator-General has indicated that this process can commence once approval is granted to PTP under the EPBC Act.

ES4 The Proponent

The Proponent for PTP is Eaton Place Pty Ltd. The principal shareholders of the proposed PTP are the Scarf and Hatsatouris families of Sydney, New South Wales. These family companies, along with associated businesses, have successfully undertaken major property developments in NSW, including shopping centres, apartment developments, and commercial property development over the past 30 years. The family developments have all been designed with consideration of the sensitivities of the site locations and the need by its customers for quality facilities The Proponent has an exemplary environmental record. There are no current or former proceedings under a law of the Commonwealth or a State for the protection of the environment or the conservation and sustainable use of natural resources against Eaton Place Pty Ltd, any Board member or its senior management.

ES5 Environmental Impact Assessment and Approvals

ES5.1 Environment Protection and Biodiversity Conservation Act 1999

On 14 December 2012, the PTP (EPBC 2012/6643) was designated a controlled action requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) before it can proceed. The nominated controlling provisions are:

- Sections 12 and 15A - World Heritage properties
- Sections 5B and 15C National Heritage places
- Sections 18 and 18A - Listed threatened species and communities
- Sections 20 and 20A - Listed migratory species
- Sections 24B and 24C – Great Barrier Reef Marine Park.

The designated assessment approach is by environmental impact statement. The process for assessment was therefore as follows:

- Preparation of draft EIS guidelines by DotE and invitation for public comment on the draft guidelines. The draft EIS guidelines were issued for public comment on 19 February 2013.
- Finalisation of the EIS guidelines and issue to the proponent. The final EIS guidelines were issued to the Proponent on 18 April 2013
- Preparation of a draft EIS by the Proponent
- Initial review of the draft EIS by DotE to determine suitability for publication (this document)
- Publication of the draft EIS for public comment. The PTP EIS was made available for public comment from 16 December 2013 to 24 January 2014 and two submissions were received, once from Gladstone Regional Council and the other from Port Curtis Coral Coast registered native title group.

- Addressing of public comments by the Proponent. Copies of submissions and the Proponent's response are provided in Appendix J. Minor edits were also made to the EIS to clarify matters raised in submissions, however the submissions did not raise any issues that resulted in additional assessment or changes to the overall conclusions of the EIS in relation to the nature and significance of impacts.

On 29th November 2013, draft reports for the Great Barrier Reef Region Strategic Assessment and the Great Barrier Reef Coastal Zone Strategic Assessment were released for public comment. At the request of Department of the Environment, the proponent undertook a review of the consistency of PTP against the draft strategic assessment reports.

A decision by the Federal Minister for Environment is now pending.

ES5.2 Other Commonwealth Legislation

The proposed PTP at HHI will not impact directly on the Great Barrier Reef Marine Park (GBRMP) and hence no formal approvals are required under The *Great Barrier Reef Marine Park Act 1975*. Commercial tourism operators who may visit PTP in the future would be required to operate under permit conditions issued by the *Great Barrier Reef Marine Park Act 1975* if they operate activities within the GBRMP.

Native title has been extinguished by historic leases on all land on HHI that would be impacted by the development. In areas where public infrastructure crosses land subject to native title (access road, bridge, boat ramp), native title will be suppressed under the *Native Title Act 1993*.

ES5.3 Approvals under Queensland Legislation

The predecessor to PTP, the HHID, underwent assessment under the Queensland SDPWO Act, and as Coordinator-General's report was issued in February 2011, recommending that the project proceed subject to a range of conditions. As PTP is a modified version of HHID, if PTP receives EPBC Ac approval, the Proponent will then apply to the Coordinator-General for a Change Report in relation to the Coordinator-General's Report for HHID.

The Coordinator-General's report contains overarching conditions and recommendations to Queensland Government agencies and Gladstone Regional Council in relation to PTP, and the Proponent will then need to obtain a range of approvals from State and local government agencies including:

- A material change of use (MCU) seeking preliminary approval under the planning scheme from Gladstone Regional Council
- Subsequent development approvals under the planning scheme for buildings and other facilities of the project
- Approval to clear native vegetation (*Sustainable Planning Act 2009* (SP Act) *(Qld)* and *Vegetation Management Act 1999* (VM Act*)(Qld)*

- Approval to operate environmentally relevant activities associated with water treatment and wastewater treatment (SP Act and *Environmental Protection Act 1994* (EP Act) (*Qld)*
- Approval to disturb or clear marine plants (SP Act and *Fisheries Act 1994 (Qld*)
- Approvals to undertake works in a tidal area (SP Act and *Coastal Protection and Management Act 1995*) (*Qld)*
- Approvals under the *Nature Conservation Act 1992 (Qld)* in relation to interfering with listed species (if required)
- Approval to operate a recycled water scheme under the *Water Supply (Safety and Reliability) Act 2008 (Qld)*
- Approval to place structures in the Coastal Marine Park under the *Marine Parks Act 2004 (Qld)*
- Approvals in relation to road and intersection upgrades under the *Transport Infrastructure Act 1994 (Qld)*
- Riverine protection permits in relation to any works in declared watercourses under the *Water Act 2000 (Qld).*

Individual operators of commercial premises may also need to obtain specific approvals in relation to matters such as storage of dangerous goods, operating boat workshops and other activities. Operation of a commercial tourism activity in the Great Barrier Reef Coast Marine Park (GBRCMP) will also require a permit.

The Proponent will require a new SL under the *Land Act 1994 (Qld)* that will include the Commonwealth and Queensland Government development conditions.

A Cultural Heritage Management Plan (CHMP) has been agreed with the Island's Traditional Owners as represented by the Port Curtis Coral Coast Aboriginal Corporation and is registered with the Queensland DATSIMA under the *Aboriginal Cultural Heritage Act 2003 (Qld).*

ES5.4 Consultation

An extensive community consultation program was undertaken in the period 2005-07 coinciding with preparation of the HHID EIS.

The Terms of Reference were released for public comment from 18th November 2006 to 18th December 2006. The HHID EIS was released for formal public comment under the SDPWO Act from 8th December 2007 to 4th February 2008. The program:

- Notified the community that the EIS had been lodged for assessment by the Queensland Coordinator-General and called for written submissions on the EIS by community members
- Provided information to stakeholders and community members to enable their review of the EIS and project reference design
- Obtained input from local councils, Queensland Government and Commonwealth agencies on the EIS

- Satisfied the statutory requirements of the SDPWOA in relation to the exhibition of the EIS and invitation for written submissions.

Consultation was focused on the local and regional communities surrounding the Island, as well as key stakeholders. A three-tiered consultation approach was undertaken incorporating:

- Key stakeholders identified via a desktop study and initial interviews with elected representatives and referral agencies
- All 'affected' and 'interested' persons offered the opportunity to participate in the study
- Feedback collated and considered in conjunction with the relevant technical contact.

During the preparation of the PTP EIS continuing consultation has been carried out with QLD Government Departments, Gladstone regional Council, Gladstone Area Promotion and Development Ltd (GAPDL) and Gladstone Community Groups.

The Draft EIS was made available for public comment from 16 December 2013 to 24 January 2014. Access to the Draft EIS was made available as follows:

- A printed copy was placed at the State Library of Queensland, Cultural Centre, Stanley Place, South Bank Brisbane
- A printed copy was placed at Gladstone Regional Council offices, Goondoon Street, Gladstone
- The Draft EIS was available for download at http://www.pacificus.com.au
- Printed copies of the Draft EIS were made available for purchase and electronic copies were made available free of charge and could be obtained by telephoning a free-call number, or emailing an information request to the proponent.

As of the closing date for public comments, submissions had been received from:

- Gladstone Regional Council
- Dillons Lawyers on behalf of the Port Curtis Coral Coast registered native title group.

Copies of submissions are provided in Appendix J and amendments have been made to this EIS in response to comments made by Gladstone Regional Council. The submission from PCCC did not require any amendments to the EIS as the comments were in relation to the existing Cultural Heritage Management Plan rather than matters of national environmental significance.

Consultation will continue into the detailed planning, design, construction and operation phases of the PTP.

ES6 EIS Methodology

The principle objective of the EIS is to support the assessment and decision making process under the EPBC Act. To this end, the EIS:

- Addresses the assessment requirements specified in Section 102 of the EPBC Act and Schedule 4 of the *Environment Protection and Biodiversity Regulations 2000* (EPBC Regulations)
- Describes those aspects of the construction and operation proposal relevant to the identification and assessment of potential impacts
- Provides a description of the physical, biological, cultural and social characteristics of the project area and surrounds, including a specific analysis of the MNES values present or potentially present
- Identifies and evaluates all relevant impacts of the PTP proposal on MNES and provides mitigation measures and project commitments to avoid, mitigate or offset any adverse impacts.

A tailored impact assessment methodology has been developed for assessment of PTP drawing on international best practice (for example, IAIA 1999, Asian Development Bank 1999, Noble 2011). The approach centres on:

- Understanding the existing environmental values, systems and interactions, particularly in relation to MNES values
- Identifying the extent to which the PTP will cause direct and indirect changes to environmental values and systems as these relate to MNES
- Determining whether these changes will cause significant and/or unacceptable impacts to MNES values
- Identifying whether reliable and practical measures are available to mitigate significant and/or unacceptable impacts such that these are acceptable with mitigation measures applied.

The overall methodological approach to identifying and evaluating impacts on MNES is shown in Figure ES.5 which also provides cross references to where each step in the methodological approach is addressed within this EIS.

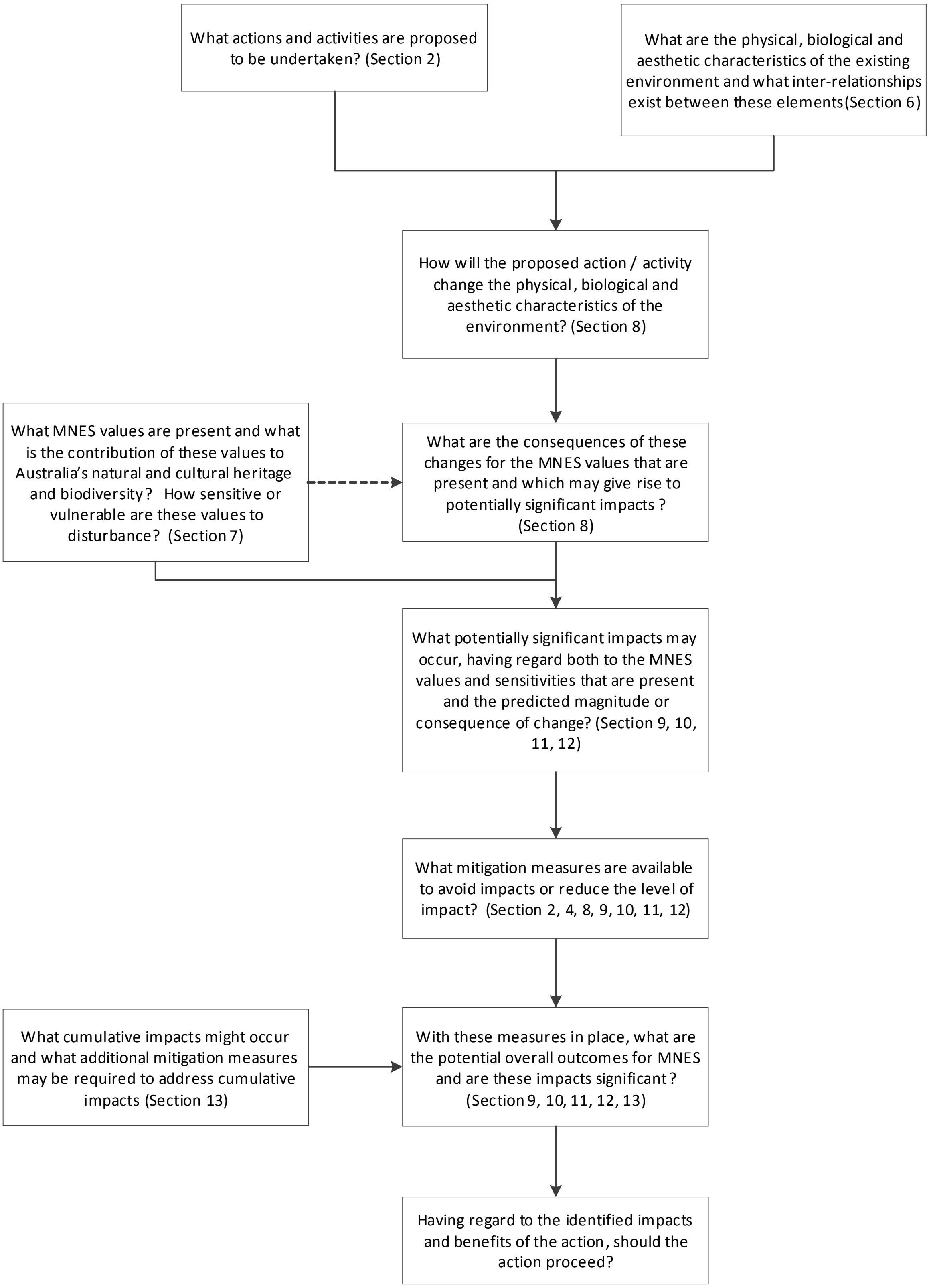


Figure ES.5 - MNES Impact Assessment Methodology

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DEWHA 2009a).

An impact significance framework was developed based on the internationally recognised approach to impact assessment, whereby impact significance is the product of:

- Value or importance of the individual feature, resource or system that might be affected: For example, impacts on threatened species are considered more severe than impacts on common species. Similarly, impacts on places or items of high habitat, biodiversity or heritage value, or on resources that are critical for ecosystem function are also more significant.
- The severity of the impact is based on consideration of the consequence of the impact on that population, resource or system. Factors affecting impact severity may include:
  - magnitude and extent of the effect, being the size of group affected or scale or size of effects in the context of the study area. Impacts affecting large proportions of population, ecosystems or resources are more significant as are impacts affecting larger areas and/or
  - duration and reversibility of the effect.

The scale used for determining importance of MNES values present was based on whether the values were considered "highest importance", "moderate importance", "lower importance" and "not present". Highest importance features included those features which make a major contribution to the OUV of the GBRWHA, habitat for endangered species, internationally or nationally important habitat for migratory species or highly protected marine park zones. Moderate importance features were those values that were important representations of MNES values at a regional level and included important habitat for vulnerable species as well as features or values that make a moderate contribution to the OUV of the GBRWHA. Lower importance values were those that were common or well represented at a regional scale and/or across the GBRWHA/NHP and GBRMP and make a minor contribution to the OUV of the GBRWHA. This scale assumes that all MNES values have significant importance through listing as MNES, and hence, even the "lower importance" rank is relative to the overall importance of all MNES and there is no "negligible importance" criteria for MNES values.

The impact severity scale was developed for each of the categories of MNES included as a controlling provision for the assessment and based on whether impacts were severe, moderate, low or negligible.

As a number of measures have been incorporated into the design of PTP to avoid or minimise impacts, the traditional approach of first assessing "raw" impact and then assessing "residual" impact based on the likely effectiveness of mitigation measures was not strictly followed and hence "raw" impacts are assessed on the basis of measures incorporated into the design and overall delivery approach of PTP, with further mitigation measures identified to address significant impacts as required.

The impact significance matrix was then developed based on the overall significance of the impact being the product of the importance of the value and the severity of the impact as shown in Table ES.1. In line with definitions used in DotE guidelines, impacts are categorised into two categories; significant and not significant. The significance threshold was deliberately set conservatively low in view of the fact that all MNES values are important through listing under the EPBC Act and hence, even relatively minor impacts on MNES values may be significant.

Table ES.1 - Impact Significance Matrix

Importance of value / Severity of impact ↓	Highest Importance	Moderate Importance	Lower Importance	Not present
Severe	Significant	Significant	Significant	No impact
Moderate	Significant	Significant	Not significant	No impact
Low	Significant	Not significant	Not significant	No impact
Negligible	Not significant	No impact	No impact	No impact

In addition to evaluating the significance of impacts, which are planned events that are reasonably likely to occur as a result of an action, it is necessary to consider hazards, being unplanned events. A qualitative risk matrix consistent with the AS/NZS ISO 31000: 2009 Risk management – Principles and guidelines was used and adapted to remove the “almost certain” and “likely” likelihood criteria. Hazards that are “likely” or “almost certain” are effectively the same as impacts, as impacts are defined as the likely consequences of the proposed action.

Where the significance assessment indicated that additional mitigation or management might be required over and above that already incorporated into the development approach and design, further mitigation measures were identified based on the following hierarchy:

- Avoiding impacts where possible, for example through relocation or other design measures to avoid direct and indirect disturbance to sensitive areas
- Minimising impacts which cannot be avoided, for example by reducing the duration of an activity, reducing the footprint of a component of the project or retaining some habitat features
- Rehabilitating disturbed areas, for example, through replanting native vegetation on completion of construction
- Managing impacts, for example through implementation of erosion and sediment control plans.

Consistent with the EPBC Act offsets policy (SEWPaC, October 2012) offsets will only be proposed to compensate for unavoidable residual impacts.

ES7 Project Description

ES7.1 Development Concept and Objectives

PTP will include a range of tourist accommodation including resort hotels, holiday accommodation and camping grounds as well as a residential component. The PTP will also include environmental education/research facilities, retail and commercial precincts, beach access, an 18-hole golf course (with irrigation by recycled water), and community, recreational and leisure facilities. These facilities will be accessible to tourists, residents of PTP and nearby communities including Gladstone.

Given its location within the GBRWHA/NHP and the potential for nature based tourism in the area, the Proponent will utilise certification schemes such as that developed by Eco-tourism Australia (http://www.ecotourism.org.au) to set requirements for tour operators, accommodation providers and tourism facilities proposing to operate at the PTP. Eaton Place is a gold member of Ecotourism Australia.

The Proponent will provide all necessary infrastructure for the PTP as well as contributions for external infrastructure so that State and regional infrastructure providers are not adversely affected. The Project will not require any public sector investment.

PTP will be developed to the highest environmental standards, utilising state-of-the-art engineering and architectural solutions to minimise impacts on the local environment, to minimise the demand for and consumption of energy and other natural resources and to ensure long-term environmental sustainability of the development. Environmental management plans will be prepared to monitor and manage any impacts on the surrounding environment and will include triggers for corrective action where adverse effects are detected by monitoring.

To maximise outcomes for environmental, social and economic aspects of PTP, the following development goals have been identified by the Proponent:

- The contribution that HHI and surrounding waters makes to the OUV of the GBRWHA will not be significantly diminished
- The development will provide for an opportunity for visitors and residents to understand and experience the OUV of the GBRWHA/NHP
- Natural environment is maintained, protected and enhanced so that areas and features of conservation significance are retained and the human population can enjoy living in close proximity to, and harmony with the natural ecosystems
- Social environment will be based on a vibrant, dynamic and diverse community that has a strong environmental awareness and is committed to sustainable living and self-development
- Built environment will be appropriate to the scale of the development and the natural environmental setting. Infrastructure systems will be based on latest advances in sustainable living, but will be suitable for management and basic maintenance by the occupiers.

Performance targets and development principles have therefore been incorporated into the project planning and design for the Natural Environmental, Social Environment and Built Environment such that PTP will be an environmentally sustainable development.

MNES specific conservation objectives were also developed and are presented in Section ES 11.6.

The land use elements of the PTP have been located with careful consideration to HHI's environmental constraints including existing regional ecosystems, topography of the site, utilisation of views and vistas and integration within the natural landscape.

ES7.2 Project Master Plan

The PTP Master Plan is shown on Figure ES.6.

The proposed community will consist of an estimated 2,700 tourists and 1,200 residents at full development. Accommodation for permanent residents will account for 30% of all accommodation within the development. The majority of permanent residents are expected to be the 700 full time workers (and their families) who will be employed in tourism and supporting businesses within the PTP.

The total proposed development area for the PTP is 465 ha, including 307 ha for the development footprint and 158 hectares for open space, golf course, parkland and buffers. The Master Plan has been developed over a series of iterations to maximise use of cleared and disturbed areas, make best use of the natural assets of the SL and minimise impacts on key environmental values in particular MNES.

The development will include the following tourism and recreational facilities:

Accommodation

- 240 room 5 Star hotel
- 150 room 3 Star hotel
- 20 room Health Spa/Retreat
- 70 room Motel
- Caravan Park and Camping Ground
- Holiday apartments and villas
- Residential accommodation

Recreation and Leisure

- White sand protected beach
- Restaurants / Bars/Cafes
- Indigenous Cultural Centre
- International Golf Course
- Sports Centre and Facilities
- Retail shops
- Terrestrial and Marine Centre
- Boat ramp and boat hire

PTP will also deliver a range of community facilities which will be accessible to residents of HHI and adjoining communities, who currently lack easy access to these facilities. The community and support facilities include:

- Surf Lifesaving Club
- Tourist Information Centre
- Community Centre
- Community Markets
- Conference Centre
- Picnic and Barbecue Areas
- Native Plant Nursery
- Ecological Design and Display Centre
- Bus Services to Tannum Sands and Gladstone
- Staff and residential accommodation
- Airstrip and helipad

The proposed community facilities will be developed by the Proponent and then maintained and operated or subsidised by the Proponent until the costs of operation are matched by income from local government rates and levies or from commercial operation of the facility. The Proponent will work with emergency service providers and other government service providers to allow establishment of required services.

The Proponent is committed to PTP being an environmentally sustainable community, with the smallest eco footprint possible. Design and operations guidelines for all buildings will be prepared by the Proponent and will include:

- Sustainable, smart housing design principles
- Energy and waste strategies
- Height and bulk, colours and energy efficiency for individual buildings
- Regulation of water supply, water demand management and wastewater disposal
- Photo-voltaic electricity and solar hot water generation requirements for each building
- Communications infrastructure
- Landscape design and vegetation management
- Requirements for greenhouse efficient hot water systems and energy efficient lighting
- Requirements for rainwater tanks of a specified size for all residential lots
- Requirements for commercial buildings to capture rainwater from roof areas.

ES7.3 Project Precincts

The proposed PTP includes the following precincts:

Headland Resort Precinct

Component	Use	No of Units	Total GFA (m^2)	No of levels	Land Area (ha)
Headland Resort Hotel (H1)	T	240	38,000	3	3.00
Headland Holiday Homes (H2)	R	36	16,200	2	3.50
Headland Holiday Apartments (H3)	T	130	32,500	3	2.60
Headland Holiday Cottages (H4)	T	220	77,000	2	11.50
Foreshore Homes (H5)	R	64	28,800	2	6.25

T – tourist accommodation
R – residential accommodation
GFA –gross floor area

Sub-tropical, "resort style" landscaping will planted throughout this precinct. Landscaping will include a mixture of native and exotic planting, with covenants placed on planting design with regard to exotic species.

Golf and Beach Resort Precinct

Component	Use	No of Units	Total GFA (m^2)	No of levels	Land Area (ha)
Beachfront Tourist Hotel (G1))	T	150	24,000	3	2.75
Beachfront Villas (G2)	T	220	99,000	2	21.50
Beachfront Apartments (G3)	T	70	17,500	3	1.70
Golf Course Villas (G4)	R	130	58,500	2	12.70
Golf Course Cottages (G5)	R	180	63,000	2	9.40
Golf Course Apartments (G6)	T	230	57,500	3	5.60
Golf Club House (G7)		1	1,000	1	0.40

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

Sub-tropical, "resort style" landscaping will planted throughout this precinct. Landscaping will include a mixture of native and exotic planting, with covenants placed on planting design with regard to exotic species.

Parking for day visitors to HHI and bus circulation will be located adjacent to the Golf Club House. Access ways to the beach will not be permitted from individual villas.

Resort Village Precinct

Component	Use	No of Units	Total GFA (m^2)	No of levels	Land Area (ha)
Motel (V1)	T	70	5600	2	0.50
Village Apartments (V2)	R	120	30000	2	4.40
Caravan Park and Camping (V3)	T	170 sites			4.00
Village Retail and Commercial (V4)			5000	2	1.00
Community Services Centre			1200	1	0.24
Life Saving Club			400	1	0.08
Public Parking					1.20

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

The Resort Village Centre will be designed to function as a multi-purpose environment catering for tourists, local residents, visitors, special interests groups and related commercial activities. The centre will create a development anchor and focal point, positioned to promote and sustain highly visible activity and community services for permanent or holiday residents. Public amenities, including BBQ areas, beach access points, toilets and public parks will be located at strategic points throughout the precinct. A surf lifesaving club and beach pavilion will be located at the base of the headland near the Village centre to provide facilities for beach safety and public amenities.

Ocean View Precinct

Component	Use	No of Units	Total GFA (m^2)	No of levels	Land Area (ha)
Spa Retreat (S(1)	T	20	5000	1	2.00
Ocean View Villas (S2)	R	120	42000	2	60.00

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

Individual sites will occupy the eastern slope and northern slopes of the central spine of the Island and Hummock Hill to take advantage of the outstanding ocean and coastal views.

Colosseum Precinct

Component	Use	No of Units	Total GFA (m^2)	No of levels	Land Area (ha)
Bushland Holiday villas (B1)	T	160	40000	1 and 2	32.00
Colosseum Village Apartments (B2)	R	120	30000	2	4.80
Colosseum Villas (B3)	T	245	61250	2	49.00
Colosseum Village (B4) ▪ Retail ▪ Ecological Design Centre ▪ Tourist information Centre ▪ Indigenous Cultural Centre ▪ Native plant Nursery			 2500 1200 150 800 150	 1 2 1 1	 1.50 0.20 0.01 0.20 2.50
Terrestrial & Marine Research (B5)			500	2	1.0
Boat Ramp (B6)					1.50
Airstrip (B7)			250		10.00
Island Services (B8) ▪ Desalination Plant ▪ Salt Evaporation Ponds ▪ Waste Water Treatment Plant ▪ Maintenance Depot ▪ Electricity Sub-station ▪ Emergency Generator ▪ Service Station and Fuel Storage ▪ LPG tank				2 Max	7.00

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

A native plant nursery will display and sell plantings for shade trees, medium sized native street trees; native palms, hardy, native shrubs and groundcovers non-invasive, drought tolerant, low maintenance exotic shrubs and groundcovers for use throughout the development. Plants provided will include those endemic to the area and where practicable, propagated from regionally available seed.

The Indigenous Cultural Centre will provide cultural experiences and would display information on the aboriginal history of HHI.

The proposed Terrestrial and Marine Research Centre will undertake ecological and environmental monitoring, environmental education and extension programs The programs will be designed to encourage community awareness, appreciation and understanding of native wildlife and to promote the GBRWHA values to visitors and residents of HHI.

The Island Services Area will include water treatment plants, wastewater treatment plant, electricity substation, maintenance depot, solar array and LPG tanks.

ES7.4 Golf Course

An eighteen- hole championship golf course will designed by golf course designers accredited by the Society of Australian Golf Course Architects (SAGCA). As well as being a key recreational feature of PTP, the golf course provides the opportunity to operate a closed cycle water management system using recycled water for irrigation.

The course will follow natural ground levels and require minimal excavation and filling. Drainage will include a combination of surface and sub-surface drains. Fairways and green surrounds will be contoured to minimise runoff into sensitive vegetation areas. The roughs that make up a significant area of the golf course will be maintained in the natural uncleared condition, without irrigation.

Management of the proposed golf course will be based on the Australian Golf Environmental Initiative of the Australian Golf Course Superintendents Association, including e-par®, which is an ISO 14001-based EMS specifically designed for golf courses. A golf course and turf management plan will include:

- Management of irrigation rates to protect soil structures, surface water runoff quality and groundwater quality and levels
- Groundwater and surface water quality monitoring
- Corrective actions when monitoring shows sub-critical trigger levels have been reached
- Integrated pest management plan.

These plans will link closely with the Recycled Water Management Plan required under the *Water Supply (Safety and Reliability) Act 2008 (Qld)*.

A key advantage of use of treated wastewater for golf course irrigation is the ability to minimise the use of fertilisers, provide for a more consistent application of nutrients and to negate the need to discharge into the surrounding receiving waters. Modelling using the *model for effluent disposal by land irrigation* (MEDLI) will determine optimal irrigation rates and demonstrate that irrigation of the golf course will not lead to leaching of contaminants to the underlying aquifer or mobilisation of contaminants through surface runoff.

Grass species selected for the proposed golf course will be native, drought resistant and hardy and consideration will also be given to the potential for sterile species to be used.

ES7.5 Plan of Development

The plan of development provides the principal controls for implementation of the PTP in accordance with the Master Plan, guiding all aspects of development. Provided the PTP is approved under the EPBC Act, the Proponent will then apply to Gladstone Regional Council for a preliminary approval under the provisions of the *Sustainable Planning Act 2009* (*Qld*). Preliminary approval will incorporate the plan of development into the GRC Planning Scheme; however this approval will not result in a development permit that permits site works to commence. The Plan of Development is required to reflect the conditions of both State and Commonwealth approvals.

The approved plan of development will provide the planning framework against which all development within the PTP, whether requiring a development permit or not, is assessed. It incorporates details of the planning intent for each of the precincts, determines the level of assessment for proposed land uses for each of the precincts, and identifies the applicable codes and provisions against which a proposal will be assessed.

All buildings and other built environmental features must comply with the Plan of Development and the development codes contained therein. It is in the plan of development that the ecological principles of the development are expressed through intents and provisions, while it also addresses building design and siting provisions such as:

- Establishing building envelopes that, for most building types, require at least 50% of mature habitat trees outside the building envelopes to be retained
- Building heights being consistent with tree height and ridgelines
- Building form including the use of contemporary architecture incorporating tropical design principles
- Use of low pitch roofs
- Selection of building materials that appear light, are in natural colours, blend with the surrounding landscape and consist of non-reflective material
- Avoidance of light spill into habitat areas and coastal areas
- Compliance with Green Building Council of Australia 'green star' rating scheme or Australian Building Code energy efficiency requirements.

ES7.6 Land Tenure

Current land tenure for the proposed PTP is Lot 3 on FD841442 is a Development Lease held by the Proponent that is subject to SL/52155. Conditions of the Special Lease include the right to convert land within the Development Lease to freehold title, subject to the lease conditions. HHI consists of 11 lots and erosion prone areas and estuarine wetland buffer zones adjacent Boyne Creek, Yacht Creek and Sandfly Creek that are located on separate land tenure from Lot 3 and the Special Lease.

The access road to HHI, Clarke's Road, is a dedicated road reserve extending from Foreshores Road to the current causeway. This will be extended to cover the proposed bridge across to HHI. Native title has been extinguished over Lot 3 (i.e. the Special Lease). Infrastructure such as the bridge and road corridors outside the lease area will be dedicated as road reserves and thus native title will be suppressed over these areas.

All land to be developed for tourism, industrial, commercial and residential use (including the golf course) is proposed to be held under freehold title. A number of these freehold precincts, including the hotels, apartments and retails centres, will be developed under group or strata title. All other accommodation units will be located on individual titles. All land developed for public facilities including roads, drainage, water supply, power, sewerage, solid waste, public parkland, beach access, public boat ramp, educational facilities will be dedicated to the GRC.

ES7.7 Conservation Area

An agreement is in place with the Queensland Government that the remainder of the Special Lease, an area of approximately 695 ha and other lots on HHI will be designated as a Conservation Area under the *Queensland Nature Conservation Act 1992*.

Funding will initially be provided by the Proponent for the development and implementation of the management plan. As the development proceeds, a bushland levy will be imposed on landholders with the goal that by completion of the development phase (approximately 16 years), there would be a sustainable funding base in place. At this point, the intent is for the Proponent to hand management over to Gladstone Regional Council, with ongoing funding from the bushland levy.

ES7.8 Project infrastructure

ES7.8.1 Overview

The Proponent will provide all necessary infrastructure for the development as well as contributions for external infrastructure so that local and State infrastructure providers are not affected.

The proposal includes the design, construction and operation of the development and all infrastructure, including:

- Upgrade of the an existing access road (Clarke's Road)
- Construction of a bridge across Boyne Creek
- Construction of a boat ramp
- Upgrade of the airstrip
- Construction and operation of a desalination plant and evaporation ponds
- Provision of water supply and sewerage headworks and systems,
- Provision of electrical power from the mainland to the Island
- Construction of all roads on the island
- Stormwater collection and treatment systems (WSUD)
- Provision of telecommunications infrastructure
- Solid waste management.

The infrastructure development will be undertaken under a BTO (Build-Transfer-Operate) agreement with the GRC. Under this arrangement the Proponent will build the infrastructure, transfer ownership of the infrastructure to GRC and operate the infrastructure under a management agreement with GRC.

Installation of electrical power and gas will be by relevant authorities at the developer's cost. Operation will then be undertaken by the relevant authority. Costs of operation and maintenance will be through supply tariffs.

ES7.8.2 Water and Wastewater Management

Runoff from coastal development has been recognised as a threatening process for the Great Barrier Reef (GBRMPA 2009) and for coastal ecosystems generally. Hence, there has been considerable research and development in sustainable water management practices for urban areas and golf courses, and the PTP will incorporate state-of-the-art water management techniques in this regard.

In summary:

- There will be no discharges of any waste streams or contaminated stormwater streams to the coastal environment
- Water sensitive urban design (WSUD) principles will be applied with the overarching objectives for stormwater management being:
  - no significant increase/decrease in volume of runoff up to and including the one in one hundred year rainfall event
  - no increase in pollutant loads.
- Potable water supply from a small desalination plant producing 440 kL/day. Brine from the plant (125 kL/day) will be treated in evaporation ponds
- Rainwater tanks capturing rooftop runoff will be required on all buildings to supplement desalinated water and offset increases in surface runoff
- Treated sewage will be provided to all buildings through "third pipe" reticulation for toilet flushing and all external uses.
- Lined storages will be provided at the golf course and Colosseum Village for water in excess of residential/tourism/commercial demands. This water will be used for irrigation of the golf course and, when excess water is available, the nearby airstrip.

As required to meet public health standards, the sewage treatment plant will have an emergency overflow to an existing drainage line leading to Boyne Creek in the event of failure of any component of the sewerage or treatment system, or excessive wet weather. A number of preventative measures will be incorporated into the design, including duplication of key components of the system, back-up power supply and low-infiltration sewers. Contingency measures will also include provision of emergency storage. The likelihood of emergency overflows is therefore very low.

ES7.8.3 Waste Management

Domestic and general wastes will be by far the largest solid waste stream generated from the PTP. All facilities operating within the PTP will be required to segregate recyclable and non-recyclable components of waste. The Proponent will also provide awareness raising material and encourage facilities and individuals to practice waste avoidance and minimisation. In particular, the Proponent will discourage the use of non-biodegradable plastic packaging that can be a hazard to marine fauna and migratory shorebirds.

There is a range of waste management contractors operating in the Gladstone Region, and during the 16 year development phase, a waste contractor will be engaged to remove waste for recycling or disposal at existing mainland facilities. As the development progresses and the rates base is established, domestic waste management and collection responsibilities will be transferred to GRC, with waste material continuing to be disposed off-Island.

Any commercial activities generating non-domestic waste will be required to arrange for waste removal through existing waste management contractors. As nearby Gladstone is a major industrial hub and also services mining development, a wide range of waste contractors are available.

Domestic waste management and collection responsibilities will be transferred to GRC following completion of initial stages as part of the gradual hand-over of project responsibilities. Commercial waste management and disposal will be the responsibility of the waste generator, who will engage an authorised recycling/waste contractor to dispose of waste material off-Island. There are a number of authorised management contractors and waste disposal facilities in the Gladstone region.

Brine (concentrate) from the desalination process will be placed in evaporation ponds and the resultant crystalline salt removed for disposal or reuse at suitably authorised waste management and disposal facilities which are available in Gladstone. There will be no discharge of brine to the environment. As sludge from water treatment plants is organic in nature, the potential to reuse as a soil conditioner will be investigated. Otherwise, sludge will be removed for disposal or reuse at suitably authorised waste management and disposal facilities which are available in Gladstone.

ES7.8.4 Energy

Total peak electrical energy demand for the development is expected to be 8,000 kilowatts. Alternative power sources investigated for PTP included:

- Mains grid connection from Ergon Energy's network on the mainland
- On-Island generation using a gas fired cogeneration plant or diesel engine generators
- Solar/photovoltaic cell arrays
- Wind turbines.

The preferred power supply option is for household/building level solar power, supplemented by connection to the electricity grid. Ergon Energy has confirmed that power to PTP is available from the existing network near Foreshores Estate, approximately 12 km from the Island. Overhead power lines will be constructed from the existing network to the Boyne Creek Bridge, following existing road reserves. The powerlines will then be attached to the bridge and, once on HHI, continue underground to a substation located within the island's services centre. Both high voltage and low voltage reticulation around the Project will be via underground cables within the road reservations.

Bottled LPG gas will also be provided for to businesses and household use.

ES7.8.5 Telecommunications

A microwave relay tower will be established within PTP with direct links to the national communication network. Residents will have access to latest technology for wireless telephone, internet, television, radio and other communications.

ES7.8.6 Traffic and Transportation

The existing road network to Clarks Road is adequate for the projected traffic volumes generated by PTP with Clarks Road being constructed to a Class 3 Rural Arterial Road. The Bruce Highway-Turkey Beach Road intersection will be upgraded by the Proponent during the development of PTP.

The on-island road network will be centred on a main arterial road running from the Boyne Creek Bridge to the Resort Village. Road capacity will be 10-12,000 vehicles per day. The road will be a 2-lane, limited access, 60 kph, divided road. The north and south directional lanes of the road will be divided by a 50 m wide nature strip to lessen impacts on wildlife movements across HHI. Tourist facilities and residential and commercial development will not front directly onto the road. Collector streets will provide for traffic volumes of 3,000 vehicles per day and will provide access within each precinct of the proposed development. Cycling and walking paths will be provided to encourage visitors and residents to utilise these transport modes when weather permits.

A bus station will be provided in Resort Village and bus lay-bys will also be incorporated into design of the main access road. Subject to demand, the Proponent will provide a regular bus service between the island, Tannum Sands and Gladstone.

The proposed Boyne Creek Bridge will be a balanced cantilever structure consisting of three spans of 40 m, 70 m, and 40 m. The bridge will be launched from engineered earthen abutments utilising the existing causeway alignment. Construction of the proposed bridge will require a temporary access jetty to be constructed for plant access from which bridge construction activities will be conducted.

On completion of construction of the bridge it is proposed to remove the centre 70 m of rock fill from the existing causeway to reinstate tidal flows through Boyne Creek.

A boat ramp will be built adjacent to the western side of the proposed bridge over Boyne Creek. The boat ramp structures will be designed in accordance with the Australian Standard – *Guidelines for Design of Marinas (AS3962-2001).*

The existing private airstrip to the east of the main ridgeline will be retained and upgraded to allow use by planes with a maximum take-off weight of less than 5,700 kg.

The airstrip will be for private planes, helicopters for scenic joy flights, or small charter flights (less than 10 persons) bringing visitors to the Island and will not have provision for night time operation. Aviation fuel will be stored at the airstrip subject to the operator obtaining development approval and complying with Australian Standard AS 1940 (storage and handling of flammable and combustible liquids) and other relevant standards and guidelines. Operators of commercial tours into the GBRMP/GBRCMP will also require a permit.

ES7.9 Construction

Subject to, and following approval of the project under the EPBC Act, numerous State Government and Local Government approvals will be required before construction can commence. These approvals include approval of the detailed design of all infrastructure and major structures.

Construction activities and schedule associated with PTP are shown in Table ES.2.

Table ES.2 – Proposed Construction Activities and Schedule for PTP

Component	Timeframe	Construction Activities
Upgrade of external (mainland) road network including Foreshores Road and Clarks Road Upgrade Bruce Highway intersection Upgrade Turkey Beach Road Intersection	Phase 1 Years 1-3 Phase 3 Years 8-9	Confirm design parameters, including design standard and service requirements Conduct survey and geotechnical investigations. Prepare detailed design. Obtain permit to clear assessable vegetation (Vegetation Management Act). Prepare Erosion and Sediment Control plan and install devices Prepare and implement Construction Environmental management Plan (CEMP). Clear vegetation as required within road reserve. Grade road reserve as per detailed design. Install culverts and drainage systems. Install road base, bitumen surface, shoulder treatments (Reinstate remaining areas within road reserve with native vegetation
Bridge over Boyne Creek	Phase 1 Years 1-3	Confirm design parameters, including design standard and service requirements. Conduct survey and geotechnical investigations Prepare detailed design. Obtain Operational Works permits for works in a tidal zone and marine plants Prepare Erosion and Sediment Control plan and install devices Prepare Acid Sulfate Soil management plan and construct treatment areas. Prepare CEMP. Remove mangroves from construction area. Excavate for bridge foundations, treating acid sulfate soil. Install bridge foundations and bridge deck. Construct bridge approaches Reinstate disturbed areas and monitor for mangrove regeneration.
Internal road network – Trans-Island boulevard and associated services Minor road network (collector and access streets) Airstrip	Phase 1 Years 1-3 Years 2-16 As required to service development modules during phases 2 and 3	Confirm design parameters, including design standard and service requirements Conduct survey and geotechnical investigations. Prepare detailed designs. Obtain permit to clear assessable vegetation (*Vegetation Management Act*). Prepare Erosion and Sediment Control plan and install devices Prepare CEMP. Clear vegetation as required within identified road alignment. Install culverts and drainage systems. Construct earthworks Install road base, bitumen surface, shoulder treatments. Reinstate remaining disturbed areas within road alignment with native vegetation

Component	Timeframe	Construction Activities
Power Supply – external, above ground power lines, 12 km	Phase 1 Years 1-3 (in conjunction with upgrade of Foreshores Road and Clarks Road) Phase 2 Years 8-9	Confirm design parameters including exact alignment of power lines. Vegetation clearing to be undertaken with clearing required for road upgrades. Prepare CEMP. Install poles and transmission line. Install transformers and other equipment at connection point. Make connection.
Power supply – internal (underground) Water and wastewater reticulation Gas reticulation	Years 2-25 As required to service development modules during phases 1, 2 and 3 Coordinated with road installation wherever co-located	Confirm design parameters, including design standard and service requirements Conduct survey and geotechnical investigations. Prepare detailed designs. Obtain permit to clear assessable vegetation (Vegetation Management Act). Prepare CEMP. Prepare Erosion and Sediment Control plan and install devices Clear vegetation as required within specified alignment. Clear topsoil and set aside for reuse. Excavate trenches and install power/gas/water as per design. Back fill trenches. Dispose of excess spoil to regional landfill or beneficial reuse if available. Replace topsoil and reinstate in accordance with design
Water and wastewater treatment plants and evaporation ponds	First units in years 1-3 (phase 1). Subsequent units as required to meet population growth	Confirm location and design parameters. Conduct survey and geotechnical investigations. Prepare detailed design. Obtain permit to clear assessable vegetation (if required). Prepare Erosion and Sediment Control plan and install devices Clear vegetation and strip topsoil – stockpile for later use in landscaping. Conduct any excavations and stockpile for reuse on the project. Install plant as per design. Install evaporation pond as per design. Use topsoil for landscaping around plant and evaporation pond.
Boat Ramp – Boyne Channel Associated boat/trailer parking	Year 3	Confirm design parameters, including design standard and service requirements Conduct survey and geotechnical investigations (including ASS identification). Prepare detailed design. Obtain permit to destroy marine plants and assessable vegetation. Prepare Erosion and Sediment Control plan and install devices. Prepare ASS management plan and construct treatment areas. Remove mangroves from construction area.

Component	Timeframe	Construction Activities
		Excavate for boat ramp foundations as per design Install boat ramp and queuing pontoons. Clear vegetation and conduct earthworks for car park. Construct car park. Reinstate disturbed areas and monitor for mangrove regeneration.
Golf Course	Years 7-8	Prepare detailed design, including identification of vegetation clearing requirements and wildlife corridors. Identify appropriate grass species compatible with climate and soils. Apply for permit to clear assessable vegetation (VM Act). Prepare Erosion and Sediment Control Plan and install devices as per schedule. Conduct earthworks and install permanent drainage systems and lagoon systems. Place topsoil/top dressing and sow fairways and greens with selected grass species. Plant remaining areas with selected native species. Maintain temporary erosion and sediment control devices until 80% grass cover is achieved and permanent stormwater and drainage systems are in place.
Buildings	Years 2-16	Prepare detailed design, including identification of vegetation clearing requirement Obtain building permits from GRC. Obtain permit to clear assessable vegetation (if required). Prepare Erosion and Sediment Control plan and install devices Clear vegetation and strip topsoil – stockpile for later use in landscaping. Conduct any excavations and stockpile for reuse on the project. Construct foundations and install site services. Erect buildings. Maintain temporary erosion and sediment control devices. Landscaping of cleared areas with selected native species.

Construction materials are proposed to be derived from existing approved sources located within the local area, such as aggregate quarries, existing manufacturers and business. Typical construction materials to be sourced for PTP will include, but not be limited to concrete, bricks, timber, steel, stone aggregate, glass and plastics. Sourcing of materials for various stages of the proposed project will be at the discretion of the principal contractor awarded at each stage of the project. Raw materials for the project will be obtained from local sources and businesses wherever possible.

An estimated average of 190 jobs per year would be directly generated during construction, with a peak employment of 350 persons. It is estimated that construction will generate an average of 260 direct and indirect jobs per year, and a peak employment of 460 persons. At a State level, the project is estimated to directly and indirectly generate almost 4,700 person years of employment in construction, with an average of 300 jobs per year, and a peak employment of 550 persons.

Construction would create employment opportunities that include skilled and unskilled positions in engineering design, construction supervision and trades, earthmoving, equipment operation, building and landscaping. At a regional level the PTP would provide new opportunities in the building trades for those seeking to leave agricultural activities, particularly in the younger age groups.

The Proponent will develop an overall construction environmental management plan (CEMP), with performance requirements to be applied to individual contractors. Performance requirements will include:

- Standards for erosion and sediment control and management of stormwater
- Management of acid sulfate soils
- Waste minimisation, reuse and recycling and general storage and management of wastes
- Selection and use of sustainable materials
- Minimisation of energy and water consumption
- Dust management
- Vegetation clearing and fauna management
- Weed prevention and control
- Earthworks requirements
- Management of diesel, oils and other hazardous materials, including transport, storage, handling and spill response capability
- Bushfire prevention and response.

Contracts will include requirements to meet all legislative obligations, avoid environmental harm where possible, comply with all conditions of approvals and permits and meet the performance requirements set by the Proponent. Individual contractors will then be responsible for developing and implementing management plans that meet the performance requirements and will be subject to audits and supervision by the proponent's environmental specialists. Penalties for non-compliance, including termination of the contract, will be included in contracts. Contractors will be required to clean up and make good any damage caused by environmental incidents.

ES7.10 Project Costs

Anticipated construction costs for the PTP are anticipated to be $956 Million (at 2013 prices) over the 16 year construction period. A breakdown of anticipated development costs are outlined in Table ES.3.

Table ES.3 - Estimated Construction Costs for the Proposed Development

Cost Item	Cost ($)
Primary Infrastructure	38,000,000
Internal Civil Works Infrastructure	77,000,000
Community Infrastructure	30,000,000
Statutory and Associated Costs	15,000,000
Infrastructure Maintenance Costs	16,000,000
Management costs and Professional Fees	40,000,000
Tourism Infrastructure	560,000,000
Residential Buildings	180,000,000
TOTAL (Excluding interest)	**956,000,000**

ES7.11 Operation and Maintenance

A build, transfer, operate system is proposed for infrastructure and services required for the proposed PTP. Infrastructure and services required for the PTP (including potable water treatment and supply, wastewater treatment and recycled water, stormwater and roads) will be installed by the developer at the developer's cost. The Proponent will transfer the completed public infrastructure to the GRC. The proponent proposes to enter into an operation and maintenance agreement with the GRC to maintain and operate the infrastructure for a period of years to be agreed and until such operation and maintenance costs can be covered by income from rates applied to the developed land.

Management requirements for particular aspects of PTP are as follows:

- Waste Management: Domestic waste management and collection responsibilities will be transferred to GRC following completion of initial stages as part of the gradual hand-over of project responsibilities. Commercial waste management and disposal will be the responsibility of the waste generator, who will engage a licensed recycling/waste contractor to dispose of waste material off-Island.
- Airstrip: Operation of the proposed airstrip will be as a private operation for small/light single turbo-prop aircraft only. Night time use will not be provided for. Airport Operations Procedures will include an overfly restriction over important roosting sites for migratory birds.
- Golf Course: Operation of the proposed golf course will be based on current and future best management practices including the AGCSA (2001) Guidelines and e-par®, which is an ISO 14001-based EMS specifically designed for golf courses. To mitigate potential impacts associated with the golf course, the proponent will develop and implement a Golf Course Management Plan in accordance with AGCSA Guidelines.
- Conservation Area: The conservation area will be maintained, protected and enhanced through a management contract, for the duration of the development period, between the Proponent and an appropriate environmental management company that will also manage the offsets required under QLD VM Act. The GRC will assume responsibility for continuing management of the protected area after expiration of the development period and will introduce a Special

Area Levy on the land owners and businesses on the island to meet the costs of ongoing management.

ES8 Consideration of Constraints and Alternatives

As the PTP is proposed within a SL identified by the Queensland Government for uses including *business, industrial, commercial, residential, tourism and recreation*, there are no alternative locations available for consideration.

While it would be possible to provide an equivalent number of residential and tourism accommodation units elsewhere in the Central Queensland region, and potentially within 45 minutes' drive of Gladstone, the particular attributes of HHI make it favourable over any other location within easy reach of Gladstone. In particular:

- The coastal location provides a micro climate that is more comfortable for tourists and residents, and reduces the need for artificial cooling, minimising energy consumption
- The beach and surrounds are attractive and provide outdoor recreational opportunities that cannot be provided anywhere else on the Central Queensland coast
- The land for the PTP is available and has long been identified by the Queensland Government for this type of development under a special lease.

This combination of features is not available elsewhere on the central Queensland coast between Yepoon to the north and Agnes Waters/1770 to the south.

Since issue of the SL in the 1980s, a range of development alternatives have been proposed for HHI:

- In the mid 1990s, a development approval was granted for a development including 5,000 residential lots, two golf courses, a marina and a hotel and convention centre. The footprint for this development was slightly over 1,000 ha.
- In 2002, investigations were undertaken for a rocket launching facility, in conjunction with a specialist aerospace technology precinct and residential and tourism development.
- In 2011, the Queensland Government approved the HHI Development (HHID), a tourism focussed development consisting of tourism and residential accommodation for up to 4000 people on a footprint of approximately 530 ha.

The current proposal, PTP, represents the outcome of a number of master plan iterations informed by an increased understanding of the environmental values of HHI and surrounding waters. In particular, the footprint has been iteratively revised to avoid areas of high environmental value and minimise direct impacts on areas of moderate environmental value.

Key features of the current Master Plan that reflect this approach include:

- A development footprint of 10% of the total island area

- No disturbance to the coastal area including all coastal wetlands and mangrove vegetation, supratidal salt pans and beaches, except for the proposed bridge and boat ramp which affect less than 0.5 ha. This will protect the vulnerable Water Mouse if it is present on HHI
- No disturbance to the critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and provide for a buffer adjacent to this area. This also protects habitat for the vulnerable black-breasted button quail which is considered highly likely to be present
- No disturbance to the 10 ha patch of *Eucalyptus melanophloia* woodland (classified as 12.12.8 under the Queensland Regional Ecosystem Description Database) that does not occur on other islands within the GBRWHA
- Retention of 229 ha of *Eucalyptus tereticornis* and *E. crebra* dominated forest (classified as 12.12.12 under the Queensland Regional Ecosystem Description Database) which does not occur on other islands within the GBRWHA
- Retention of at least 50% of trees throughout the master plan footprint. This will provide nesting and foraging habitat for native animals including the vulnerable Grey-Headed Flying Fox
- Providing vegetation buffers to sensitive ecosystems
- Providing buffers along ephemeral watercourses within PTP and preserve of existing drainage paths on HHI
- Retaining major east-west habitat connectivity for wildlife movement across HHI. This is particularly achieved by the proposed location of the golf course, the design of the trans-island connector road and the lower density bushland precinct that will provide footprints that are highly permeable to ground dwelling fauna
- Including a water supply and wastewater system that maximises water reuse and limits discharges into the coastal environments
- Providing stormwater systems that ensure that the quantity and quality of stormwater flowing through the existing ephemeral streams to the surrounding marine areas is not significantly changed in rain events up to the 100 year ARI event
- Ensuring that stormwater from the project area will not impact on the coastal vine thicket
- Achieving a high level of visual amenity, consistent with the HHI landscape to minimise adverse impacts on views from the GBRWHA through architectural design and selection of building materials
- Locating elements of the PTP to minimise visibility when viewed from the GBRWHA and restrict building heights so that elements are not visible above the ridgelines or treelines
- Consolidating tourism elements to the northern coastline of HHI and amalgamation of the major tourist accommodation and attractions to provide for ease of management of these areas and enhanced social and amenity aspects

- Minimising human contact with areas that may provide habitat to protected and migratory species.

Feasibility studies have been undertaken on water supply, wastewater management and stormwater management and power supply options. A range of water supply options was examined and it was determined that a mix of roof catchment (rainwater tanks) and desalination would provide the most reliable and lowest impact water supply option.

In relation to wastewater management, the option of discharging treated wastewater was discarded immediately and options examined included various means to reuse greywater and treated wastewater. The preferred option of treating wastewater to a high standard and recycling for use in toilets, irrigation of the golf course and landscape areas and other outdoor uses identified after an assessment of technical feasibility, water balance and environmental and public health risks and benefits.

For stormwater management, the approach was to utilise current best practice measures as set out through Water Sensitive Urban Design. Within this approach, a range of stormwater quality improvement devices were examined to select those that would perform best given the local meteorological and topographical characteristics and the nature of development proposed.

The location for the boat ramp was selected based on utilising an existing disturbed area and hence, alternative locations were not examined.

If the PTP did not proceed, the do nothing option would result in HHI remaining in an unused state. Benefits of the project would be foregone, including:

The no project option would result in HHI remaining in an unused state. Benefits of the project would be foregone, including:

- $925 million direct value added regional income from building and construction
- Domestic, interstate and international expenditure predicted to be $65pa million by 2016 and $95pa million by 2024
- International tourism expenditure (excluding domestic and interstate tourists) to the region of $151.2 million (NPV) over a 30 year period from the date of development inception
- An estimated average of 190 jobs per year from 2015 to 2030 directly generated during construction
- An estimated 300 jobs per year at a state level
- Regional employment opportunities for both skilled and unskilled positions, including in engineering design, construction supervision and trades, earthmoving, equipment operation, transport and building and landscaping
- 700 jobs created by PTP’s tourism activity by 2025
- At a state level, PTP is estimated to directly and indirectly generate up to 850 jobs per annum by 2025

- Access to high quality tourism, residential, and recreational opportunities for existing and future residents of the region, including residents attracted to the region by further development in the State Government's Gladstone State Development Area.

ES9 Project Need and Justification

PTP is proposed for a unique location in that it provides ready access to coastline, beaches, waterways, ocean views and bushland areas. HHI is close to Gladstone for health, transport, education and social services. The location is also unique from the perspective that other areas of the coastline in the region are committed to development for port, mining, national parks and urban uses. HHI is the only location in the Central Queensland area that provides the diversity of settings in relative proximity to a service centre and is available for development. PTP meets the criteria to be considered a "Catalyst Project" under the Central Queensland Tourism Opportunity Plan (2009-2019). The project meets all of the economic objectives of the Gladstone Regional Economic Development Strategy (March 2010) by diversifying the region's economic base, diversifying the community profile, proving needed recreational facilities and adding to the region's appeal as an investment location and as a place in which to work, live and do business.

The PTP will make a major contribution to meeting regional tourist accommodation demands over the next 20 years offering a wide range of accommodation types, from 5 star hotels, serviced and self-catering units and villas through to cabins and caravan park and backpacker accommodation. The resort will appeal to a broad cross section of both domestic and international tourists.

PTP will contribute to a positive image of the area as a destination in its own right for local and international visitors and business people. Estimated tourism expenditure from the project will rise to $80 million per year by 2030. The tourism sector is second only to the industrial and services sector in the region and must be supported to diversify the regional economy.

Over the next 20 years, Central Queensland's regional economy, population growth and investment will continue to be driven by the mining, mineral resources and energy industries which is projected to create over 20,000 local job opportunities in the same period. The Region must present an exceptional social climate as well as a good business climate to successfully compete for business investment and attract people to work in the region. The PTP will offer high quality leisure and accommodation opportunities for the people of the Region and will be a major asset in attracting people to migrate to the region for investment and employment.

ES10 Environmental Characterisation

ES10.1 Topography and Land use

The topography of HHI is characterised by four distinct land units:

- The Main Range unit which consists of a line of low rocky hills, which run approximately north-south across the centre of the island. The highest point on the island is Hummock Hill with an elevation of 126.2 m AHD.

- Undulating plains underlain by acid intrusives occur at the base of the Main Range unit and surrounding areas. They appear as plains merging with the dune areas to the west and east or to the tidal flats to the south.
- Sand dune areas extend from the undulating granodiorite plains to the west, north and east coasts of the island, merging into coastal beaches.
- Tidal areas comprising mangroves and salt flats.

HHI is not used currently used for any economic activity nor have any improvements been undertaken since the SL was issued in 1991. Cleared areas and natural ecosystems in various stages of regrowth comprise the majority of the PTP area. Vehicle access to the Island is possible at very low tide access via a constructed causeway (see Figure ES.8).

Figure ES.8 - Boyne Creek Causeway at Low Tide

There is currently no power, telecommunication (with the exception of intermittent mobile phone coverage), water or wastewater infrastructure servicing the Island.

A Pastoral Lease existed on the Island from the 1870s to 1980. Sheds, fencing and a cattle dip located near the headland, are evidence of former pastoral activities. Land clearing was conducted over much of the Island for maintenance of the pastoral lease and as a source of wood for railway sleepers. Lantana infestation occurred over much of the western portion of the Island in the early part of the 1900s with Government intervention during the 1930s to halt the infestation.

Little cultivation use has been undertaken on the Island except for a few citrus trees near the shack on Hummock Hill. Based on surveys conducted by SKM (2007) in 2005 there is no good quality agricultural land on the Island that would be impacted by PTP. There are no permanent water courses or natural freshwater wetlands on the Island although there are some low-lying areas that receive and hold surface run off. A small constructed dam, located in a saddle of the main ridge bisecting the Island, normally holds water throughout the dry season.

ES10.2 Climate and Natural Hazards

The climate of the HHI area is subtropical with hot wet humid summers and low winter rainfall. Maximum and minimum temperatures range from 32°C to 13°C. Relative humidity varies with the seasons as well as time of day. Mean 9 am humidity is generally greatest in late summer, ranging from a maximum of 72% during February to 65% during August. Mean annual rainfall is approximately 1000 mm per year with highest rainfall recorded during summer months (predominantly associated with storm and cyclonic events). January and February typically receive the highest monthly rain averages with around 170mm/month. During the winter and early spring months mean monthly rainfall generally drops to less than one third of the average summer monthly rainfall totals with the lowest average monthly rainfall of 35 mm/month occurring in August

Winds are predominantly easterlies with the strongest winds recorded during summer from the east. Cyclonic activity in the region of the Island occurs predominantly between January and March. Extreme weather conditions associated with cyclones are severe wind velocities. Extreme rainfall and increased tidal effects (storm surge).

Earthquake risk is relatively minor, but compliance with AS 1170.4 – 2007 and any related standard will be required for all proposed constructions to minimise earthquake effects.

Changes in local weather patterns resulting from climate change have the potential to affect the operation of a project in the future. The DERM (2009b) have published climate change projections for the Central Queensland region including Gladstone. Potential impacts from changes in climate are considered to be:

- An increase in erosion potential during construction due to an increase rainfall intensity
- Increases in tropical cyclone intensity in Queensland
- An increase in water demand as a result of higher temperatures and evaporation
- An increase in demand for air-conditioning due to higher temperatures
- A reduction in storm water design capability due to increased rainfall intensity
- Increased bushfire hazard due to increased temperature and reduced rainfall.

ES10.3 Geology and Soils

HHI is an extension of the mainland Miriam Vale Granite geological unit comprising of a bedrock core of granodiorite flanked by colluvial/alluvial plains which grade into relict beachridge or foredune strandplains on the ocean side of the Island and intertidal saltflats and mangrove muds on the landward side of the Island. The relict beach ridges and foredune strandplains consist of Holocene age sand ridges and inter-ridge swales probably formed during the mid to late Holocene sea level “stillstand”, the relatively stable sea level period from about 6,500 years before present (yr BP) to the present day. PTP will be developed on approximately 12% of the relict beach ridge systems.

There is a Mineral Occurrence/Inactive Prospect, No. 486524 HHI for mineral sands contained in the strandplains. The project would prevent 12% of the Island's identified mineral sands resource from being exploited. There are no current Exploration Permits or Mining Permits over the deposits.

Soils within the proposed development area range from sandy (gleyed) podzolic soils on within the relict beach ridge system to sandy to loamy surface (hardsetting) duplex soils on colluvial plans to deep brown, yellow brown or mottled duplex soils and sodosols on the Miriam Vale granite. Many of the soils within the proposed development footprint are classified as high erosion risk. Acid sulfate soils exist within the proposed bridge and public boat ramp footprints. Further investigation of acid sulfate soils will be conducted prior to works in accordance with QASSIT guidelines and acid sulphate soil management plans developed to manage and minimise any impacts.

Minor land contamination exists associated with the former cattle dip and fuel storage areas of the former homestead located on the northern headland. Further investigation and remediation of these areas will be conducted during the proposed construction program.

ES10.4 Water Resources

ES10.4.1 Surface Water

There are no natural permanent freshwater resources on HHI. A farm dam constructed on an ephemeral watercourse contains water for most of the year and constructed turkey's nest dams and some natural depressions contain water for some period after rain.

All watercourses are highly ephemeral and only flow during storms. Channel widths within these ephemeral watercourses are typically less than 2 m wide and become discontinuous in some areas, including as channels approach the coastline. Channels are poorly defined and ponding does not occur after periods of flow during and following rainfall events. Almost all stormwater runoff flows to Colosseum Inlet and Boyne Creek.

There is no distinct riparian zone along watercourses draining the central ridgeline or along channels crossing the colluvial plains. Vegetation associated with these watercourses consists of the same vegetation types as surrounding land, i.e. grasses and tree re-growth. An assessment of ecological value for these watercourses returned a low ecological value, with water dependant vegetation being absent.

Two ephemeral watercourses are also present in the beach ridge systems east and west of the northern headland. The ephemeral watercourse east of the northern headland is a sandy and muddy swale extending 300 m to the east from headland. The second ephemeral watercourse is in the beach ridge system west of the headland, originating at the break of slope below the headland and approximately 100 m from the shoreline and forms a broad 1km long swale (approximately 50 m wide) with no distinct channel definition. An assessment of ecological value for these ephemeral watercourses returned a medium ecological value, with some riparian vegetation, saltmarsh and mangrove vegetation being present. However, these watercourses are not considered to provide any habitat for listed threatened or migratory species due to the ephemeral nature, small size and dense vegetation.

Current sources of contamination are minimal as vegetation cover has largely been re-established over areas cleared for grazing. There is some minor soil contamination associated with a former cattle dip and other farming activities south of the headland.

ES10.4.2 Groundwater

The only notable groundwater resource identified on the Island is associated with the unconsolidated quartzose dunal sands and marine sediments located in the eastern and western sections of the Island. In both areas aquifer conditions were unconfined with a saturated thickness of less than 10m (typically 1 – 4 m). Surveys found groundwater approximately 0.5 to 5 m below surface. Groundwater movement was found to be generally toward the coastline, however saline intrusion was also detected closer to the coast. Isolated areas of fresh groundwater (<1,500 µS/cm) were found within beach dunes and at the eastern and western ends of the island. Groundwater recharge occurs primarily through rainfall infiltration with losses caused by beach face seepage and evapo-transpiration by vegetation. Groundwater dependant ecosystems are found at the break of slope of low hills in the southern areas of the Island due to the shallow soils and relative impermeability of the underlying bedrock. These areas are generally indicated by *Melaleuca* spp.

ES10.5 Coastal and Marine Environment

Coastal landforms and landscape character units of the island are:

- Coastal Headland, located on the northern tip of the Island, formed from granodiorite
- Fore dunes and beaches located along the northern coastline of the Island consisting with a general transition of *Spinefex spp.*, *Casuarina spp.*, *Pandanus spp.* and *Melaleuca spp.* to littoral vine forest and open eucalypt woodland
- Tidal Flats located within Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek consisting of intertidal banks and bars with seagrass meadows, a band of mangrove species and supratidal saltpans.

Both the Island coastline and adjacent mainland coastline have extensive intertidal wetlands (resources) consisting of:

- High Intertidal/Supratidal Claypan Flats
- Mid-tidal Mangroves
- Low Intertidal/Shallow Subtidal Mud Flats and seagrass meadows
- Low Intertidal Rocky Outcrops
- Subtidal Creek and Channel Floors with predominantly muddy bottoms.

The Island also has open coastal habitats that predominate on the northern side, consisting of:

- Sand Beaches
- Low Intertidal/Shallow Subtidal Spits, Banks and Shoal;
- Rocky Reefs and Stacks
- Offshore Subtidal Areas with mostly sandy bottoms
- Offshore Disturbed Areas (Port of Gladstone channel and dredge spoil ground).

Both Colosseum Inlet and Seven mile Creek are tide dominated estuaries with limited influence from freshwater flows. With little freshwater flow into the estuaries, stratification of denser saline layers and less dense fresh water is not found under normal dry weather conditions. Tidal mixing and marine water exchange are the dominant processes governing water quality within the estuaries surrounding HHI. Periodic storm events cause ephemeral watercourses to flow and discharge freshwater laden with suspended sediments, carbon and nutrients into the estuarine system via three main tidal channels/creeks in Boyne Creek and Colosseum Inlet. These stormwater flushes provide an important additional source of nutrients and carbon for the adjacent estuarine ecosystem around the Island which acts as a carbon and nutrient sink, cycling these products through the ecosystem. Existing water quality in Boyne Creek, Colosseum Inlet and marine waters seaward of the Island exceed the Central Queensland region water quality guidelines for nutrients and some physico-chemical parameters.

HHI has 438 ha (mapped as 12.1.3 under the Queensland Regional Ecosystem (RE) classification system) of mangroves primarily in Colosseum Inlet and Boyne Creek. 85% of the mangroves are *Rhizophora*. The total area of mangroves in Colosseum Inlet was mapped at 4,410 ha.

Erosion prone areas (Coastal Management Zones) on the northern coastline of the Island are not part of the SL for the proposed development. Public infrastructure, such as beach access and stormwater drainage (west of the northern headland) will need to cross these areas. The existing erosion prone area west of the northern headland provides protection for up to a 100 year storm recurrence. Marine infrastructure within the estuarine and coastal environment around HHI includes the existing causeway access to the Island at the end of Clarks Road and public boat ramps/access points at Turkey Beach, Foreshores Estate and Wild Cattle Creek.

The National Land and Water Resources Audit (NLWRA 2001) classifies Colosseum Inlet as a 'near-pristine' estuary with a 'slightly affected' ecological status. The Port Curtis Integrated Monitoring Program (PCIMP) monitoring program found water quality in the area of HHI met ecosystem health indicators most of the time. Estuarine and coastal waters of HHI are contained in the Baffle Creek catchment which has an area of 3,996 km^2, of which 80% is cleared for agricultural purposes, mainly pastoral activities.

Results of water quality sampling for nutrients in Colosseum Inlet and marine waters north of the Island returned concentrations of key nutrients such as ammonia, nitrogen oxides and phosphorous that exceed WQO and ecosystem health values for these waters. This is likely to arise from nutrient laden runoff from disturbed catchment areas.

Seagrass meadows in Port Curtis and Rodds Bay cover approximately 12,000 ha. The meadows provide important habitat and food for marine turtles, dugong, fish, crabs and prawns. The value of the seagrasses to dugong has been recognised by the declaration of the Rodds Bay Dugong Protection Zone B. A number of surveys of the seagrass meadows within Port Curtis and Rodds Bay have been undertaken since 2002. Annual monitoring programs commenced in 2009 for monitoring the impacts of the major port expansion and industrial development in the northern areas of the Port of Gladstone. A detailed survey of intertidal and subtidal seagrass beds around HHI and in Rodds Bay in November and December 2002 Identified intertidal and deep-water (>5m depth) seagrass beds in locations within Colosseum Inlet, Boyne Creek, Seven Mile Creek and Rodds Bay. The area of these seagrass beds ranged from 0.1 to 484 ha. Most beds were composed of aggregated patches, meaning that the seagrass meadow consisted of numerous patches of seagrass separated by gaps of unvegetated sediment.

In 2009 the then Queensland Department of Employment, Economic Development and Innovation (DEEDI) commissioned a further seagrass survey which found that the distribution of seagrass areas in Port Curtis and Rodds Bay were similar to those observed in 2002, however there had been a 10% reduction in area, mainly within the deep water meadows. The report concluded that this loss was climate related and that the variability of the seagrass coverage from year to year was primarily caused by changes in rainfall, river discharges and temperature.

Several rocky reefs are present in near shore waters located 4.5 km north of HHI, in particular Seal Rocks 2 km northeast of Northern Headland and Creek Rocks 1.3 km northeast of Sandfly Creek. Seal Rocks and Creek Rocks are both classified as HPZ under current GBRMPA Zoning. A rocky reef, identified as “Hummock Hill Reef” by Alquezar *et al.* (2007), extends a distance of approximately 900 m parallel to Main Beach, from about 200 - 900 m offshore. These reefs have some coral and algal cover.

A number of aquatic species are listed under either State or National conservation legislation that either inhabit or migrate to or through Rodds Bay and Colosseum Inlet. Marine mammals such as dolphins and dugong are known to either migrate through or inhabit the Rodds Bay area. The latest significant survey of marine megafauna species in the area was carried out for the *Report for Marine Megafauna and Acoustic Survey -November 2011*) (GPC 2011). The survey provides baseline information on the marine megafauna species between Port Alma, Port Curtis and Rodds Peninsula. The largest numbers of megafauna were observed in Rodds Bay and Port Curtis.

Sightings of Indo-Pacific humpback dolphins were recorded across the survey area. A total of 34 snubfin dolphins were observed, all to the north of Curtis Island. It appears that this area is the snubfin dolphin’s most southerly limit on the east coast of Australia (Cagnazzi 2011), with no documented snubfin dolphin sighting records from the Narrows, Port Curtis or Rodds Bay in recent years.

Anecdotal evidence from local commercial and recreational fishermen indicates that dugongs have been seen within Colosseum Inlet and Seven Mile Creek, though not frequently. *Report for Marine Megafauna and Acoustic Survey -November 2011* (GPC 2011) sighted one dugong off the eastern tip of HHI in the Feb/March and one dugong in Boyne Creek during high tide in the June surveys.

Marine reptiles that occur or may occur in waters adjacent to HHI include sea turtles, sea snakes and the saltwater crocodile. The EPBC Act Protected Matters Report (refer to Appendix C1) lists five species of sea turtle that may occur or have suitable around HHI. Turtle species that are confirmed to occur within the vicinity of HHI include the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), and flatback turtle (*Natator depressus*). A 2006 Qld PWS survey confirmed low-density nesting activity (two fresh tracks and five old tracks) by flatback turtles on HHI, on the beach, east of the northern headland. Anecdotal evidence from the local community suggests the presence of saltwater crocodiles (*Crocodylus porosus*) within the Colosseum Inlet and Seven Mile Creek Systems, though population numbers are thought to be very low and a recent survey by Queensland government did not identify any crocodiles south of the Fitzroy River.

The coastal waters of the Curtis Coast lie on the zoo-geographical boundary between northern tropical waters and southern temperate waters, leading to a large biodiversity within the regions fisheries (Olsen *et al.* 1980). Surveys found 19 estuarine/coastal fish species and 10 reefal/pelagic species were targeted by recreational and commercial fisheries within waters around HHI. Reference to the Qld DPIF Declared Fish Habitat Summary for Colosseum Inlet notes barramundi, blue salmon, bream, estuary cod, flathead, grey mackerel, grunter, jewfish, king salmon, mangrove jack, queenfish, sea mullet, school mackerel, whiting, banana prawns, endeavour prawns, king prawns, mud crabs as being key fisheries values.

Video surveys by Rasheed *et al.* (2003) revealed medium-density macroinvertebrate communities on rubble reefs surrounding Seal Rocks, dominated by bryozoans, hard corals, hydroids and echinoids, with a low density (<6 individuals per site) of colonial hard corals and a medium density (6-20 individuals per site) of solitary hard corals.

Recreational fishing in the waters of Colosseum Inlet and Boyne Creek consists predominantly of line fishing and crab-pot setting (Dames & Moore, 1995). Access to local waters is typically via boat ramps from Foreshores estate, Boyne Island, Tannum Sands, Turkey Beach and the causeway at the end of Clarks Road. Mud crabs are the main species targeted within Colosseum Inlet and Boyne Creek by commercial operators. The average mud crab annual fishery value (2012) is $244,985 for the survey grid sites around HHI. The waters offshore of the Island are exploited by otter trawlers of the East Coast Trawl Fishery (ECTF) targeting species such as banana prawns and scallops. Combined, the estimated mean annual commercial value of this fishery in the offshore waters adjacent to Island was $86,523, for a total of 8.8 tonnes landed by 10 boats over 50 days' effort per year.

ES10.6 Terrestrial Environment

The ecological features of HHI have been surveyed extensively over a period of 20 years with supplemented by additional survey work undertaken in association with other coastal projects within the Curtis Coast Region of Queensland. This section discusses the general terrestrial ecological values of HHI, while MNES values are discussed in Section ES11.

Mapping produced by Queensland government identifies 14 Regional Ecosystems on HHI. Vegetation surveys by Central Queensland University, SKM and Greening Australia confirmed the mapping. Two

Endangered Regional Ecosystems are known from the Island, namely Queensland Blue Gum on alluvium (RE 12.3.3) and Poplar Box on alluvium (12.3.10). Two regional ecosystems are not present on any other islands within the WHA, namely *Eucalyptus melanophloia* woodland (12.12.8) and *Eucalyptus tereticornis* and *E. crebra* dominated forests (12.12.12). Essential habitat is vegetation in which a species has been known to occur that is endangered, vulnerable, rare or near threatened (EVNT). Qld DNRM maintains a database of Essential Habitat Factors for all Endangered, Vulnerable and Rare taxa in Queensland.

HHI is mapped as containing Essential Habitat for the koala (*Phascolarctos cinereus*) and the wallum froglet (*Crinia tinnula*). Neither species has been recorded during five separate fauna surveys despite targeted surveys. Mapping accompanying DotE's *Significant impact guidelines for the vulnerable water mouse* Xeromys myoides (DEWHA 2009d,e), indicates a known population of water mouse on the eastern end of HHI, however surveys of suitable habitat at the proposed bridge have not identified this species as occurring within the development footprint.

The studies recorded 103 terrestrial plants species on the island but did not find any flora species listed as Endangered, Vulnerable or Rare (EVR) under the *EPBC Act (1999)* or *Queensland Nature Conservation Act (1992)*.

A total of 12 threatened species were identified within the EPBC Act protected matters search undertaken in November 2013. Wildlife Online records showed that there were no records of threatened species within one kilometre of HHI and ten records of EPBC listed species within a 25 km search area. Of these ten species, two are known to occur (flatback turtle and loggerhead turtle) and two are suspected to occur due to suitable habitat (water mouse and black-breasted button quail). Detailed surveys, undertaken over a period of 20 years, found that HHI has low fauna species diversity, likely due to a combination of the lack of permanent freshwater on the island, being fully isolated from the mainland and impacts of historic grazing and burning regimes on habitat for ground-dwelling fauna.

Thirty-three species of mammal have been recorded from surveys on the Island. A single threatened species, the grey-headed flying fox, which is listed as Vulnerable under the EPBC Act, was observed foraging on the island, but no roosts of this or any other bats (flying fox or microbat) species were observed.

125 species of avifauna have been recorded from surveys on HHI. The diversity of species observed is typical of a coastal habitat mosaic which includes terrestrial and marine ecosystems. Threatened species recorded are beach thick-knee, little tern and eastern curlew, while signs indicative of black-breasted button quail have also been observed. There is no suitable habitat for these species within the development footprint and the interface between the development and suitable habitat areas is to be managed to minimise edge effects and light spill that might degrade adjacent habitat.

A total of fourteen terrestrial reptile species has been recorded from the Island. None of the species recorded are considered to be rare or threatened in Queensland or at a National level. A total of five amphibian species has been recorded from the Island by the collective surveys of Bill Carter and Associates in 1988 (reported in AGC Woodward-Clyde (1993)), AGC Woodward-Clyde (1993), Dames

& Moore (1995), CQU (2006) and SKM (2007).None of the species recorded are considered to be rare or threatened in Queensland or at a National level. A substantial nocturnal survey effort has been expended by numerous observers over an extended period, indicating that the low diversity of species recorded is indicative of low habitat quality.

A number of migratory terrestrial, marine and shorebirds have been observed on and around HHI and these are discussed in Section ES11.4.

ES10.7 Landscape and Visual Amenity

Six broad land form patterns are represented on HHI (based on MacDonald *et al.* (1990)) as shown in Table ES.4.

Table ES.4 - Landform and landscape Patterns on Hummock Hill Island

Landform Pattern	Landform and Landscape
Beaches	Very gently inclined to gently inclined aggraded slopes at <5%, occasionally gently undulating plain with a wave built berm at the slope crest, intertidal. Foredunes consist of gentle sloping and undulating land to very steep embankments. Along the front of the dunes low lying pioneer species such as coastal spinifex and creepers dominate Behind the pioneer species low shrubs and trees such as coastal she oaks at a height of approximately 5 m grade into littoral vine forest greater than 5 m
Tidal Flats	Very gently inclined to gently inclined aggraded gently undulating plain, intertidal. Vegetation is distinct from the sandy regions with salt marshes, mangrove communities, sand and mud flats, and intermittent low density sea grass communities
Sand Plains	Very gently inclined to gently inclined aggraded gently undulating plain with relict parallel beach ridges with slopes between 5-10%. *Eucalyptus tereticornis* dominated forests *Dry melaleuca* spp. woodlands present in the lower swales
Low Hills	Gently inclined to moderately inclined eroded rolling rises with slopes between 10-20% on granodiorite with occasional tors. Open canopy cover dominated typically with mixed eucalypt woodland with grassy understorey and occasional herbs. Occasional melaleuca in lower—lying and depressional areas; casuarinas occur towards the seaward fringe Below the east facing foot slopes of Hummock Hill the gently sloping outwash plains dominated by poplar box and blue gum. Vegetation is considered “advanced re-growth” after the area was selectively cleared when the island was used for pastoral activities and logging The evidence of past pastoral activities is scattered throughout the LCU typified by abandoned fences, drains and turkey nest dams Tree heights are generally above 10 m in height
Central Ridge	Moderately inclined to steep ridge with slopes greater the 20% with a crest leading to maximal upper slopes that lead into waning mid and low slopes, eroded, steep low hills to steep hills with drainage depressions and ephemeral creeks. Partially cleared with mixed open canopied eucalypt woodland on the steeper and lower slope areas predominately ironbark species with a predominantly grassy understorey. Broken views are available from the ridgeline Tree heights are generally 8 - 15 m in height

HHI and Hummock Hill itself have distinctive landscape characteristics which are more in common with the adjacent mainland and estuary system than with the Great Barrier Reef. Offshore islands make a significant scenic contribution to GBRWHA scenery in many parts of the GBRWHA but that is not the case for HHI which is close to and appears part of the mainland as viewed from most viewpoints. In general, there are few attributes of aesthetic World Heritage values to be seen along this part of the Queensland coastline nor in the HHI study area in particular. A study of the aesthetic values of the GBRWHA did not identify any special places within 40km of HHI (Context, 2013).

The landscape characteristics and features of the coastline in this local area are visible from offshore as the background to GBRWHA waters, and to that extent they make some contribution to the aesthetic World Heritage values. Landscape viewsheds from key vantage points (sensitive view receptors) around the Island are defined by the topographic height of the landform, identifying and what land is likely to be seen from a certain point. The sensitive receptors identified for the PTP include:

- The Esplanade and beach at Tannum Sands
- Bangalee
- Clarks Road
- Mundoolin Rocks
- The marine waters of the GBRWHA
- Gladstone Harbour
- Aerial view

From most viewpoints HHI is not perceived as an island distinguishable from the mainland, although it contributes to the overall diversity of scenery and island land forms. The only attribute which is well represented on HHI are the mangroves, which are part of the extensive Colosseum Inlet system of intertidal wetlands

As seen from the air (looking northwards), the district coastline is visually dominated by large industrial and port structures, ships, and the urbanised and industrialised context of Gladstone, Boyne Island, Tannum Sands and the township of Turkey Beach. Passengers on commercial flights into and out of Gladstone have views of HHI from high altitudes (generally 1.5 to 3 km) and for short periods of time, and other commercial flights along the coastline are at higher altitudes (up to 8 km). At these heights, the ‘island’ nature of HHI is not readily apparent, and it appears to be part of the adjacent mainland.

HHI contributes marginally to aerial vistas and scenic diversity in that its terrestrial areas are undeveloped and vegetated. The adjacent Colosseum Inlet, with its attractive estuarine pattern of mangrove-lined channels, makes a more significant contribution to aerial vistas.

ES10.8 Air Quality Nose and Vibration

The existing conditions within the local environment are primarily natural sources, including particulates from ocean salt spray and wind transport of soil from exposed areas. Due to its coastal location, HHI is generally considered to have relatively good air dispersion conditions.

The identified sensitive receivers are restricted to small communities such as Mundoolin Rocks, south of the Island and Bangalee on the south eastern tip of Wild Cattle Island and transient visitors within the local estuarine system.

The main potential for construction phase air quality impacts is likely to arise from dust generation during earthworks and vehicle movement over unsealed surfaces and would occur following the initial stages of construction, as residential receivers begin to inhabit the island.

Provided appropriate dust management measures are incorporated as part of proposed earthworks and construction, impacts on adjacent vegetation communities and ecosystems are expected to be managed to acceptable levels. However, further investigation into potential dust impacts and appropriate mitigation strategies specific to the types of construction methods to be employed would be undertaken by the construction contractor(s) during further design development. Mitigation measures will be provided considered in the development of detailed air quality management plans.

Construction and operation of the developed Island has the potential to generate greenhouse gas emissions. Construction activities generating greenhouse gas emissions include the use of diesel powered construction equipment, the transportation of materials to and from site and electricity consumption for construction related activities and site services.

Greenhouse gas reduction measures during construction and operation of the HHI development will aim to maximise energy efficiency in line with measures such as the Building Code Australia strategies (2003). This will include sourcing supplies that are located close to HHI, using renewable energy for site amenities and minimising waste generation.

The existing noise environment at the site is typical of a rural environment, dominated by: insects, birds and other wildlife; wind rustling leaves; and wave noise from the nearby ocean. Some transient noise from visiting boats and leisure craft would also contribute to the noise environment within the area surrounding the proposed development. Distant noise from occasional aircraft over flights on their approach to and departure from Gladstone may also occur on occasion.

Sensitive sites to the development are likely to be residences and holiday homes at Bangalee on the southern tip of Wild Cattle Island, residences at Mundoolin Rocks and isolated rural residential properties adjacent Clarks Road, Foreshores Road and Turkey Beach Road.

Potential noise and vibration generation from construction activities will be variable, depending on the stage of works, type of equipment operating at a particular time and the proximity to sensitive noise receptors.

The main noise and vibration impacts during construction on HHI are likely to be from the use of heavy equipment for transport, earthworks and vegetation clearing and other civil works following construction of early stages of the development and as tourist and residential accommodation expands. To limit the potential for noise and vibration impacts the Construction Contractor would be responsible for managing construction activities and ensuring that the construction environmental management plan includes minimisation of noise and vibration emissions.

Operational activities also have the potential to cause noise and vibration impacts at the new residential areas. Further investigation of detailed noise management measures will take place as part of a detailed design for the project components and management measures, including appropriate siting of noise generating items to maximise shielding provided to residences and restricting potentially nuisance noise sources to least sensitive times of the day, would be incorporated to ensure that noise and vibration impacts are not significant.

ES10.9 Cultural and European Heritage

The traditional owners of HHI are the Gooreng Gooreng and Gurang people.

Areas of indigenous cultural heritage and non-indigenous cultural heritage have been identified within the development footprint, especially adjacent to and within the proposed northern bridge abutment, headland holiday homes and village precinct which coincide with area of high indigenous cultural heritage significance. Seven sites and places of cultural heritage significance were detected through a field survey and a search of the [then] DNRW administered Register and Database. Five of these sites or places are within the proposed development footprint. A low potential for further items or sites of high or exceptional cultural/archaeological significance exists within the study area. There is likelihood for further historic items of low to moderate significant to exist, particularly around the former Homestead Complex on the northern headland.

A Cultural Heritage Management Plan (CHMP) has been signed between Eaton Place and the traditional owners and registered with the Queensland Government. Assuming the recommendations made in the Cultural Heritage Impact Report are suitably implemented, the nature and level of potential impact by the PTP will be acceptable in terms of impact to appropriately significant cultural heritage sites and places within HHI.

The first known records relating to the European tenure of HHI include an 1877 telegraph from Mr Thomas Farmer, requesting clarification of the nature of land tenure for ‘Hummocky Island’ to the Under Secretary for the Lands Department in Brisbane. Pastoral Leases were held by various parties from 1878 to 1991, when the Pastoral Lease was converted to a Special lease for development purposes. The leaseholders used the island for cattle grazing and timber.

Probably the greatest effect on the Island and its landscape was lantana infestation. First reported in 1905, by 1917 the situation threatened the viability of pastoral lease on the Island. The Queensland Government released trial flies introduced from Honolulu onto the Island in 1917, in an attempt to eradicate the lantana. This trial was conducted in conjunction with additional conditions imposed on the leaseholders to clear large areas of land on the Island and keep them clear.

Application to ring bark 2000 acres of gum and Moreton Bay Ash at the north of the Island was administered in 1917. In the ensuing years a majority of the island was cleared. Field surveys in 2007 revealed no infestation of lantana. On-line searches of the Register of the National and Commonwealth Heritage Registers, Register of the National Estate and the Queensland Heritage Register web sites revealed no sites of historic significance have been recorded in these databases within the study area.

ES11 Assessment of MNES Values

ES11.1 Commonwealth EPBC Act Protected Matters

Table ES.5 provides the results of the search of the Commonwealth EPBC Act Protected Matters Database for the area around HHI.

Table ES.5 - Results of Conservation and Protected Areas Searches for HHI and Surrounds

Matters Of National Environmental Significance	No.	Details
World Heritage Areas	1	Great Barrier Reef
National Heritage Places	1	
Wetlands Of International Significance (Ramsar Sites)	None	
Great Barrier Reef Marine Park	Adjoins	Northern coastline of HHI adjoins General Use Zone, Habitat Protection Zones within 2 km.
Commonwealth Marine Areas	None	
Listed Threatened Ecological Communities	None	
Listed Threatened Species	34	Refer to Appendix C1
Listed Migratory Species	50	Refer to Appendix C1

ES11.2 Great Barrier Reef World Heritage Area and National Heritage Place

HHI and surrounding waters, to the low water mark on the mainland coast, are part of the GBRWHA/NHP. World heritage listing indicates a site of global importance and OUV when considered as a whole. In Australia, world heritage properties are also automatically listed as national heritage places.

Some of the key features that contribute to the global importance of the GBRWHA include:

- The Great Barrier Reef is the world’s most extensive coral reef ecosystem
- The reef extends nearly 2300 km from north to south and the latitudinal extent of the reef means that it crosses a number of climatic zones which has led to significant ecological diversity
- The longitudinal extent of the reef is also large, with a width up to 250 km offshore, encapsulating the entire cross section of the continental shelf from low water mark on the

Queensland coastline to oceanic waters over 2,000 m deep. This also contributes significantly to the ecological and geological/geomorphological diversity of the GBRWHA.

- As a consequence of its extent, range and complexity of habitats available, the GBRWHA is considered to have the highest biodiversity of any world heritage area. There are a range of endemic species present in the GBRWHA and the WHA also provides habitat to a range of listed threatened species.
- In addition to the overall geological, geomorphological and ecological diversity of the GBRWHA, the WHA includes a large number of individual sites and features that display unique or very high values in terms of natural beauty, geological and geomorphological formations and plant and animal habitats or associations. (UNESCO June 2012a)

While the unique coral reef ecosystem is the central focus of the GBRWHA, the WHA encompasses a wide range of other features and habitats that provide a buffer to the coral reef ecosystem, support overall ecological services that are maintain the health of the coral reef ecosystem and in themselves, feature unique or very high value features that contribute to the overall OUV of the WHA.

HHI is one of over 600 islands located within the GBRWHA. Key values that the islands of the WHA contribute to the overall natural diversity of the GBRWHA include:

- Geomorphological features
- Flora and fauna
- Aesthetic values
- Record of significant natural processes (MICDA/MINCA 2004).

The Great Barrier Reef ecosystem satisfies all four of the natural environment criteria for world heritage listing. An assessment of the contribution that HHI and surrounding waters makes to each of the criteria and to the overall outstanding universal value, is provided in Table ES.6. Assessment of importance is based on the criteria for significance assessment identified in Section 1.7.4.

Table ES.6 - Contribution of HHI and Surrounding Waters to the OUV of the GBRWHA/NHP

Criteria [(1)]	Key contributions of HHI and surrounding waters to OUV
Criterion vii: contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	HHI and surrounding waters feature a minor expression of some aesthetic values based on the presence of low profile coastal panoramas, with some disturbance due to industrial development at nearby Boyne Island. HHI is therefore of lower importance for this criterion. A recent study of aesthetic values of the GBRWHA did not identify any special places, values or attributes associated with HHI and the surrounding area, with the nearest such features being Curtis Island/the Narrows, 40km north of HHI and the Capricorn Bunker Group, which lies 50-150km offshore from HHI. HHI is of **lower importance** for this criterion and makes a minor contribution to the OUV of the GBRWHA.
Criterion viii: Outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features	In relation to this criterion there is a minor expression of several features that contribute to the OUV of the GBRWHA present at HHI and in surrounding estuarine waters: ▪ Minor expression of coastal geological and geomorphological changes and estuary formation ▪ Minor expression as an example of a continental island ▪ Minor expression of geological and geomorphological processes in formation of coastal beaches and sand dunes, intertidal mud flats and tidal creeks. HHI does not feature any unique or unusual landscape or geomorphological features at either a regional or WHA-wide scale that make a contribution to the OUV of the GBRWHA. A recent study of geological and geomorphological features of OUV in the GBRWHA did not identify HHI as being either "representative" or "best" example of a continental island, nor were any other important geological and geomorphological features identified on or around HHI. Features on the mainland coast, which lie outside the GBRWHA boundary also contribute to these values. Expressions of these values are present and protected at the nearby Eurimbula National Park. HHI is of **lower importance** for this criterion and makes a minor contribution to the OUV of the GBRWHA.
Criterion ix: Outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals	In relation to this criterion, minor expressions of some features that contribute to the OUV of the GBRWHA are considered present as follows: ▪ Minor expression of the relationship between coastal geomorphic processes and environmental processes ▪ Minor expression of erosion and accretion processes in relation to sand banks and beaches ▪ Minor expression of relationship of local Aboriginal groups to the natural environment as evidenced through shell middens and artefact scatters in locations such as sand dunes and ephemeral wetlands. Minor evidence of post-settlement use as a grazing property. On this basis, HHI is of **lower importance** for this criterion and makes a minor contribution to the OUV of the GBRWHA.
Criterion x: Contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation	In relation to this criterion, HHI and surrounding waters make a minor or moderate contribution to the OUV of the GBRWHA based on features as follows: ▪ Minor expression of biodiversity, supporting a wide range of plants and animals typical of the Capricorn/Mackay region, including some threatened species and a threatened ecological community, as well as several vegetation communities not well represented elsewhere in the GBRWHA ▪ Regionally important expression of shallow intertidal and subtidal mangrove, seagrass and mud flat habitats

Criteria [1]	Key contributions of HHI and surrounding waters to OUV
	■ Regionally important expression in relation to dugong habitat, with the wider Rodds Bay DPA supporting 5-10% of the southern GBRMP population of Dugong. ■ Minor expression as habitat for the Indo-Pacific humpback dolphin. ■ Regionally important expression as habitat for green, flatback and loggerhead turtles, with minor nesting by flatback turtles occurring some years ■ Regionally important expression of floristic diversity, with two vegetation communities that, while present on the adjacent mainland, are not well represented elsewhere in the GBRWHA. These features make minor or moderate contributions to the OUV of the GBRWHA. In addition, internationally (eastern curlew) and nationally (all other species) important roosting and feeding sites for migratory shorebirds make a major contribution to the OUV of the GBRWHA. On this basis, HHI is of **moderate importance** for this criterion when considered overall. Migratory shorebird habitat and critically endangered regional ecosystem are considered of **highest importance** as individual features.

(1) UNESCO June 2012a (see also Appendix C2)

The need to encompass all of the elements that contribute to the OUV of the GBRWHA has led to the boundary of the GBRWHA extending well beyond the reef ecosystems themselves to include areas that, while not of themselves containing the superlative phenomenon and unique features reflected in the statement of OUV, are important in maintaining the OUV of the GBRWHA (Lucas et al, 1997). Thus, by providing habitat for animals that move through wide geographic ranges or rely on inshore and estuarine environments at various stages of their life cycle, the waters surrounding HHI contribute to the integrity of the GBRWHA.

Management and protection of the terrestrial world heritage values of HHI occurs through Queensland legislation and policies. The proposed PTP received approval from the Queensland Government in February 2011, through the release of a Coordinator-General's report under the *Queensland State Development and Public Works Organisation Act 1971*. Management and protection of waters around HHI is through joint management of the Great Barrier Reef Marine Park Authority, in respect of the GBRMP component and the Queensland Government in respect of the GBRCMP component.

ES11.3 Listed Threatened Species and Communities

HHI features 190 hectares of vegetation that generally meets the criteria for a critically endangered ecological community system, *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*, although the vegetation has not been identified on mapping prepared by the then Department of Environment, Water, Heritage and the Arts (DEWHA 2009g) and was not identified in the Protected Matters Search Report (Appendix C1 to the EIS). This community exists as a mosaic with *Corymbia spp.*, *Eucalyptus spp.*, *Acacia spp.* open forest to low closed forest and is in moderate condition, with some significant rubber vine (*Cryptostegia grandifolra*) invasion. The total area of Vine Thicket/ with *Corymbia spp.*, *Eucalyptus spp.*, *Acacia spp.* open forest to low closed forest mosaic on HHI is approximately 190 ha in two patches behind the island's northern shoreline.

The remnant extent of this ecological community in the SEQ Bioregion was 1,977 ha in 2003, from an estimated pre-clearing extent of 2,993 ha (TSSC 2008(a)). While it does not appear that the patches on HHI have been included in this inventory, the patches on HHI represent about 10% of the total bio-regional extent and are highly significant, in spite of degradation from weed invasion.

As this is an example of a critically endangered regional ecosystem, the ecological community is considered to be of highest importance against the criteria for importance in the methodology for this assessment (see also Section ES6).

A search of the Australian Government protected matters database together with searches of Queensland Government databases and results of surveys undertaken on and around HHI has identified eight EPBC listed threatened species that are known or likely to occur. These species, together with occurrence and characteristics are summarised in Table ES.7.

Table ES.7 - Listed Threatened Species

Value	Description	Importance
Water mouse *Xeromys myoides*. Vulnerable	Mapping accompanying SEWPAC's Significant impact guidelines for the vulnerable water mouse (DEWHA 2009d,e), indicates occurrence on the eastern end of HHI. Suitable habitat exists but there are no known populations in the vicinity of the proposed PTP and trap surveys at the location of the proposed bridge and boat ramp did not capture any water mouse. Water mouse utilises intertidal habitats and feeds on invertebrates gleaned from mudflats. Key threats include loss of habitat, disruption of food sources due to poor water and sediment quality and predation. These threats are largely absent from HHI.	Lower-moderate importance
Black-breasted button quail *Turnix melanogaster* vulnerable	Considered likely to occur due to suitable habitat (coastal vine thicket) and sighting of "platelets" and scats characteristic of quail species including the black-breasted button quail. There are no confirmed sightings but feeding platelets characteristic of several species of quails including black breasted button quail have been seen in the coastal vine thicket. Tolerant to dry conditions, black breasted button quail forages amongst leaf litter, feeding on invertebrates and seeds. Threats include habitat loss and fragmentation, fire and predation.	Lower importance
Grey-headed flying fox *Pteropus poliocephalus* vulnerable	Suitable foraging habitat, with some recorded sightings. No evidence of a camp or of heavy utilisation of the area. HHI is beyond the northern extent of current known range, but within what is believed to be the original range. Grey-headed flying fox forage over an area of up to 15 km from camps but may travel further when making seasonal journeys between camps. Main food sources are nectar and pollen from eucalypts, melaleucas and banksias but foraging on introduced species also occurs, particularly in urban areas. Threats include habitat loss and fragmentation as well as culling in fruit crop areas and urban areas. Grey-headed flying fox are known from urban and rural areas as well as areas with native vegetation.	Lower importance

Value	Description	Importance
Squatter Pigeon *Geophaps scripta scripta* vulnerable	Suitable foraging habitat exists although historical absence of permanent freshwater and lack of connectivity with the mainland has probably precluded colonisation. In spite of being easy to detect in surveys, squatter pigeon has not been detected in any six ecological surveys undertaken since 1993. There are no records within 25km of HHI.	Not present
Red Goshawk Erythrotriorchis radiates vulnerable	Not sighted during surveys, and no sightings within 25km of HHI, however red goshawk is inconspicuous and hard to detect in surveys. Is known from Kroombit Tops area, about 50km south-west of HHI and Eurimbula National Park, approximately 30km south of HHI. Forages over a wide range, but usually focusses on riparian zones for foraging and nesting.	Lower importance (may be an occasional visitor)
Australian painted snipe, Rostratula australis endangered, migratory	Typically uses large, shallow wetlands with open edges that provide ready access to the waterbody and foraging habitat. Farm dams and ephemeral wetlands on HHI are small and generally have trees close to the water's edge which limits habitat suitability for Australian painted snipe.	Not present (lack of suitable habitat)
Yakka Skink *Egernia rugosai* vulnerable	While not known from Queensland bioregion classification 12, yakka skink is known from Queensland Regional Ecosystem landzone 3, which is present on HHI. HHI is outside modelled distribution, however the adjacent mainland is modelled as an area where the species "may occur". Yakka skink live in colonies in areas featuring rocks, hollow logs and dense ground vegetation. Yakka skink feed on plant materials, fruits and insects, not usually moving too far from shelter to feed.	Lower importance (not present?)
Brigalow scaly-foot *Paradelma orientalis* (previously listed as vulnerable but removed from listing in May 2013.	While not known from Queensland bioregion classification 12, brigalow scaly-foot is known from Queensland Regional Ecosystem landzone 3, which is present on HHI. HHI is outside modelled distribution, however the adjacent mainland is modelled as an area where the species "may occur". Brigalow scaly-foot utilises a range of habitats including remnant brigalow woodland and eucalypt woodland with an understory of brigalow, vine thickets and other habitats with shelter provided by rocks, tussock grasses or thick leaf litter. On nearby Boyne Island, a colony is located in woodland with sparse understorey and dense layer of leaf litter.	Lower importance (not present?)
Collared delma *Delma torquata* vulnerable	While not known from Queensland bioregion classification 12, collared delma is known from Queensland Regional Ecosystem landzone 3, which is present on HHI. HHI is outside modelled distribution, however the adjacent mainland is modelled as an area where the species "may occur". Utilises microhabitat of rocks, logs, bark and leaf litter.	Lower importance (not present?)
Dunmall's snake *Furina dunmalli* vulnerable	HHI is outside the modelled distribution range for this species, however there are known records from near Gladstone area and the immediately adjacent mainland is identified as an area where the species "may occur". Records are largely from sites between 200m and 500m elevation, and microhabitat requirements include cracking clays. These conditions are not present on HHI.	Not present (lack of suitable habitat)

Value	Description	Importance
White-bellied storm-petrel *Fregella grallaria grallaria*) vulnerable	Largely a pelagic bird, nesting over 1,000 km from HHI in the Lord Howe Island Group. Forages over the continental shelf in the non-breeding season. May be occasionally present over HHI as a vagrant, possibly after severe weather events.	Not present (occasional vagrant)
Southern giant-petrel (*Macronectes giganteus)* endangered, migratory	Largely a pelagic bird, with breeding colonies over 3,000 km from HHI. Disperses north to Tropic of Capricorn in non-breeding season and may occasionally forage over land with prey including penguins and rabbits. While the southern giant-petrel might occasionally be present in the Central Queensland area, presence would be as an uncommon vagrant and it is not considered that waters around HHI, or HHI itself provide any important habitat.	Not present (occasional vagrant)
Kermadec petrel *Pterodroma neglecta neglecta* vulnerable	Largely pelagic species inhabiting the central Pacific ocean from about 20ºS to 35ºS, reported as only occasionally reaching the Australian east coast. No breeding colonies within 1,000 km of HHI.	Not present (occasional vagrant)
black-throated finch *Poephila cincta cincta* endangered	Closest recent record is 150km from HHI and HHI is considered well south of the current range. Not identified in surveys, despite being relatively easy to identify in surveys. Suitable habitat is defined as being habitat within 5km of permanent water and will utilise farm dams and water troughs. Lack of records in the area makes it unlikely that black-throated finch has colonised HHI since permanent water was introduced by graziers.	Not present
Large-eared pied bat *Chalinolobus dwyeri* vulnerable	HHI is not within the foraging range of any known populations and suitable roosting habitat of caves, abandoned mines, rock overhangs and crevices is not present on HHI. Anabat survey results did not identify this species.	Not present
Northern quoll *Dasyurus hallucatus* endangered	HHI is within the possible historic distribution range, however there have been no records south of Townsville since 1999. Suitable denning habitat is not present on HHI and It is unlikely that northern quoll would move between HHI and the mainland.	Not present
Koala (combined populations of Qld, NSW and ACT) *Phascolarctos cinereus* vulnerable	Suitable habitat is present on HHI, however not identified on HHI in spite of targeted surveys, including night time call playback. Signs of habitation such as scratches on trees have not been identified. Koalas are poor swimmers and do not generally occur on islands. Lack of water in drought conditions may preclude presence of koala on HHI. Note that only 42ha or 5.5% of suitable habitat on HHI is within the development footprint.	Not present
Humpback whale *Megaptera novaeangliae* Vulnerable, migratory	Humpback whales migrate along the East coast of Australia, but generally in waters more than 30m deep. Tracking data indicates that humpback whale migratory paths are through the Capricorn Bunker group of islands and reefs, 50-150km east of HHI and humpback whales do not approach the shore in the vicinity of HHI. Inshore waters of Rodds Bay and Port Curtis have not been identified as being utilised for calving, resting or aggregation.	Not present
Blue whale *Balaenoptera musculus* endangered, migratory	Recognised aggregation and feeding areas for the blue whale are along the Victorian and South Australian coastlines. May move into areas of upwelling in tropical waters in the Southern winter, however no such areas are known near Rodds Bay or Port Curtis.	Not present

Value	Description	Importance
Flatback turtle *Natator depressus* Vulnerable, migratory, marine	Known to occur in waters around HHI. Flatback turtles have been observed to nest intermittently in very low numbers on beach to east of headland. Flatback turtle use soft bottom habitat over the continental shelf with water depths 10m to 40m. In eastern Queensland, nesting occurs between Bundaberg and Torres Strait with the main east coast nesting sites at Peak, Wild Duck, Avoid and Curtis Islands. Juveniles are known to eat gastropod molluscs, squid and siphonophores (soft corals, hydroids, jellyfish) however little is known of the adult diet. Predation of eggs by feral animals and disturbance of nesting activities are key threats to marine turtles. Other anthropogenic threats include boat strike and entanglement with and ingestion of fishing line, nets and other debris.	Moderate importance
Green turtle *Chelonia mydas* Vulnerable, migratory, marine	Known to occur in waters around HHI. Juvenile turtles spend first 5-10 years in open ocean Adults forage in shallow benthic habitats including coral, rocky reef, seagrass beds and algal mats Nesting has not been observed on HHI. Nearby key nesting and inter-nesting areas are the Capricorn and Bunker Island Groups, 50-150 km offshore from HHI, Curtis Island, 50 km north of HHI and Facing Island, 25 km north of HHI. Juveniles may eat plankton and other animals and adults primarily eat seagrass and algae. Predation of eggs by feral animals and disturbance of nesting activities are key threats to marine turtles. Other anthropogenic threats include loss of seagrass beds, boat strike and entanglement with and ingestion of fishing line, nets and other debris.	Moderate importance
Loggerhead turtle *Caretta caretta* Endangered, migratory, marine	Known to occasionally occur in waters around HHI. No nesting sites within close proximity. Juvenile turtles spend about 15 years feeding in open ocean while adults move inshore to coral and rocky reefs, seagrass beds and muddy bays. Nearest nesting sites to HHI are in the Capricorn Bunker Island Groups, 50-150 km offshore from HHI. Predation of eggs by feral animals and disturbance of nesting activities are key threats to marine turtles. Other anthropogenic threats include boat strike and entanglement with and ingestion of fishing line, nets and other debris.	Lower importance
Whale shark *Rhincodon typus*, vulnerable, migratory	Not known from the Port Curtis and Rodds Bay areas but may occasionally come inshore and therefore may be occasionally present. Waters around HHI are not considered important habitat for whale shark.	Lower importance (not present?)
Green sawfish *Pristis zijsron* vulnerable	Original range likely to have extended south to Jervis Bay in NSW, however there are no recorded sightings south of Cairns since the 1960s. There have never been any records between Moreton Bay and Townsville. Suitable habitat of shallow muddy inshore coastal waters and estuarine waters is present in waters surrounding HHI.	Not present

ES11.4 Listed Migratory Species

HHI and surrounding waters provide habitat for some listed migratory species as shown in Table ES.8.

Table ES.8 - Listed Migratory Species

Value	Description	Importance
Migratory Terrestrial Birds	Seven species known or potentially occurring, however HHI does not support important populations or provide key habitat.	Lower importance
Migratory Marine Birds	Several species of egrets and terns known to occur, however there are no known breeding colonies or locations for these species on HHI. Beaches on HHI may be too narrow at high tide to provide suitable nesting habitat for terns.	Lower importance
Migratory Shorebirds	Intertidal foraging and roosting habitat of international and national importance is available at HHI and in the surrounding Colosseum/Mundoolin and Rodds Bay conglomerate of sites.	Highest importance
Dugong *Dugong dugon* Migratory marine	Known to occur in waters around HHI. Not identified as one of the most important locations for dugong in Queensland, but nevertheless provides foraging habitat on intertidal and subtidal habitat.	Moderate importance
Indo-Pacific humpback dolphin *Sousa chinensis* Migratory, Cetacean.	Known to occur, however common throughout the region. Waters of HHI do not appear to offer any unique or important habitat.	Lower importance
Flatback turtle *Natator depressus* Vulnerable, migratory, marine	See Table ES.5	Moderate importance
Green turtle *Chelonia mydas* Vulnerable, migratory, marine	See Table ES.5	Moderate importance
Loggerhead turtle *Caretta caretta* Endangered, migratory, marine	See Table ES.5	Lower importance

ES11.5 Great Barrier Reef Marine Park

HHI lies within the Mackay Capricorn Management Area of the GBRMP and the Mackay/Capricorn management area of the Queensland administered GBRCMP. HHI is situated on the landward boundary of the Mackay Capricorn Management Area of the GBRMP and the Mackay/Capricorn management area of the Queensland administered GBRCMP. The GBRMP boundary runs from offshore to the northern tip of the Island, along the northern shoreline, and to the southern tip of the Island where it cuts across the entrance of Rodds Bay to Rodds Peninsula. The area of the GBRMP adjacent to HHI is jointly administered by the Great Barrier Reef Marine Park Authority (GBRMPA) and Queensland. The landward limit of the GBRMP boundary on the island is the low-water mark; areas between the low-water mark and highest astronomical tide (HAT) are classified as "internal waters of Queensland", areas above the low water mark on the Island are not part of the GBRMP but are in the Great Barrier Reef Coastal Marine Park administered by Queensland State.

Waters surrounding HHI are zoned for general use. The objective of this zone is: "*to provide for the conservation of areas of the Marine Park, while providing opportunities for reasonable use*" (GBRMPA 2003). Most recreational and fishing activities are allowed in the general use zone with some restriction on fishing methods and size of catch. Aquaculture, harvest fishing for aquarium fish, coral, beachworm, sea cucumber, trochus and tropical rock lobster, research activities and tourism activities all require a permit.

The general use zone is the most accessible zone to the public, and provides an important connection between the community and the GBRMP/GBRCMP generally, and the more sensitive features of the two marine parks. The general use zone also provides connectivity between the more highly protected zones and representative areas and with adjacent ecosystems that are also important to functionality of the ecosystems within the GBRMP/GBRCMP.

The nearest habitat protection zones are Creek Rocks (24-001), which lies 1-2 km from the nearest point of HHI, and about 5 km north-east of Tiber Point and Seal Rocks (23-067) which lies about 5 km north of Tiber Point.

The nearest conservation park zone is at Rodds Peninsula, 14 km to the east and the nearest national park zone is also located at Rodds Peninsula, 20 km to the east. There are no buffer zones, scientific research zones or preservation zones within 50 km of HHI.

In terms of reef ecosystems, HHI lies within an area designated as "coastal southern fringing reefs" (RE8). The bioregion information sheet for this bioregion notes that it is "dominated by episodic Fitzroy River flood plumes". In terms of non-reef ecosystems HHI lies within the "high nutrient coastal strip" (NA3). The bioregion information sheet for the "high nutrient coastal strip" identifies the bioregion as consisting of "*terrigenous mud and high levels of nutrients from the adjoining land*". The bioregion features seagrass in sheltered sites and provides good turtle and dugong feeding habitat.

The Mackay-Capricorn management area has lower tourist visitation levels then other management areas of the GBRMP, receiving around seven per cent of the total number of commercial tourism days spent within the GBRMP.

ES11.6 Conservation Objectives for MNES

Identified conservation objectives for PTP in relation to protection of MNES values are as follows:

- Aesthetic values are retained such that views from within the WHA/NHP are not degraded
- Coastal processes of beach and dune formation are not altered
- Estuarine processes associated with tidal waterways and erosion and accretion of sand banks and mud flats are not altered
- HHI remains clearly recognisable as a continental island

- Aboriginal cultural heritage is conserved and managed through the agreed cultural heritage management plan
- Coastal wetlands, supratidal, intertidal and subtidal habitats are not degraded
- Waters around HHI continue to provide habitat for marine turtles and dugong
- Water quality and hydrological conditions in coastal and enclosed coastal waters surrounding HHI is not degraded when compared to water quality objectives
- Representative examples of all terrestrial ecological communities and habitats are retained and protected
- Floristic diversity, including EPBC Act listed ecological communities, is retained and protected
- Migratory shorebird habitat is not disturbed or degraded
- All elements that contribute to the outstanding universal value of the GBRWHA are retained in recognisable and viable condition
- Threats to the GBR ecosystem and habitats and species that are components of the ecosystem are not exacerbated
- Tourists, other visitors and residents are made aware of the MNES values and other environmental values of HHI and surrounding waters and how to protect these values while staying at the development and undertaking activities in and around HHI.

The assessment undertaken for PTP demonstrates that all conservation objectives can be achieved.

ES12 Identification of Impacts and Mitigation Measures

ES12.1 Impact Categories

Primary impact groups were identified through the impact pathway analysis and the following key groupings of impacts were identified:

- Direct impacts on terrestrial, intertidal and marine habitat and ecological communities
- Indirect impacts on terrestrial vegetation and habitat
- Impacts on water quality (leading to associated indirect impacts on habitat)
- Direct impacts on terrestrial threatened and migratory animals
- Direct impacts on marine threatened and migratory animals
- Increased levels of activity in the GBRWHA/NHP and GBRMP
- Changes in landscape character and visual amenity
- Impacts on geological and geomorphological features and processes.

The impact significance methodology developed for the assessment was used to determine whether potentially significant impacts on MNES might occur by exploring both the significance of the MNES value present, and the severity of impact on that value, or, in the case of the GBRWHA, the reduction in any contribution made to the OUV of the GBRWHA.

ES12.2 Direct impacts on terrestrial habitat and ecological communities

Impacts on terrestrial habitat and ecological communities and the contribution that these make to the OUV of the GBRWHA may occur through the following mechanisms:

- Clearing of habitat within the development footprint
- Fragmentation of terrestrial habitat
- Protection of habitat through an actively managed conservation area and Wildlife and Habitat Management Plan.

Development of the PTP will require full or partial clearing of 465 ha of native vegetation. This includes 307 ha for development and 158 ha of golf course, open space and vegetation buffers. In the Golf and Beach Resort, Ocean View and Colosseum precincts, 50% of mature habitat trees will be retained. The development footprint has been designed to avoid all areas identified as having moderate or highest values for MNES.

There will be no clearing of the EPBC Act listed critically endangered ecological community, *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and representative examples of all other ecological communities and habitats are also retained. This includes two vegetation communities, *Eucalyptus melanophloia* woodland and *E. tereticornis* and *E. crebra* dominated forest, which are not well represented in the GBRWHA/NHP and therefore contribute to the floristic diversity of the GBRWHA/NHP. The entire 10 ha patch of *Eucalyptus melanophloia* woodland will be retained and 60% of the *Eucalyptus tereticornis* and *E. crebra* dominated forest will also be retained, leaving a total of 229 ha of this community on HHI.

Clearing will not take place in the coastal zone except for 0.11 ha of mangrove and 0.2 ha of salt marsh for the proposed bridge and boat ramp and upgrade of the Clarke's Road causeway across saltpan on the mainland. This clearing will occur in an area that is already affected by clearing and fragmentation for the existing causeway and access road.

The proposed development footprint for PTP will partially bisect HHI, however fauna movement between habitats will be retained through retention of fauna corridors and retention of vegetation throughout the proposed footprint. In particular, an east/west fauna corridor of at least 300 m wide will be retained. Within habitat corridors, ground cover, including rocks and logs will be retained and enhanced where necessary to assist migrations of ground dwelling animals. The entire footprint is intended to be permeable to animal movements and this is enhanced by retention of habitat trees. The central section of the arterial road is to be designed as a single lane, dual carriageway with a vegetated median strip 50-60 m wide to facilitate fauna movements across the road. This section will align with the main east-west habitat corridor.

Access to existing water resources, including a farm dam which currently provides the only semi-permanent water supply on the island, will be retained, and additional water resources will be provided at the proposed golf course and Colosseum village in the form of recycled water storage ponds. While not intended as habitat features, design features will be incorporated into these ponds to maximise habitat values.

Most animals present on HHI are known to move through modified semi-urban and rural landscapes and will movement will not be particularly restricted by the proposed development. Seed dispersal mechanisms between the two patches of coastal vine thicket will not be affected.

Availability of foraging habitat for the vulnerable grey-headed flying fox *Pteropus poliocephalus* may be reduced. However, HHI is not important habitat for grey-headed flying fox and 50 % of trees are to be retained in woodland areas which grey-headed flying fox will be able to utilise if they do visit the area. Fragmentation will not affect grey headed flying fox as this species is known to forage in urban and rural areas.

Although presence of yakka skink *Egernia rugosa*, collared delma *Delma torquata*and brigalow scaly foot *Paradelma orientalis* is not confirmed, potential habitat may be lost. Pre-clearing surveys will be undertaken and if these species are identified, a species conservation and management plan developed. As these animals have small foraging ranges, fragmentation of foraging areas is not expected, however seasonal movements between populations may be affected. If more than one population is identified, habitat corridors will be enhanced with rocks and logs to facilitate safe movement.

A very small area of potential water mouse foraging *Xeromys myoides* and nesting habitat will be lost. The area to be cleared is less than 0.005% of available habitat and is in an area already disturbed. Further fragmentation will therefore not occur, however it is recognised that the presence of the boat ramp and associated activity may deter water mouse from moving through this area. A water mouse colony is however known from adjacent to a sewage treatment plant at Cannonvale in North Queensland, indicating some tolerance to activity.

Foraging habitat for terrestrial migratory bird species may be reduced however HHI is not considered to provide important habitat for any terrestrial migratory bird species and five of the seven species present or potentially present are known to forage in urban areas.

A small area of foraging and roosting habitat for migratory shorebirds will be lost, equivalent to less than 0.005% of available habitat. Surveys indicate very low usage of this area by migratory shorebirds. Fragmentation of habitat will not occur.

The Proponent is seeking to surrender the undeveloped areas of the special lease on completion of the PTP and also manage the balance of HHI as a Conservation Area. The Queensland Government supports this and the Coordinator-General's report contains a condition to this effect, as well as a recommendation to the Queensland Minister for nature conservation to declare the area under the *Nature Conservation Act 1992*. If this occurs, this will remove any threat of development of the area of *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* that sits within the special lease, place a large area of this critically endangered ecological community within the conservation estate and also protect the two other vegetation communities that are poorly represented elsewhere in the WHA.

The Proponent will prepare a management plan for the conservation area addressing current threats, managing access and use of the area and enhancing habitat and vegetation community structure. Management of the area will enhance resilience of the terrestrial habitat and ecological communities to effects of climate change. Extension and environmental education programs will also be linked to the conservation area. Management actions will be implemented from commencement of the proposed development.

Management of the conservation area will initially be funded by the Proponent and ultimately be funded from a bushland levy to be imposed on landholders in the proposed PTP. This will allow management of the conservation area to be handed over to the Gladstone Regional Council once the development phase is complete.

As a condition of the Queensland Government's Coordinator-General's report for the HHID (February 2011), if the proposed PTP goes ahead, the Proponent is also required to prepare a comprehensive Wildlife and Habitat Management Plan for management and enhancement of wildlife and habitat within the development footprint. The Wildlife and Habitat Management Plan will complement the conservation area management plan, providing for an holistic approach to management of conservation values of HHI within and outside of the development footprint and management of interfaces between the developed area and conservation area.

Terrestrial vegetation clearing and fragmentation is therefore not predicted to affect any individual EPBC listed threatened or migratory species or ecological communities. Overall terrestrial biodiversity within the GBRWHA/NHP is also retained and the contribution made to the OUV of the GBRWHA will be enhanced through the proposed managed conservation area and Wildlife and Habitat Management Plan.

ES12.3 Direct impacts on intertidal and marine habitat and ecological communities

Direct impacts on intertidal and marine habitat and the contribution that this makes to the OUV of the GBRWHA may occur through the following mechanisms:

- Direct disturbance to marine habitat from construction of the proposed bridge and boat ramp
- Fragmentation of marine habitat
- [Partial] removal of the causeway
- Anchor damage from recreational vessels.

Note that indirect impacts relating to changes in water quality and increased levels of activity are discussed in Sections ES12.5 and ES12.8 respectively.

Construction of the proposed bridge will disturb up to 0.4 ha of muddy intertidal and subtidal substrate and the cause loss of about 0.5 ha of muddy substrate on the edge of Boyne Creek. This represents about 0.005% of this type of habitat available within the Colosseum Inlet/Boyne

Creek/Seven Mile Creek estuary. The reduction in habitat and food sources for larger marine fauna is negligible.

The existing causeway across Boyne Creek may present some barrier to movement of marine animals, however, no observations have been made to determine the extent of this effect. It is a condition of Queensland Government Coordinator-General's report on the HHID that the Boyne Creek causeway be breached to restore unrestricted passage to marine fauna. Partial breaching of the Boyne Creek causeway, involving removal of a central section of about 70 m would remove artificial impediments to animal movement, providing some improvement to habitat connectivity, especially at low tide. Any loss of hard substrate habitat within the causeway would be negligible in the context of available habitat in the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary and will be partially offset by introduction of hard substrates on the bridge pylons and boat ramp/pontoon.

An existing causeway across salt flats on the mainland will also be upgraded and the upgrade will include installation of culverts to allow tidal flows across the salt flat. This may improve the value of this habitat.

The proposed bridge will be elevated and allow free passage of marine fauna and tidal currents. The proposed boat ramp will be flush with the bed and bank of Boyne Creek and will not present any barrier to movement. No fragmentation of marine habitat is expected.

Damage to coral reef and seagrass ecosystems from anchoring of recreational vessels has been identified as a threat to marine habitats in the GBRMP/GBRWHA. There are no coral reef ecosystems in the waters surrounding HHI, however there are two patches of rocky reef 2 km and 5 km offshore with some coral cover. There are also extensive intertidal seagrass beds in Seven Mile Creek and subtidal seagrass beds offshore from the eastern end of HHI, as well as smaller patches within Boyne Creek.

The Seven Mile Creek area has been identified as a fishing spot and may attract recreational boats. Some increased anchoring may occur over seagrass beds in waters surrounding HHI. The majority of seagrass beds in Seven Mile Creek and Boyne Creek are intertidal and hence there is less likelihood of anchoring in these areas. While seagrasses will regenerate after disturbance reasonably quickly, recovery would be impeded by repeated damage and medium to long term loss of biomass would be expected (Campbell and McKenzie 2001, Campbell and McKenzie 2004). This in turn could affect green turtles, dugong and other marine fauna which feed on seagrasses.

Seagrass beds in waters around HHI are considered moderately important to dugong and green turtle and as it is difficult to confidently predict that impacts from anchoring will be low, the health and abundance of seagrass in Seven Mile Creek will be monitored as part of the Marine Ecological Monitoring Program. If adverse effects are identified, the Proponent will work with the Queensland Department of National Parks, Recreation, Sport and Racing and Maritime Safety Queensland to establish and enforce a no anchor zone and place permanent moorings. The Proponent will also provide information to recreational boaters encouraging them to avoid anchoring on seagrass beds.

Overall, any reduction in intertidal and marine habitat is negligible and significant impacts on habitat values and the animals that utilise these habitats are not expected. There will be no diminution of the contribution that intertidal and marine habitats around HHI make to the OUV of the GBRWHA.

ES12.4 Indirect impacts on terrestrial vegetation and habitat

Indirect impacts on terrestrial vegetation and habitat, including migratory shorebird habitat, may arise from:

- Weed infestation and proliferation
- Changes in overland flow characteristics
- Changes in groundwater recharge and discharge characteristics
- Deposition of dust
- Noise-related disturbance that may affect use of habitat
- Human activity
- Microclimatic changes at edges of vegetation patches
- Artificial light
- Increased bushfire risk.

Where these impacts affect biodiversity or amenity of the GBRWHA, impacts on the contribution that HHI makes to the OUV of the GBRWHA may also occur.

HHI currently has a low to moderate level of weed infestation. Development will create conditions where existing weeds may proliferate, and there is also a risk that construction equipment, vehicles and material will accidentally convey weeds seeds to HHI and, in future, access to the conservation area may re-introduce weeds to this area. While impacts of weed proliferation and infestation can be severe, there are well-established control measures available to minimise likelihood of this occurring.

The Weed Hygiene Declaration process established by Queensland Department of Agriculture, Fisheries and Forestry will be used to ensure that all construction vehicles, equipment and building materials brought to HHI are free of weeds and the Proponent's environmental superintendent will be trained and certified in vehicle, equipment and material inspection techniques. The Proponent will undertake regular inspections of disturbed areas and contractors will be required to take remedial action if weed infestation or proliferation has occurred. Contractors will be required to leave construction areas free of weeds and with suitable ground cover in place to minimise weed infestation or proliferation.

These measures will be complemented by a weed control program implemented within the development footprint through the Wildlife and Habitat Management Plan and throughout the managed conservation area.

Overall impacts on MNES from weeds can be avoided and weed control programs may enhance habitat values for EPBC Act listed threatened and migratory species. Terrestrial biodiversity is not expected to be reduced, nor is the contribution that HHI makes to the OUV of the GBRWHA in this regard.

The proposed stormwater system has been designed to minimise changes to overland flow characteristics. In particular, existing subcatchments will be retained and overland flows towards retained vegetation, including the coastal vine thicket, will not change significantly.

The Ocean View and Colosseum precincts intersect some areas of groundwater discharge areas which are prone to waterlogging and salinization, particularly if disturbed. Development in these areas will consist of low density “acreage style” villas and houses, with the building footprint constrained to 50% of vegetation on each lot. With this style of development, there is minimal change to either surface runoff or recharge characteristics and hence, minimal change to discharge characteristics is expected. During the detailed design stage, further attention will be given to placement of individual buildings to avoid areas of potential waterlogging. Impacts on soils and groundwater dependent ecosystems from interference with groundwater recharge and discharge zones is therefore expected to be minimal.

About 20% of the recharge area of a perched freshwater aquifer in the north-west of HHI will be overlain by the proposed golf course and the Golf and Beach Resort precinct. Development of hard surfaces such as buildings and pathways will reduce infiltration and recharge while clearing of vegetation for the golf course will increase infiltration and recharge. Overall, these effects should balance out and little change is expected. There are no EPBC Act listed threatened and migratory species that utilise these areas as important habitat.

Dust generated by construction is unlikely to adversely affect vegetation of HHI due to the amount of dust likely to be mobilised, and also the short duration of exposure at any one location. Wet season rainfall is adequate to wash dust off leaves such that long lasting effects do not occur. Once development is complete in any one location, disturbed surfaces will be sealed or revegetated. A buffer is also provided for in the footprint between development works and the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community and other ecological communities that are to be retained.

Noise levels from construction and operation activities are unlikely to be at levels that will disturb fauna. Noise from aircraft may affect migratory shorebird roosting and foraging sites and an exclusion zone is proposed. Noise from recreational boating is not expected to disturb this habitat due to separation distances between habitat areas and navigable channels.

Noise levels within the GBRWHA/NHP will increase but only in the immediate vicinity of the proposed development and this is not expected to affect the OUV of the GBRWHA.

As visitors to the WHA/NHP will be expecting some level of development, this will not affect enjoyment of the GBRWHA/NHP. Noise from the PTP will not be audible in the GBRMP.

If scenic flights are operated from the airstrip on HHI, migratory shorebirds may be affected by aircraft noise and the proponent intends to impose an aircraft exclusion zone within one kilometre of the main roosting and foraging sites and monitor the effects of aircraft noise on roosting and foraging birds. Impacts on flying foxes and bats are not expected, particularly given that the airstrip will not be designed for use at night.

Existing restrictions on human access to sensitive migratory shorebird habitats and the beach used intermittently by turtles for nesting will be retained.

Clearing of vegetation exposes the edges of remnant vegetation to microclimatic changes which in turn can decrease the habitat value of these remnants. Interfaces between developed areas and areas managed for habitat values will be managed to provide protection for adjacent vegetation, including the coastal vine thicket ecological community.

There will not be any increase in exposure of the coastal vine thicket endangered ecological community to edge effects, and the existing exposed edge near the headland will be protected by establishment of a managed buffer of 80-100 m wide.

The PTP will introduce artificial light. This can affect fauna in a range of ways, including assisting with nocturnal foraging, making animals more visible to predators and confusing animal movements. Mitigation measures will be required to minimise light spill from the proposed development. In terms of EPBC listed threatened and migratory species:

- Black-breasted button quail forage during the day and roost in the coastal vine thicket at night. As there is no proposed development within several hundred metres of the coastal vine thicket, light-related impacts are not considered significant
- Grey-headed flying fox are known to forage over urban areas, including from camps established in urban areas and would therefore not appear to be affected by light.
- Some reptiles including brigalow scaly foot are. GHD (August 2012) identified that artificial light may assist nocturnal reptiles in foraging, but may also increase risk of predation. If colonies are identified close to the footprint, light spill will need to be minimised and additional ground cover can be provided.
- Terrestrial and marine migratory birds that are present forage during the day. Five of the seven species of terrestrial migratory birds present or potentially present are known to utilise urban and semi-urban areas and would not appear to be affected by artificial light. If terns are nesting on the beach, the measures adopted to protect turtle nesting from impacts of artificial light will also protect tern nest areas.
- Migratory shorebirds may avoid areas illuminated by street lights. Illumination at night time may improve foraging efficiency but may also make shorebirds more vulnerable to predation (GHD August 2012). However, given that the closest area of important migratory shorebird habitat is at least 750m from the proposed PTP, it is not expected that lighting from the proposed development will illuminate this habitat.

Ecological communities have varying sensitivities to fire, with some benefiting from low to moderate frequency regular burning in mosaic patches and others being adversely affected by fire. Development has the potential to increase fire risk and hence the frequency that ecological communities may be exposed to fire.

There are three regional ecosystems adjacent to the proposed PTP where burning is identified as being potentially harmful, and to be avoided:

- *Corymbia* spp., *Eucalyptus* spp., *Acacia* spp. open forest to low closed forest occurs adjacent to the Golf and beach precinct and may be at risk if golfers are careless with cigarettes. The mown fairways will act to retard fires, and cigarette disposal receptacles will be provided. The need to prevent fire will be reinforced with golfers.
- Coastal vine thicket is buffered from the PTP and it is not proposed to allow access to these areas.
- Foredune complex occurs adjacent to the public access beach and is also partially buffered and warning signs and cigarette disposal containers will be provided.

The remainder of ecological communities are likely to benefit from an actively managed fire regime and this will be incorporated into the management plan for the conservation area.

Fire prevention controls will include building design to meet fire requirements, as well as controls on cigarettes, campfires and other ignition sources, including from construction activities. Under Queensland legislation, smoking is prohibited in public places including beaches. As HHI is relatively flat, bushfires will generally be able to be controlled quickly, with the exception of vegetation along the steeper ridgeline, which is relatively tolerant to fires. Firebreaks, if required, will be located within the development footprint.

Overall, indirect impacts on terrestrial vegetation communities and habitats will largely be avoided through provision of a buffer between the development footprint and adjacent areas and design measures that minimise changes in overland flow and minimise obtrusive light. Ongoing management of the conservation area and of wildlife habitat within the proposed footprint together with specific management of construction activities in relation to weeds and dust is expected to be effective in mitigating potentially adverse effects of dust, fire, weed invasion, noise and activity.

ES12.5 Impacts on Water Quality

Changes in water quality may indirectly impact coastal and marine habitat quality and, where more extreme changes occur, may have acute or chronic toxic effects on marine plants and animals.

The development has been designed to minimise impacts on water quality and also on the quantity of flows being discharged into the coastal zone.

The stormwater system conforms to the principles of Water Sensitive Urban Design and includes a range of devices to remove contaminants, including litter, and ensure minimal change in the areas of subcatchments and flows in ephemeral watercourses. Modelling has indicated that the quality of stormwater released from the system will meet or exceed water quality objectives and flow rates, including low flows in ephemeral creeks will be maintained.

A first flush system will direct initial stormwater runoff from the golf course to recycled water storage ponds to capture nutrients. The recycled water storage ponds at the golf course are designed to overflow only, on average, one wet season out of every ten.

With this design, adverse impacts on water quality in the coastal zone are not expected.

All wastewater will be treated and recycled, with recycled water used for toilet flushing, garden watering and other outdoor uses and irrigation of the golf course and public areas. In wet weather, excess water will be irrigated onto the air strip.

A number of design measures have been adopted to minimise the likelihood and duration of any overflow of untreated or partially treated sewage in the event of a power outage or malfunction in the pumping or treatment systems. These include duplication of key mechanical items, back-up power generation and provision of storage within the system. The selected wastewater treatment system is likely to be a physical and chemical treatment process rather than a biological process as these processes perform more reliably when there is a variation in flows, as occurs in a predominately tourist development. The sewerage system will also be designed to minimise inflows in wet weather.

In the rare event that an overflow of untreated sewage occurs, an estimated 35 kg of nitrogen and 9 kg of phosphorus would be discharged into Boyne Creek in a 24 hour period. As the sewerage catchment is residential and tourism, there will be minimal levels of other contaminants such as heavy metals. These loads are unlikely to have more than a short term effect within several hundred metres of the release point, and effects would be reversible as mangrove ecosystems readily assimilate nutrients.

Preliminary modelling has been undertaken to determine the sustainable irrigation rates for the golf course and other areas, and has demonstrated that recycled water can be utilised without adverse effects on soil structure, groundwater or surface water runoff. Further modelling will be undertaken and a Recycled Water Management Plan will be prepared in accordance with the requirements of the Queensland *Water Supply (Safety and Reliability) Act 2008*. This will include a comprehensive safety and environmental risk assessment, following the methods specified in the Act and also set out in the National Water Quality Management Strategy (NRMMC 2004 and 2006).

A comprehensive monitoring program is also proposed that will detect any build-up of nutrients and allow for corrective action including adjustment of irrigation rates if pre-determined trigger levels are exceeded. Trigger levels will be set conservatively to ensure early detection of any build-up of nutrients well before irreversible effects occur. Management, monitoring and corrective action requirements will be set out in a turf and irrigation management plan will be developed for the golf course which will link to the Recycled Water Management Plan.

As recycled water is to be used for irrigation of the golf course, there is minimal need to apply additional fertiliser. In-situ soil monitoring will determine whether additional fertiliser is required and allow fertiliser application rates to be optimised such that excess nutrients are not applied.

The modelling and assessment undertaken indicates that the recycled water system, including irrigation of the golf course and other areas can be undertaken without any adverse impacts on soils, surface waters and groundwater.

Water supply will be from a desalination plant, supplemented with rainwater tanks and recycling of wastewater. Brine generated by this plant will be disposed of in an evaporation pond with no discharge to the environment.

Pesticide use at the golf course and in other areas will be avoided wherever possible. If pesticides are required, selection of pesticides will have regard to ecological toxicity and environmental fate such that release of and build-up of pesticides in the coastal and marine environment is avoided.

If a service station or other fuel storage and dispensing facility is established, this will be required to comply with regulatory standards and Australian standards including requirements in relation to storage facilities, handling, transportation and emergency response. These requirements will also apply to temporary fuel supplies that may be established by construction contractors. These standards minimise the likelihood of an accidental release and also minimise the likelihood of releases entering watercourses or coastal environments.

Otherwise, there will not be any large quantities of environmentally hazardous materials stored or used at PTP. Regulations also govern the packaging, storage and handling of small quantities of fuels and other chemicals at the household level and in maintenance facilities, and it is illegal under the Queensland *Environmental Protection Act 1994* to discharge contaminants to land or surface waters, or store and use potential contaminants in such a way that there is a likelihood of discharge.

Construction activities will expose soils to erosion forces, and may result in discharges of sediment to the coastal and marine environment. As construction occurs in a staged manner over 16 years, the area exposed to erosion effects will generally be less than 50 ha per year. An assessment of erosion risk in each precinct was undertaken and identified the appropriate level of erosion and sediment control required to minimise impacts on the receiving environment in each precinct. Flows from each precinct occur naturally towards Boyne Creek which is a less sensitive receiving environment in terms of sediment. Nevertheless, erosion and sediment controls will be employed in line with best practice and will be effective in minimising sediment release.

Erosion and sediment control methods will be based on the most recent applicable guidelines at the time. Currently, the International Erosion Control Association Australasia's *Best Practice Erosion and Sediment Control Guidelines* (2008) (International Erosion Control Association Australasia) and the *Queensland Urban Drainage Manual* (DERM 2008) are considered best practice for Queensland. Erosion and sediment control principles will be based on the following hierarchy:

- Divert clean flows around disturbed areas, with provision of scour protection where concentration of flows is likely
- Minimisation of the area of soil exposed to erosive forces by clearing the minimum possible work area at all times, and protecting unused areas, for example through the use of mulch
- Stabilisation/ revegetation of exposed areas as soon as practicable following the completion of works
- Capture of overland flows from exposed areas in sediment retention devices. For larger disturbance areas, sediment basin will generally be required in accordance with the erosion and sediment control guidelines. This also provides the option of using flocculants if subsoils are particularly dispersive and take a long time to settle.

Construction of the bridge and boat ramp and upgrade of the Clarke's Road causeway will involve excavation, disturbance or displacement of several thousand cubic metres of intertidal and subtidal sediments including some potential acid sulfate soils. All potential acid sulphate soils will be removed from the construction area and placed in a specially constructed cell for neutralisation and validation. Management will be in accordance with the QASSIT *Soil Management Guidelines* which contain proven measures for management of acid sulfate soils. Sediment release to Boyne Creek will be minimal and can be contained using silt curtains if necessary.

Given the proposed design measures and other controls, it is not expected that any degradation of water quality will occur in surface waters including ephemeral waterways on HHI as well as enclosed and open coastal waters surrounding HHI. Impacts on MNES values including migratory shorebird habitat and marine turtle and dugong habitat are not expected. Water quality within the GBRWHA/NHP and GBRMP is also not expected to be affected and the contribution that water quality and marine and intertidal habitats around HHI makes to the OUV of the GBRWHA will not be diminished.

The Proponent also proposes a marine water quality monitoring program and marine ecological monitoring program to monitor any changes from baseline conditions during the development phase. This will validate the effectiveness of the proposed design and mitigation measures and also detect any changes early enough to allow corrective actions to be implemented before irreversible effects occur. Baseline data collection will be undertaken prior to commencement of construction activities and monitoring effort will be consistent with other water quality and ecosystem health monitoring activities in the Port Curtis/Rodds Bay region.

ES12.6 Impacts on Individual terrestrial threatened and migratory animals

Direct impacts on terrestrial threatened and migratory animals and native terrestrial animals generally may arise from:

- Injury or mortality during vegetation clearing activities
- Injury or mortality from vehicle strike
- Injury or mortality from aircraft strike

- Increased predation.

During vegetation clearing, arboreal animals and ground dwelling animals are vulnerable to injury or mortality. Nests and burrows will also be lost. Black-breasted button quail (if present) will not be affected as clearing will not take place within or immediately adjacent to potential habitat. The vulnerable grey-headed flying fox is not known to roost on HHI and forages at night when clearing will not be taking place.

Pre-clearing surveys by qualified ecologists will be required in suitable habitat for brigalow reptiles. If these animals are found to be present, a review will be undertaken to determine whether the immediate area can be avoided. If the area cannot be avoided, a relocation plan will be developed and implemented.

Pre-clearing surveys by qualified ecologists will also identify whether there are nests for the migratory terrestrial birds white-bellied sea-eagle and rainbow bee-eater. If nests are observed, every effort will be made to avoid or delay clearing until chicks have fledged. Other terrestrial migratory bird species present or likely to be present will be readily able to move away from clearing activities.

A previous survey did not identify water mouse in the area of mangroves that are to be cleared at the bridge and boat ramp. Water mouse are quite mobile and would be able to move into immediately adjacent habitat if disturbed.

Clearing is not required within any foraging and roosting habitat for migratory shorebirds and hence, there is no associated impact.

As development of the PTP progresses, a road network will be developed, including a main arterial road running north-south across HHI. This road will bisect habitat areas that are to be retained to the east and west. The central portion of this road, between the Headland Resort and Bushland precincts will be a single lane dual carriageway, with a vegetated strip of 50-60 m in between the carriageways to facilitate fauna crossing. The speed limit on the main arterial road will be set at 60 km/hour on the main arterial road and 40 km/hour on smaller local and collector roads. Road design for all roads will follow Queensland and local government design standards, including the requirements of the Queensland Department of Transport and Main Roads Fauna Sensitive Road Design Manual (DMR 2000, DTMR 2010) which includes a risk assessment process to identify the need for formal fauna crossings of roads.

In terms of potential impacts on listed species of national environmental significance there will be no roads through the vine thicket that provides potential habitat for the black-breasted button quail. If water mouse is utilising mangrove and intertidal habitat in the vicinity of the bridge and boat ramp, water mouse will be able to move from east to west under the bridge. As the water mouse is nocturnal, and the majority of boat ramp activities will be undertaken during daylight hours, vehicle strike of water mouse at the boat ramp is not likely to occur.

If brigalow reptiles are present, movements would generally be at night when traffic volumes are lower, however, these small reptiles would be vulnerable to vehicle strike. If habitat assessment or pre-clearing surveys identify suitable habitat for brigalow reptiles in proximity to the main arterial road, these would become priority target species in relation to selection of road crossing methods.

Impacts from mortality or injury during vegetation clearing or from vehicle strike on common ground dwelling native animals and arboreal mammals are not likely to be such that fauna diversity is impacted (for example, through local extinction of a particular species) and hence, biodiversity values of the GBRWHA/NHP are not expected to be affected. Pre-clearing surveys will identify the need for relocation of fauna and a risk assessment at the detailed design stage will identify whether formal fauna crossings of the main arterial road are required.

Monitoring of impacts of vehicles on fauna will be undertaken over a period of 2-4 weeks annually until the PTP reaches full capacity and then the frequency will be reduced to bi-annually or less if mitigation measures appear to be effective. If mitigation measures are not operating effectively, further modifications will be made, using the DTMR manual and other national and international best practice guidelines.

Condition 14, Schedule 1 of the Queensland Coordinator-General's report requires the Proponent to address management of road impacts on fauna in the Wildlife and Habitat Management Plan (see also Section 8.3.9).

The potential for migratory shorebird species to come into proximity with vehicles is likely only at the bridge crossing where birds may fly over or under the bridge while commuting east-west along the waterway. However, the relatively slow vehicle speeds (60 kph speed limit) combined with the protective railings on the bridge, and the high visual acuity and flight manoeuvrability of shorebirds, including at night, will mean that the risk of vehicle strike to migratory shorebirds is negligible. It is estimated that less than 10 small aircraft would utilise the airstrip on most days, with up to 20 in peak periods such as major holiday periods. Data from Cairns airport, which is located adjacent to coastal wetland habitat indicates that up to 24 bird strikes may occur for every 10,000 aircraft. It is expected that the annual number of aircraft using the airstrip at PTP will be well below 10,000 per year, and also, aircraft will be propeller driven, rather than jets, which have a higher incidence of bird strike. Hence, the number of birds potentially killed by aircraft is low, particularly in the context that HHI is not considered to support important populations of threatened birds.

Migratory shorebird movements generally occur along the coast at heights around 50-150m and hence, are unlikely to be affected by aircraft as the height above the coastline during take-off and landing will generally exceed 150m. An aircraft exclusion zone has been established over the important migratory shorebird roosting and foraging habitat south-east of the airstrip approach.

As grey-headed flying fox forage at night, this animal will not be affected by aircraft movements, as the airstrip will only be equipped for day time use.

Feral dogs and cats have been identified on HHI. The proponent will ban pet cats from HHI, and impose strict controls on domestic dogs such that the PTP will not contribute to the current level of predation risk on HHI. The Proponent also intends to implement a feral animal control program as part of the management approach for the proposed conservation area and wildlife habitat management plan. This will reduce predation risk for native animals on HHI.

With proposed pre-clearing surveys and development of avoidance or mitigation measures if required, existing populations of EPBC Act listed threatened and migratory species are not expected to be reduced by mortality from vegetation clearing and vehicle strike and reduced predation risk may benefit these animals.

In combination, impacts of injury, mortality and predation of terrestrial native fauna are not expected to affect biodiversity in the GBRWHA/NHP and hence this aspect of the OUV of the GBRWHA will not be diminished by the PTP.

ES12.7 Impacts on Individual marine threatened and migratory animals

Direct impacts on marine threatened and migratory animals and marine fauna generally may arise from:

- Injury or mortality from impingement or entrainment in the desalination plant intake
- Injury or mortality from boat strike
- Entanglement with litter and debris
- Impacts of lighting on nesting turtles and hatchlings
- Noise from boat ramp and bridge construction
- Increased recreational fishing effort
- Upgrade of zoning of Rodds Bay Dugong Protection Area.

The proposed desalination plant intake will be placed on the bridge and will draw water from the middle of the Boyne Creek. Impingement and entrainment impacts will be negligible as the intake screen around the inlet pipe has a surface area of about $2.5m^2$ and intake velocity will be low. Entanglement with and ingestion of litter and debris is a significant cause of turtle strandings and mortality. Migratory shorebirds may also ingest and become entangled with litter and dugong may become entangled with debris such as fishing nets.

It is illegal to drop litter on land or from a boat and the Proponent will make sure that all visitors, including recreational boaters are aware of this law and of the impacts of litter on marine turtles and other marine fauna. Restrictions are also in place under the Queensland *Fisheries Act 1992* and the Great Barrier Reef Marine Park Zoning Plan (GBRMPA 2003) in relation to fishing methods and in particular use of certain mesh nets that may entangle dugong and turtles.

The Proponent also proposes mitigation measures on land to minimise litter being blown or washed to the marine environment, including retention of coastal vegetation, pollutant traps in the stormwater system, provision of rubbish bins and regular litter collection. The Proponent will also promote the use of biodegradable plastic packaging amongst retailers within the PTP. Construction contractors will be required to keep construction sites free of litter.

The Proponent will also provide signs and written awareness raising information to inform recreational boaters of the sensitivity of the waters in terms of turtles and dugong, and the need to adhere to speed limits, avoid littering and maintain a close look out for turtle and dugong.

Intermittent, low level flatback turtle nesting has been observed on the beach to the north-east of the proposed PTP. The separation distance, natural topography and retention of coastal vegetation will limit the potential for lighting from the proposed development to disorient nesting females and hatchings. Light levels on the beach will be monitored and further screening applied if necessary. The building specifications in the Plan of Development also specify that light spillage must be minimised. Construction of the proposed bridge and boat ramp will generate some underwater noise however this will be intermittent and of short duration, in the order of one to two months. Adverse impacts on dugong and marine turtles are not expected due to the short duration of works and low noise levels from most aspects of the works.

Increased access to waters around HHI will increase recreational fishing effort, since the main activity undertaken by recreational boaters is fishing. Fishing effort and recreational fish catch has declined from 2000 to 2010 at a Statewide and regional level, indicating that pressure on fish stocks from recreational fishing on has reduced.

While waters around HHI are already accessed by recreational fishers, an increase in recreational fishing effort is expected in the Colosseum inlet/Boyne Creek/Seven Mile Creek estuary due to the provision of the proposed boat ramp. Recreational fishing effort in offshore coastal waters will increase to a lesser extent as the size of boats that can be launched at the proposed boat ramp will only be able to access the open coastal waters in fin weather and, due to navigational restrictions at the mouth of Colosseum Inlet and Seven Mile Creek, under certain tidal conditions.

While an increase in local recreational fishing effort is predicted, recreational fishing effort at a regional level is not expected to increase as a result of the proposed PTP as the overall population increase from the proposed PTP is very small at a regional scale, and the proposed boat ramp is likely to result in redistribution of recreational boating activity an fishing effort rather than an overall increase. Hence, while GBRMPA has noted concerns about impacts of recreational fishing in proximity to major regional centres such as Gladstone, fish populations at a regional level should not be further affected by the proposed PTP.

Controls on fishing methods and the number of fish and season when certain species can be taken are in place under the GBRMP zoning plans and Queensland *Fisheries Act 1992*. These controls are imposed to regulate the sustainable use of fisheries. Through its zoning plans, GBRMPA has designed approximately one third of the GBRMP/GBRCMP as “no take” zones (GBRMPA 2012). The proponent will ensure that signs and written information on fishing restrictions are available at the boat ramp and tourist information centre.

Given that the overall number of recreational boats likely to engage in fishing activities in water around HHI remains low at most times, and the legislative controls in place on recreational fish catch, it is not considered likely that unsustainable levels of fishing will occur in the local area. MNES present are not likely to be affected directly by reduced fish populations, and any reduction in fish populations is not likely to be significant enough to upset the balance of the food chain in the area. Impacts on MNES, including impacts on diversity of marine species and the contribution this makes to the OUV of the GBRWHA and the GBRNHP and GBRMP are not expected to be significant or unacceptable.

However, there is some uncertainty as to the overall effects of recreational fishing on fish stocks, and the proponent will ensure that if any additional controls are imposed by either GBRMPA or the Queensland Government that recreational boaters using the boat ramp are made aware of these.

If a proposal by the Queensland Government to upgrade the zoning of the Rodds Bay Dugong Protection Area goes ahead, the proponent has committed to purchasing up to four commercial fishing licences so that the local and regional commercial fishing industry is not disadvantaged by the rezoning. This would reduce fishing pressure in the region and would also further restrict the use of mesh nets in this area which would benefit dugong and marine turtles.

ES12.8 Increased levels of activity in the GBRWHA/NHP and GBRMP

The proposed PTP is expected to result in increased visitation to the Mackay-Capricorn management area of the GBRMP/GBRWHA/NHP. This will include boat based and land based activities. Improved access to the GBRWHA/NHP and GBRMP may also increase research activity in the area. Increased activity levels may increase associated activity-related impacts but will also facilitate access to and enjoyment of the WHA/NHP and MP. The Mackay-Capricorn management area received 120,000 visitor days in 2012 which is seven per cent of the commercial tourism visitor days to the GBRMP.

The capacity of the proposed PTP is planned to be 3,900 persons, made up of around 2,300 tourists and 1,600 residents. Visitor levels will fluctuate throughout the year, depending on seasons, school holidays and other factors. Visitors may access the GBRMP and waters of the GBRWHA/NHP via commercial marine tour operators, or may bring their own boats.

As the proposed PTP does not include any marina or mooring activities, boat-based commercial tourism operating directly from HHI would only be able to utilise smaller, trailerable boats or alternative vessels such as kayaks. Larger boats could be based at Gladstone, potentially with a booking agent at the proposed PTP.

The proposed PTP will include an airstrip and in future, it is possible that commercial tour operators will operate scenic flights from this airstrip. There is currently one scenic flight operator in Gladstone and charter flights are also available from Gladstone to Lady Eliot Island and Lady Musgrave Island.

Operation of a commercial tourism activity in the GBRMP requires a permit from GBRMPA, which allows GBRMPA to regulate sustainable levels of commercial tourism activities. Given the range of controls in place, GBRMPA considers impacts of commercial tourism to be minor (GBRMPA 2009). Given GBRMPA's ability to regulate commercial scenic flights through its permit system, significant or unacceptable impacts on the GBRMP and the OUV of the marine component of the GBRWHA/NHP are not expected. As noted above, if scenic flights are operated from PTP, the proponent will impose a buffer zone above and either side of key migratory shorebird roosting and foraging sites.

A number of visitors to the GBRMP and GBRWHA/NHP do not utilise commercial tours but use their own boats. This is particularly the case for residents living adjacent to the GBRMP/WHA/NHP who make an average of 15.5 visits per year to the GBRMP/WHA/NHP, mostly involving boat based activities or swimming and mostly lasting for one day or less. The permanent residential population for the project is less than 1% of the regional population and well within population growth forecasts for the region. Associated increase in boat ownership attributable to the project is predicted to be about 120 boats, a very small proportion of regional boat ownership which was estimated to be 46,000 boats in January 2013. At a regional level, increases in visitation levels to the GBRMP/WHA/NHP are therefore not considered significant.

An increase in local visitation levels is expected in the waters around HHI, particularly as the project includes a formal boat ramp. Recreational boaters can currently access Colosseum Inlet/Boyne Creek/Seven Mile Creek from boat ramps at Turkey Beach and Tannum Sands, and boats also launch from the mainland side of the existing causeway and several other informal locations.

Based on current usage levels of boat ramps in the region, it is estimated that around 50-150 boats will utilise the new boat ramp each weekend, with peak numbers occurring on key holiday weekends. This will include existing residents of the region, new residents of PTP and those visitors to PTP that bring their own boats. Studies by the Queensland government have identified that there will be a regional shortfall in boat ramps in the next 10-15 years if new facilities are not provided. Many of the boats utilising the PTP boat ramp will represent a redistribution of boating activity rather than an overall increase in boating activity at a regional level.

The types of boats that will utilise the boat ramp at PTP will be small trailerable boats, typically up to six metres long with outboard motors. This gives rise to the potential for discharge of human wastes and small quantities of hydrocarbons from recreational boats. Queensland legislation prohibits release of litter, oils, hydrocarbons and other contaminants from vessels into waters. Even if releases do occur, the amounts will be very small, with predicted boat usage at the boat ramp of up to 150 boats on peak holiday weekends, the typical length of trips being less than five hours and boat occupancy is typically three people or less. Both human wastes and hydrocarbons will be broken down and assimilated through chemical, physical and biological processes and it is unlikely that any degradation of water quality will occur.

Boat strike, from both recreational and commercial boats, has been identified as a threatening process to marine turtles and dugong. Higher risks are associated with faster moving boats, particularly in shallow waters.

Navigational limitations in the waters around HHI will naturally restrict boat speed and as an estimated 84% of recreational boating activity is associated with fishing, boats in the Colosseum

Inlet/Boyne Creek/Seven Mile Creek area will often be stationary or drifting, with only short trips required to move from the boat ramp to fishing areas. The large seagrass bed in Seven Mile Creek, and smaller seagrass beds on the banks of Seven Mile Creek and Boyne Creek and tributaries are intertidal, and this also limit boat movements and boat speed across key foraging areas. Seagrass beds offshore from HHI are in deeper water which will make it easier for turtles and dugong to avoid boats.

The *Transport Operations (Marine Safety) Regulation 2004 (Qld)* includes a general speed limit of six knots in the vicinity of boat ramps and near the shoreline. The Coordinator-General has recommended that this speed limit be extended by Maritime Safety Queensland (Queensland Coordinator-General 2011). While the proponent does not have the legal power to impose a speed limit for recreational boats, the proponent is committed to working with Maritime Safety Queensland to also impose a six knot speed limit on vessels in all sensitive habitat areas.

By limiting boat speed, the risk of boat strike of turtles and dugong will be reduced and the overall risk at a regional level is not expected to increase. Significant impacts on marine turtle and dugong populations from boat strike are therefore no expected.

The location of the PTP in the Mackay-Capricorn Region of the GBRMP/GBRCMP and GBRWHA presents a range of opportunities in relation to raising environmental awareness and appreciation. There is limited tourism development in this southernmost part of the GBRWHA and marine park and a consequential reduced appreciation and awareness of the features of the area that contribute to the Outstanding Universal Value (OUV) of the GBRWHA and the values of the GBRMP/GBRCMP.

An environmental education facility is proposed at PTP to encourage community awareness, appreciation and understanding of native wildlife and to present and promote the GBRWHA/NHP values to visitors. Programs offered at the facility will promote an understanding of the environmental values of the GBRWHA/NHP and the GBRMP and will include both voluntary conservation works and environmental education.

Tourism attractions to be developed on HHI will be required to have natural and cultural heritage themes, taking advantage of the natural setting. These will also provide an important opportunity to present the heritage values of the area and raise awareness of the need to protect natural and cultural heritage values.

ES12.9 Changes in Landscape Character and Visual Amenity

The project footprint will be partially visible from several locations on the mainland, including some parts of Tannum Sands and the small settlements of Bangalee and Mundoolin Rocks and also to people on recreational boats and commercial ships offshore to the north of HHI. From most viewpoints, HHI appears indistinguishable from the mainland, and does not feature the spectacular scenic values and amenity that contribute to the OUV of the GBRWHA. HHI is not located in a remote and undeveloped area of the GBRWHA/NHP and does not have wilderness values.

Visual impacts of the PTP will be minimised by a number of measures:

- Vegetation clearing will not occur within the coastal zone. Vegetation clearing will also be minimised throughout the proposed development, with building clearing envelopes restricting clearing to 50% of most blocks, and at least 50% of habitat trees to be retained.
- Development will follow existing contours with minimal changes to landform. In particular, buildings will not protrude above the wooded ridgeline.
- Strict controls will be imposed on building heights, built form building materials and colours.
- Lighting will be designed to minimise light spill beyond the development footprint.

With these measures in place, minimal change will be discernible from most viewpoints. The existing natural setting is largely retained and buildings will be well screened by retained vegetation. Impacts on aesthetic values of the GHRWHA/NHP were examined using the Queensland Government's Scenic Preference Rating Tool and no significant change to the contribution that HHI makes to the OUV of the GBRWHA was identified.

The footprint will be visible from commercial flights into and out of Gladstone, however, these views are in the context of the port, industrial and residential development associated with Gladstone, and are not part of a tourism experience of the GBR.

ES12.10Impacts on geological and geomorphological features and processes

HHI does not feature any unique or unusual landscape or geomorphological features and in this regard makes only a minor contribution to the OUV of the GBRWHA. HHI and its surrounds present examples of coastal geological and geomorphological processes associated with estuary, beach and dune formation and is an example of a continental island.

The footprint and development precincts of the proposed PTP have been specifically designed with existing topographic features in mind. The headland, which is a prominent feature, will not be altered at all, and the natural landform is taken advantage of in terms of being a focal point for the proposed development. HHI will remain as an example of a continental island, although it is considered to make only a minor contribution to the OUV of the GBRWHA in this regard. Sand dune formations will be largely avoided and apart from the bridge and boat ramp, there is no development in the coastal zone. Where access to beach areas is provided, elevated walkways and staircases will be used. The bridge and boat ramp will be designed to minimise changes to tidal flows and associated coastal processes in Boyne Creek. Stormwater management and drainage has also been designed so that existing subcatchments are retained with minimal alteration and runoff is managed such that increased erosion or destabilisation of ephemeral watercourses is avoided.

All landform features, including the continental island itself, the headland, Hummock Hill and coastal dune systems will therefore remain visible with negligible modification and diminution of the contribution that geological and geomorphological features of HHI and surrounding waters make to the OUV of the GBRWHA is not predicted.

ES12.11Summary of Impacts

No significant or unacceptable impacts resulting from the PTP were identified by the Proponent's EIS team. Direct and indirect impacts on MNES values identified as highly important, including those identified as making a major contribution to the OUV of the GBRWHA will be avoided through the layout of the development footprint and availability of natural buffers between these values and areas of activity.

Direct impacts on moderate importance MNES values will be largely avoided. About 40% of the extent of *Eucalyptus tereticornis* and *E. crebra* dominated forests will be cleared however the remnant patches are of adequate size to remain viable.

There will be a small number of direct impacts on lower importance MNES values but the severity of impacts is low and significant impacts are not expected.

Indirect impacts on moderate and lower importance MNES values will all be low or negligible due to design features of the PTP and the availability of established and reliable mitigation measures to manage unavoidable impacts.

There is some uncertainty as to the prediction of impacts on yakka skink and collared delma, both of which are listed as vulnerable under the EPBC Act. While these animals have not been identified in surveys to date, survey methods do not fully meet guideline requirements and it is possible that these small, cryptic reptiles have been missed. Additional habitat assessment and survey is proposed and if these reptiles are identified, habitat will either be avoided, or the animals will be translocated. As the success of translocation can be difficult to guarantee, the Proponent will involve recognised brigalow belt reptile specialists in development and implementation of relocation plans and will also control predators prior to translocation, as this is identified as the key reason why translocation programs fail.

There is also some uncertainty regarding prediction of impacts associated with recreational boating. Increases in recreational boating activity are largely associated with regional population increases, but the proposed PTP will provide improved access to the waters around HHI compared to what is currently available. GBRMPA has identified that recreational boating impacts in high use areas adjacent to major population centres pose a moderate threat to the GBR ecosystem but acknowledges that information on the actual effects of recreational boating is lacking. The Proponent has proposed a number of mitigation measures in addition to existing regulatory controls on recreational fishing, littering and contamination of waters. The Proponent has also committed to undertaking an ongoing marine water quality monitoring program and marine ecosystem monitoring program. If these programs identify degradation of water quality and/or habitat, and this is attributable to recreational boating, the Proponent will seek to work with GBRMPA, DNPRSR, Maritime Safety Queensland and other stakeholders to determine additional controls that may be required. The Proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

Otherwise, the level of confidence of impact predictions is high. Modelling has been used where necessary to demonstrate effectiveness of mitigation measures, particularly in relation to wastewater treatment and management, irrigation with recycled water and stormwater management. Monitoring is also proposed to validate model predictions and effective corrective actions are available where monitoring indicates that objectives are not achieved.

For other impacts, the high level of confidence arises because the impact mechanisms are well understood, the severity of the impact is negligible or low and there are well established and effective mitigation measures available to control residual impacts.

ES13 Cumulative Impacts

While no significant or unacceptable impacts on MNES were identified from the construction and operation of the proposed PTP, the potential for residual insignificant impacts to combine with impacts of other development in the region was examined. This is important given that the Gladstone Region has a population of nearly 60,000 people and features one of Australia's largest ports and a 29,000 ha State Development Area which provides land for existing industrial developments and has potential to attract future industrial development.

Current ecosystem health in the Port Curtis/Rodds Bay area appears to have been affected by severe wet weather events in January 2011 and January-February 2013 which have affected seagrass beds at both impact and control sites. These effects may have masked other impacts from major capital dredging programs and construction projects in the region. However, monitoring undertaken for dredging activities indicates that, apart from during and in the weeks following the severe weather events, water quality and light penetration indicators have reportedly been met.

Ecosystem health monitoring undertaken prior to the severe weather events by PCIMP indicated that ecosystem health in Port Curtis and Rodds Bay was good, with very little deviation from background sites.

There are five medium to large development proposals currently undergoing assessment in the region, including a residential development, two industrial developments, a coal export terminal and a capital dredging program. Given the presence of the Port of Gladstone and the Gladstone State Development Area it can also be expected that Gladstone will remain a hub for ongoing port and industrial development.

Under the EPBC Act, development with potential to impact on MNES must be assessed and can only proceed if an approval is given. Development with impacts on the environment generally also requires assessment under Queensland legislation. These processes provide controls on future development such that both levels of government can curtail certain types of development if unacceptable cumulative impacts are predicted.

The population of Gladstone Regional Council is forecast to almost double in the next two decades. The residential component of the proposed PTP and employment opportunities created will make a minor contribution to population increase, but the PTP represents 3% of the forecast population growth is not expected to cause population forecasts to be exceeded. Development on HHI has been envisaged since the Special Lease was issued in 1991, and the HHID/PTP was designated a significant project in 2006 and identified in the Central Queensland Tourism Opportunities Plan in 2009, allowing for agencies involved in population forecasting to be aware of the potential for the development to proceed.

A growing population will increase pressure on the environment. At a local and regional level, these pressures include clearing land for residential development and generation of wastewater and stormwater. Development approval requirements, including approval requirements under the EPBC Act and Queensland Government requirements include controls on clearing of land such that biodiversity is maintained. This includes requirements to offset remnant native vegetation and important habitats, if clearing cannot be avoided. Current approaches to stormwater and wastewater management focus on avoiding or minimising discharge of contaminants to surface waters and hence, new developments have reduced impacts in this regard.

A key area of concern in relation to impacts of population increase on the OUV of the GBRWHA/NHP and the GBRMP is the increase in recreational boating activity. An estimated 8-9% of the population owns a boat, although most boat owners use their boats infrequently. The population increase attributable to PTP is expected to contribute about 120 boats to an existing 46,000 registered boats in the Gladstone Region (Hervey Bay to Rockhampton) and 8,300 boats in the immediate Gladstone area. In terms of cumulative impacts associated with existing and forecast levels of boat ownership, this is insignificant. The main effect of PTP on recreational boating will be to provide improved access to the waters around HHI for small, trailerable boats. This is not a cumulative effect however, but largely represents a redistribution of activity. Associated impacts on MNES values have been assessed and are not considered significant. Demand for ancillary facilities for larger boats, such as marinas, is not expected to increase as access for larger boats to waters around HHI will not change because of the shallow tidal waters around the island.

GBRMPA has the ability to control impacts of activities in the GBRMP through zoning plans and permits and these are mirrored at the State level for the GBRCMP. However, lack of information on impacts of recreational activities may make it difficult for GBRMPA and the Queensland Department of NPRSR to set sustainable limits on these activities, particularly in the short to medium term.

In order to provide a further dimension to the cumulative impact assessment, the EIS also examined the extent to which the proposed PTP might contribute to existing threats to the GBR ecosystem, as identified in the Great Barrier Reef Outlook Report 2009 and to terrestrial biodiversity as identified in Australia's Biodiversity Conservation Strategy 2010-2013 (NRMMC 2010). The assessment identified that PTP is not considered to contribute to any of the identified threats.

Given that PTP will not contribute to cumulative impacts of development at a regional scale, or to threats to the GBR ecosystem or terrestrial biodiversity, no new management or mitigation measures were identified from the cumulative impact assessment.

However, the Proponent does recognise that population increases in the Gladstone Regional Council may lead to increased levels of recreational boating and fishing over and above that assessed in this environmental impact statement and that provision of a boat ramp at PTP will lead to local intensification of recreational boating activity. The Proponent will seek to work with GBRMPA and relevant Queensland Government agencies with management responsibilities in relation to impacts of recreational boating.

ES14 Consequential and Facilitated Impacts

The consequential impacts of providing improved access to land and water components of the GBRWHA/NHP and the GBRMP have been addressed as part of the impact assessment.

There has previously been a mineral sands exploration permit over part of HHI, however the permit has expired and, if the proposed PTP goes ahead, it is considered unlikely that a new exploration permit or mining lease would be issued. If a proposal to mine mineral sands was put forward by a third party, such a proposal would require assessment under EPBC Act and also Queensland legislation.

Pressure for other types of development on HHI is unlikely to arise. Outside the special lease, tenure is State land and this is therefore not available for development. Further, the Proponent has committed to surrendering the remainder of the special lease and creating a conservation area across the balance of HHI.

While PTP will make a small contribution to population growth in the region, any growth is expected to be within existing population forecasts and is not expected to trigger the need for significant additional community services and facilities.

Increase in demand for goods and services will arise due to the proposed PTP. As PTP is located within easy road distance of the Bruce Highway and the population centre of Gladstone, it is unlikely that any providers of goods and services to the proposed PTP would seek to develop substantial additional facilities or premises in currently undeveloped areas. Given the scale of PTP when compared to existing and proposed industrial developments in Gladstone, and the population of Gladstone generally, it is unlikely that significant additional development would occur in Gladstone in order to provide goods and services to PTP.

The proposed PTP will increase tourist numbers in the Central Queensland region which will in turn increase demand for commercial tourism services. Commercial tourism activities in the GBRMP require a permit under the *Great Barrier Reef Marine Park Act 1975* which allows GBRMPA to consider sustainable tourism levels when assessing permits. Commercial tourism activities in the Mackay-Capricorn management area of the GBRMP are lower than in other areas (GBRMPA 2009), and any increases arising from the proposed PTP are expected to be well within sustainable limits. Increased demand for commercial tourism activities associated with the GBRMP will provide economic opportunities in the Gladstone region.

Gladstone already has a marina and associated facilities to support boat based commercial tourism and hence, an increase in demand for these activities is not likely to lead to a demand for further coastal or marine infrastructure.

Increased tourism numbers will also mean increased visitation levels at other tourist attractions in the region. A review of available and planned tourism attractions in the Central Queensland Tourism Opportunity Plan indicates that land based activities currently available are not likely to impact on MNES. Should new tourism activities centred on MNES be developed, these would potentially require assessment under the EPBC Act. The Central Queensland Tourism Opportunity Plan identifies that existing tourist activities are possibly underutilised, and the proposed PTP will also provide tourist and recreational activities as part of the development, hence significant new demand for tourism activities is not expected to arise. Consequential impacts on MNES from an increase in tourism related activities are therefore not expected.

ES15 Environmental Management Plans

A Draft Environmental Management Plan (EMP) framework has been prepared to provide input into the detailed planning, design, construction and operation phases of the project. These plans will form the basis of the development of the final plans to be used on site to ensure the safe, efficient and environmentally responsible management of the construction and operation of HHI.

The EMP provides the State and Local authorities, and the Proponent with a framework to confirm compliance with relevant legislation, regulations, policies and requirements. The plans will also provide the community with evidence that the management of the project will be undertaken in an environmentally responsible manner.

ES16 Compliance with Objectives of EPBC Act

The assessment undertaken indicates that the project is consistent with the objectives of the EPBC Act:

- Potential impacts have been rigorously assessed. A range of design and mitigation measures are proposed that will effectively and reliably manage impacts. Particular attention has been given to the overall development footprint which avoids all areas assessed as being of moderate or highest importance for MNES, and design measures that avoid adverse impacts on sensitive components of the environment.
- The project will use natural resources in a sustainable manner, including a closed loop recycled water system and partial supply with solar energy. A range of sustainability principles have been identified and incorporated into the proposed development.
- The Proponent will establish a conservation area across the balance of the Island and, on completion of the proposed development, surrender the remainder of the special lease for inclusion in the conservation area. This will remove further threat of development and provide management and protection of MNES values, particularly in relation to contribution that terrestrial biodiversity of HHI makes to the OUV of the GBRWHA/NHP.
- The project will provide an opportunity to present the OUV of the GBRWHA/NHP to visitors, thus raising awareness and appreciation of the WHA/NHP and associated outstanding universal values.

- The Proponent has committed to working with a range of Australian and Queensland Government agencies as well as Traditional Owners in relation to management of the land and waters surrounding the PTP. Relevant agencies and groups include the GBRMPA, Maritime Safety Queensland, the Queensland Department of National Parks, Recreation, Sports, and Racing, Queensland Department of Agriculture, Forestry and Fisheries, Gladstone Regional Council and the Port Curtis Coral Coast Aboriginal Corporation.
- The proposed PTP does not detract from the Australian Government's international treaty obligations as MNES values are retained and protected
- The Proponent is committed to working with Traditional Owners who have expressed an interest in participating in training programs in relation to tourism occupations and in partnering with the proponent on traditional knowledge and management approaches.

ES17 Compliance with Principles of Ecologically Sustainable Development

The concept and design of PTP is based on Ecologically Sustainable Development principles and is consistent with these principles:

- The EIS supports the decision making process by presenting a rigorous analysis of environmental economic and social aspects of PTP and proposing effective design and mitigation measures to ensure that the social and economic benefits of the project are not achieved at the expense of environmental values.
- The EIS assessment has not identified any serious or irreversible impacts on MNES or on the environment generally. Biodiversity values will be retained and essential services that underpin ecosystem health will not be not affected.
- Inter-generational equity will be retained as the PTP is not expected to have any adverse impacts on the health, diversity and productivity of the environment such that adverse impacts on current or future generations might occur.
- Intra-generational equity will be preserved as there are no particular elements of the community that will adversely affected by the PTP and the project includes a wide range of accommodation types and other facilities to meet the needs of a broad demographic.
- The EIS has not identified any adverse impacts on biological diversity or ecological integrity. Sensitive features have been avoided and water management systems designed to avoid degradation of water resources. The Proponent is committed to establishing a managed conservation area across the balance of HHI and this will assist in conserving terrestrial biodiversity in the Mackay-Capricorn region of the GBRWHA/NHP.
- PTP will promote sustainable use of natural resources including water and power supply.

ES18 Social and Economic Issues

ES18.1 Regional Profile

The Gladstone Region LGA amalgamated in 2008 from the Gladstone City, Calliope and Miriam Vale Shire LGAs. The LGA, with a total population of 59,500 people, is a diverse region with Gladstone City at its centre. Gladstone City is a major port and industrial centre, with the social and community facilities expected of a major regional city. The main urban centres are:

- Gladstone City, the largest urban centre (pop 35,000) , including the CBD
- The twin towns of Tannum Sands and Boyne Island (pop12,000), a coastal community immediately south of Gladstone
- Calliope, (pop 1,800) a dormitory town, west of Gladstone City
- Agnes Waters and 1770 (pop 3000) a coastal tourist centre 120km south of Gladstone.

The closest regional centres to Gladstone are Rockhampton (pop 76,000) located 110 km to the north of Gladstone and Bundaberg (pop 71,000) located 160 km to the south.

GRC continues to have problems providing equitable services across the local government area. Rapid population growth continues to have service demand impacts, particularly in the past 2 years with the commencement of construction of major coal-seam gas plants and other major facilities around the Port of Gladstone and the adjacent State Development Area. There has also been inadequate State and Federal Government funding to support the commensurate growth in demand for services.

There are 18 primary and preschools in the Region offering education for students in preschool to Year 7. Tertiary educational institutions include Central Queensland Institute of TAFE (CQ TAFE) and Central Queensland University. Traineeship opportunities are available through local employers and are supported by neighbouring TAFE colleges and training bodies such as the Gladstone Area Group Apprentices Ltd.

Tourism is a key industry in the both the Central Queensland and Gladstone Regions. For the year ending June 2012 domestic overnight visitors spent $710 million, domestic day visitors spent $267 million and international visitors spent $81 million, totalling nearly $1.1 billion or $2.9 million per day. However, high quality tourism facilities and infrastructure within the Gladstone Region remains relatively undeveloped outside the Agnes Waters/1770 area.

There is currently a shortage of accommodation and rental housing supply in the Gladstone region. The pressure for housing is mainly due to population growth from the expansion of industries including the development of major coal seam gas projects in Gladstone. It is anticipated that over 9,000 additional allotments/entitlements will be required within the Gladstone Regional LGA over the next 20 years. Affordable housing and shortages of rental accommodation is a major social issue in Gladstone.

ES18.1.1 Impacted communities

The communities closest to HHI and most likely to be impacted or benefited by the Project are:

- A rural residential subdivision of about 20 homes (Foreshores Estate) at the end of Foreshores Drive
- Holiday houses at Bangalee on the northern side of Colosseum Inlet
- Seven dwellings at Mundoolin Rocks east of Clarks Road.

The nearest townships to HHI are:

- Turkey Beach, a small coastal community, 25 km east of HHI, with about 200 permanent residents, a general store and public boat ramp
- Bororen on the Bruce Highway 20 km from HHI, which has a shop and a service station.
- A farming community of 600 - 700 families reside within a 20 km radius of the project.

ES18.1.2 Local Community Concerns

Consultation undertaken for the EIS identified issues in relation to potential social impacts including:

- Potential for increased traffic on existing roads, including Turkey Beach Road and Foreshores Road and the need for speed limits (road and water) to minimise wildlife accidents
- Possible degradation of landscapes and visual amenity
- Loss of open space and recreational opportunities on and around the Island, including fishing, and camping
- Capacity of schools and community facilities, including health facilities, to meet the demands of an increased population
- Concern over access for and provision of emergency services
- The need for a mixed range of residential housing and/or lots to be provided which cater for varying levels of affordability
- Potential for adverse impacts on the local housing market.

A number of benefits relating to the Project were also identified during community consultation, including:

- Potential for improved access to and utilisation of HHI
- Potential for increased property value for nearby landowners
- Improved recreational opportunities
- Increased residential development to support employment growth in the region

- Potential employment opportunities for local residents during the construction and operation phases of the Project.

ES18.2 Community Benefits

PTP would improve the range of facilities available to existing neighbourhoods, including retail and hospitality outlets for their use, and contribute to economic vitalisation in the immediate area. The Island community is expected to retain a 'small-town' coastal lifestyle with the convenience of access to a range of community services and facilities, including recreation, retail, emergency services, community hall and meeting places.

The Project is proposed to provide a range of options for holiday properties and houses for permanent residents, as detailed in the Project Description. PTP would increase the availability of residential properties in the area and provide existing local residents with access to a range of residential property options, including affordable units through to high value headland homes.

PTP is likely to help to retain younger people (15-24 years) in the area offering employment opportunities in tourism and related industries.

The following mitigation measures are proposed to maximise potential benefits and manage or avoid potential impacts on community services and facilities:

- Consultation and communication with relevant Local and State Government agencies to identify and gain commitment for provision of and contribution to social infrastructure requirements to meet the expected increase in population
- An accommodation management strategy, prepared in consultation with the Queensland Department of Housing, to ensure that adequate housing is available for construction workers and their families, and to ensure that potential housing-related impacts on the broader community are appropriately managed
- Consultation and communication with the Department of Emergency Services to identify and agree provision for emergency services
- Liaison with Rockhampton and/or Bundaberg emergency helicopter services to be included on the helicopter landing register and to develop protocols
- Consultation and communication with health authorities regarding needs of older residents, including health care, and to identify and agree on-Island health service responses, including home care services
- Provision of office space to allow for private health providers
- Facilitation of development of community groups, support networks and events to build social capital within the community
- Incorporation of Crime Prevention through Environmental Design (CPTED) principles to into the design of residential, commercial and community facilities and outdoor spaces

- Consultation and communication with Surf Lifesaving Queensland to investigate and determine the level of provision of private, funded or volunteer surf lifesaving services
- Establishment of beach safety measures, including lifeguard tower, and investigation of the need for swimming enclosure to avoid marine stingers
- Consultation with Queensland Department of Transport and Main Roads (DTMR) regarding the demand for and supply of public transport services for island residents
- Upgrading of Turkey Beach Road and Foreshores Road to cater for increased traffic loadings.

ES18.3 Project benefits

Benefits of the project include:

- Provision of 5% of the anticipated tourism expenditure target set by the Queensland tourism strategy for 2016
- Creation of community recreation facilities including sporting fields, public parks, 18 hole wild golf course and country club, tennis courts, cycling paths, a lawn bowls green, beaches, boating facilities, camping grounds etc. It is proposed that the Project would support the establishment of a primary school through the provision of land for a school, if required
- Provision of 260 construction jobs per year within the immediate region, directly and indirectly associated with the development over the 16 year development period
- Creation of employment opportunities that include skilled and unskilled positions in engineering design, construction supervision and trades, earthmoving, equipment operation, building and landscaping.
- Creation of around 700 jobs by 2024 directly employed in the tourism and hospitality services sector of the proposed development. This broadens the diversity of employment opportunities in the region and contributes to a more sustainable employment base.
- An increase in accessibility to estuarine and coastal waters which increases recreational and nature-based opportunities for the local population
- Improvement in the range of facilities available to existing neighbourhoods, including retail and hospitality outlets for their use, and contribute to economic vitalisation in the immediate area.

ES19 Conclusions

The PTP is a controlled action with the following controlling provisions:

- Sections 12 and 15A - World Heritage properties
- Sections 5B and 15C National Heritage places
- Sections 18 and 18A - Listed threatened species and communities
- Sections 20 and 20A - Listed migratory species
- Sections 24B and 24C – Great Barrier Reef Marine Park.

The individual species, ecological communities and other values that contribute to these overarching MNES were identified and the importance of each individual value or component was assigned using pre-determined rankings of lower, moderate or highest importance.

The following values of highest importance were identified on HHI:

- Migratory shorebird habitat on the south-eastern mud- and salt-flats of HHI form part of a Mundoolin/Colosseum/Rodds Bay conglomeration of sites that are internationally important with respect to the eastern curlew and nationally important with respect to other migratory shorebirds.
- About 190 hectares of the critically endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia is present on HHI.

These values are important in themselves but also make a major contribution to the OUV of the GBRWHA.

The following values of moderate importance were identified on HHI:

- Marine turtle and dugong foraging habitat occurs in waters around HHI and flatback turtles nest intermittently and in low numbers on the beach to the east of the headland.
- Two vegetation communities that are not well represented within the GBRWHA/NHP, being a 10 hectare patch of *Eucalyptus melanophloia* woodland and 385 hectares in total of *Eucalyptus tereticornis* and *E. crebra* dominated forests. These contribute to the floristic diversity of World Heritage and National Heritage controlling provisions.
- Overall contribution of terrestrial and marine biodiversity values of HHI and surrounding waters to the OUV of the GBRWHA (*important and significant natural habitats for in-situ conservation of biological diversity*) is also assessed as moderate.

All other values that were identified as present or likely to be present were considered of lower importance.

Potential impacts of PTP on MNES values were identified and evaluated using a methodology based on international best practice, adapted to assessment of impacts on MNES. A number of design and mitigation measures have been incorporated into the development concept to avoid or minimise impacts on MNES values and the environment generally, and further mitigation and management measures identified as part of this environmental impact assessment. Taking these measures into account, no significant or unacceptable residual impacts were identified.

Direct and indirect impacts on highest importance MNES values will be avoided through the layout of the development footprint and availability of buffers between these values and areas of activity. No reduction in the contribution that these features make to the OUV of the GBRWHA is therefore expected.

Direct impacts on moderate importance MNES values will largely be avoided through project planning and design. There will be a small number of direct impacts on lower importance MNES values but the severity of impacts is low and significant impacts are not expected. Indirect impacts on moderate and lower importance MNES values are likely to be all low or negligible due to design features of the PTP and the availability of established and reliable mitigation measures to manage unavoidable impacts. Again, reduction in the contribution that these features make to the OUV of the GBRWHA is therefore not expected.

There is some uncertainty as to the prediction of impacts on yakka skink and brigalow scaly foot, both of which are listed as vulnerable under the EPBC Act. These animals have not been identified in surveys to date, however additional habitat assessment and survey by experienced zoologists is proposed prior to any vegetation clearing and if these reptiles are identified, habitat will either be avoided, or the animals will be translocated.

There is also some uncertainty regarding prediction of impacts associated with recreational boating. Increases in recreational boating activity are largely associated with regional population increases, but the proposed PTP will provide improved access to the waters around HHI compared to what is currently available. GBRMPA has identified that recreational boating impacts in high use areas adjacent to major population centres pose a moderate threat to the GBR ecosystem but acknowledges that information on the actual effects of recreational boating is lacking. The Proponent has proposed a number of mitigation measures in addition to existing regulatory controls on recreational fishing, littering and contamination of waters. The Proponent has also committed to undertaking a marine water quality monitoring program and marine ecosystem monitoring program. The Proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

Modelling has been used where necessary to demonstrate effectiveness of mitigation measures, particularly in relation to wastewater treatment and management, irrigation with recycled water and stormwater management. Monitoring is also proposed to validate model predictions and effective corrective actions are available where monitoring indicates that objectives are not achieved. For other impacts, the high level of confidence arises because the impact mechanisms are well understood, the severity of the impact is negligible or low and there are well established and effective mitigation measures available to control residual impacts.

A range of mitigation measures have been identified to avoid or manage potential impacts on MNES and on the environment generally from the construction and operation of the PTP. Wherever possible, the project footprint and design has sought to avoid impacts. Key aspects in this regard include:

- A development footprint that avoids all areas of highest value and most areas of moderate value
- Provision of buffers within the development footprint to areas of retained vegetation
- Provision for wildlife movement within the proposed footprint, including wildlife corridors and highly permeable areas
- Retention of 50% of habitat trees in woodland areas

- Design of an enclosed water and wastewater management system that avoids discharges to the environment and provides for 100% recycling of treated wastewater
- Design of a stormwater system consistent with the principles of water sensitive urban design that manages the quality and quantity of stormwater to mimic pre-development conditions, with potential improvements in stormwater quality runoff compared to pre-development.

A wide range of other mitigation and management measures are proposed that will effectively and reliably mitigate all potential impacts. Existing best practice standards and guidelines will be applied wherever available, for example for erosion and sediment control and acid sulfate soil management.

In relation to impacts of recreational activities on the marine and coastal environment, a number of statutory controls are already in place and the Proponent will promote education and awareness of these controls, and the importance of compliance. The Proponent will seek to impose a six knot speed limit on recreational boats in sensitive habitat areas and will work with the Queensland Government to implement this commitment.

A strict monitoring regime will also be implemented for the golf course and other areas where recycled water is to be used. For the golf course, levels of nutrients and pesticides will be monitored in soils, groundwater and surface water runoff. Corrective actions are available were monitoring indicates that the stormwater management system or use of recycled water is not meeting pre-determined trigger levels.

In relation to ongoing management and monitoring of terrestrial environmental values, the Proponent will manage the balance of HHI as a conservation area and, on completion of the proposed development, surrender the remainder of the special lease, also for management as a conservation area. This will remove any pressure for development in the remainder of the development lease area and other land parcels on HHI. The proponent will also prepare a wildlife and habitat management plan for management of biodiversity values within the development footprint until the balance of the special lease is incorporated into the conservation area. The ongoing management of the conservation area will be funded through a bushland levy to be imposed on landholders at PTP by the GRC.

With respect to management of the marine environment, the Proponent will undertake a marine water quality monitoring program and marine ecosystem monitoring program and if results of this monitoring indicate that degradation of the marine and coastal environment is occurring, the proponent will investigate the causes of this and, if these causes are attributable to PTP, take corrective actions. Framework EMPs have been developed and are included in Appendix G.

The assessment has not identified any residual significant or unacceptable impacts that require offsets under the EPBC Act Environmental Offsets Policy (SEWPaC 2012).

The PTP is designed from the ground up on ESD principles. Triple bottom line factors of economic, social and environmental issues have been considered and incorporated into the master planned project from the design stage and this has been a significant factor in avoiding all significant or unacceptable impacts on MNES.

SECTION 1
Introduction

PACIFICUS
TOURISM PROJECT

Contents

1. Introduction

1.1 The Proposed Project

The proposal is to construct and operate the Pacificus Tourism Project (PTP), a tourist and residential development, including all associated infrastructure, services and facilities, on Hummock Hill Island (HHI).

HHI is situated at the juncture of the Wide Bay and Capricorn Coasts, 30 km south east of Gladstone (see Figure 1.1) and provides the ideal combination of warm climate, accessibility, deep water estuaries, safe beaches, clean air and a landscape that ranges from open cleared areas, re-grown vegetation and natural landscape. HHI is approximately 13 km long, 3 km wide, with a total area of 3,071ha. It is separated from the mainland by Boyne Creek, a shallow tidal estuary that flows into the deeper waters of Colosseum Inlet and Seven Mile Creek. Gladstone City is a 35 minute drive from PTP, with Tannum Sands and Boyne Island located 20 minutes to the north-west and the town of 1770 is a 90 minute drive to the south east.

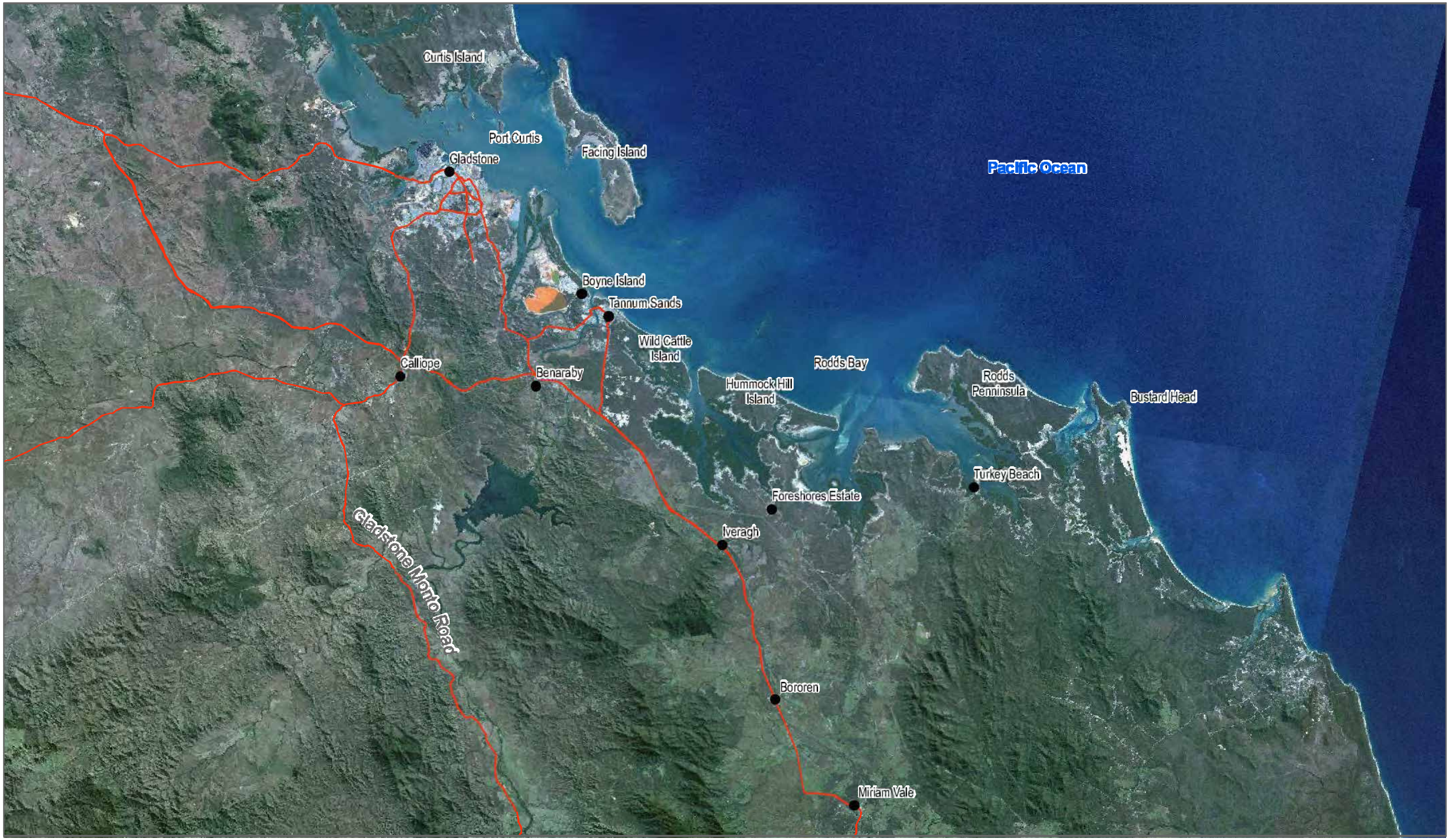
HHI and adjacent estuaries are within the Great Barrier Reef World Heritage Area (GBRWHA), the State administered Great Barrier Reef Coastal Marine Park (GBRCMP)and border the Mackay/Capricorn region of the Great Barrier Reef Marine Park (GBRMP) (administered by the Commonwealth). To the east of HHI is the Eurimbula National Park which is situated on Rodds Peninsula and to the north west is Wild Cattle Island National Park (refer to Figure 1.1).

The coastline within the region provides recreational opportunities for local and more remote populations associated with Gladstone and coal mines within the Bowen Basin to the west.

Eaton Place Pty Ltd (ACN: 110 480 772) (the Proponent) holds a Special Lease - SL 19/52155 (SL) over Lot 3 on FD841442 (1,163 ha) on HHI. The SL gives the proponent the right to develop the land for business, industrial, commercial, residential, tourism and recreational purposes. The Special Lease requires an Environmental Impact Assessment Study be undertaken (SL Condition C369) and consent for the development obtained from the Queensland Government and the Gladstone Regional Council. The Lease area had previously been used for cattle grazing and timber harvesting.

The PTP proposes to develop a range of tourist accommodation including resort hotels, holiday accommodation, camping grounds, as well as range recreational and leisure facilities. These facilities will be accessible to residents of PTP and adjoining communities, who currently lack easy access to these types of services. The PTP will also include education and village precincts, beach access, an 18-hole golf course (for wastewater recycling), retail outlets, community facilities and public infrastructure.

Only 10% of HHI will be developed. The remainder of HHI, after development, will be given conservation status under Queensland Government legislation and managed for environmental values and compatible recreational usage. Habitat values within the development footprint will also be retained to the extent possible and managed on concert with the conservation area. The Master Plan for the PTP is presented in Figure 1.2.



LEGEND

- ● Towns
- — Main Roads

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

0 2.5 5 7.5 10 km

1:450,000 on A4

Figure 1.1 - Site Location - Hummock Hill Island

PACIFICUS TOURISM PROJECT

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The Proponent recognises the outstanding universal value (OUV) of the Great Barrier Reef World Heritage Area (GBRWHA) and the values of other matters of national environmental significance (MNES) present on and around HHI and has strategically and rigorously designed PTP to protect and enhance MNES and particularly the OUV of the GBRWHA. The footprint of the PTP, and the approach to water cycle management, building design and services and infrastructure ensures minimal disturbance to the ecological and biological and cultural processes on the site and the surrounding marine environment. Where impacts cannot be avoided through design choices, management and mitigation strategies have been developed and are backed by a monitoring program to detect change in the quality of environmental values through the construction and operation phase. These will be implemented through implementation of a comprehensive, on-going Environmental Management Plan (EMP) and funded initially by the Proponent and then managed by local government using rates collected.

1.2 The Proponent

The Proponent for the project is:

Eaton Place Pty Ltd. ABN 79 000 155 591
Level 3, 53 Cross St
Double Bay 2028 NSW
Australia.

The principal shareholders of Eaton Place are the Scarf and Hatsatouris families of Sydney, New South Wales. Their family companies, along with associated businesses, have successfully undertaken major property developments, including shopping centres, apartment developments, and commercial property development over the past 30 years. There is a focus on quality in design and development of all projects the group undertakes. The Proponent has an exemplary environmental record. There are no current or former proceedings under a law of the Commonwealth or a State for the protection of the environment or the conservation and sustainable use of natural resources against Eaton Place Pty Ltd, any Board Member or its senior management.

1.3 Project History

HHI has a long history of human use; firstly by the local indigenous population and subsequently for pastoral activities, with the grant of a pastoral lease in 1870 that saw the Island used for raising beef cattle and as a source of timber. Vegetation clearing on HHI was required as a condition of Pastoral Lease renewals through this time.

The SL for development purposes was created in 1991 by the Queensland (Goss) Government following land use negotiations between mineral sand mining interests and State agencies that created National and Environmental Parks in areas of high conservation value, such as Byfield, Curtis Island, Wild Cattle Island, Rodds Peninsula, Eurimbula and Deepwater National Parks and Bustard Head Conservation Park. Remaining areas such as HHI and Middle Island were considered to have lower conservation values and also considered to have suitable opportunities for either mining or tourism. The SL has been regularly renewed since 1991 and was re-negotiated by the Proponent in 2005.

A number of developments have been proposed on HHI since the SL was issued and also following the re-negotiation of the lease. Plans were proposed for a tourism and residential development in the early 1990s; the subject of the 1993 EIS by the Tod Group (1993). Miriam Vale Shire Council issued a development approval for 5,000 lots, a marina, two golf courses and a hotel/convention centre in the mid-1990s. A further development was proposed in 1999 consisting of a hotel resort, caravan park, two golf courses, low and medium density residential, commercial science/technological precincts and a rocket and satellite launching facility.

Hummock Hill Island Development, (HHID), a project of similar size and design to PTP was the subject of a full environmental impact assessment in 2007. The project was declared a "Controlled Action" by the Commonwealth Minister for the Environment and Heritage (DEH)[1] on 13 January 2006 under Environmental Protection and biodiversity Act 1999 (EPBC). On 17 November 2006, The Project was declared a 'significant project for which an environmental impact statement (EIS) is required' pursuant to section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWOA)[2]. Under a bilateral agreement with the Australian Government, the Queensland Coordinator-General's Report was to be used by the Australian Government to make an assessment of the controlled action for the purposes of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EIS for the HHID project was advertised under the SDPWOA for public comment from 10 December 2007 until 4 February 2008. A Supplementary EIS (SEIS) which addressed the submissions made on the EIS was also undertaken. The Proponent conducted a public information and consultation program throughout the EIS process including face-to-face meetings with 'affected' and 'interested' parties, newsletter/fact sheets, online information and feedback tools, freecall 1800 number and reply paid mail service, as well as public displays and meetings. Following these extensive consultations with the public and all levels of government in Queensland, the Queensland Coordinator-General (CG) issued a Coordinator-General's report under the SDPWOA containing terms and conditions acceptable to all Queensland Government departments and the Gladstone Regional Council (GRC). The conditions of the Coordinator-General's Report are binding on the proponent and provide direction to State and local government agencies from which subsequent approvals must be obtained. Following unsuccessful negotiations with the then Department of SEWPaC the referral under the EPBC Act was withdrawn by the Proponent in July 2011. This did not affect the validity of the Coordinator-General's report in relation to Queensland government approvals.

Subsequently the Proponent and its key advisors met with SEWPaC/DotE staff on a number of occasions to formulate a new proposal that would address the Department's concerns and further address impacts on MNES, including the OUV of the GBRWHA. A new referral was accepted by the Commonwealth Minister for Environment on 14 December 2012.

[1] Since re-named Department of Sustainability Environment Water Population and Communities. (SEWPaC) and now Department of the Environment (DotE)
[2] Since December 2012, significant projects are now referred to as coordinated projects

The Queensland Coordinator-General has been briefed on the changes made in response to discussions with SEWPaC/DotE and regularly updated on progress of the PTP proposal and its assessment under the EPBC Act. The Proponent has been advised that the changes made from the HHID to the PTP are of a nature that can be dealt with as a change to the HHID project rather than requiring a completely new EIS to be prepared under the SDPWO Act. The application for a change to the project will be made under Part 4, Division 3A, Subdivision 1 of the SDPWO Act which, among other things requires an assessment of any changes in the type, scale and significance of impacts associated with the PTP. The Queensland Coordinator-General has indicated that his preference is that he receives the application for a change report after approval is granted to PTP under the EPBC Act, assuming that approval is given.

1.4 The EIS Process

The PTP was referred under the EPBC Act to the Minister for Environment on 20 November 2012. On 14 December 2012 the Minister determined that the proposed development was a controlled action under the provisions of the EPBC Act, as the action has the potential to have impact on a number of MNES. The controlling provisions for the proposal under the EPBC Act were designated as:

- World Heritage properties (section 12 & 15A)
- National Heritage places (section 15B & 15C)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- Great Barrier Reef Marine Park (section 24B & 24C).

On the same date the Minister determined that the proposed activity is to be assessed by an EIS. The EIS Guidelines identify the issues that the Australian Government requires the proponent to address. The draft Guidelines for the EIS were advertised by SEWPaC for public comment on 19 February 2013 and the final guidelines (see Appendix A) were issued to the Proponent on 22 April 2013. The Draft EIS was made available for public comment from 16 December 2013 to 24 January 2014. Access to the Draft EIS was made available as follows:

- A printed copy was placed at the State Library of Queensland, Cultural Centre, Stanley Place, South Bank Brisbane
- A printed copy was placed at Gladstone Regional Council offices, Goondoon Street, Gladstone
- The Draft EIS was available for download at http://www.pacificus.com.au
- Printed copies of the Draft EIS were made available for purchase and electronic copies were made available free of charge and could be obtained by telephoning a free-call number, or emailing an information request to the proponent.

As of the closing date for public comments, submissions had been received from:

- Gladstone Regional Council

- Dillons Lawyers on behalf of the Port Curtis Coral Coast registered native title group.

Copies of submissions are provided in Appendix J. Amendments have been made to this EIS in response to comments made by Gladstone Regional Council, and cross referencing is provided against the comments in Appendix J to show how these comments have been addressed. The submission from PCCC did not require any amendments to the EIS as the comments were in relation to the existing Cultural Heritage Management Plan rather than matters of national environmental significance.

The comments did not identify any impacts on MNES that had not already been addressed in the EIS, nor did consideration of the comments lead to any changes in overall conclusions as to the significance of impacts on MNES values. Some clarifications were made in response to comments received from GRC.

On 29th November 2013, draft reports for the Great Barrier Reef Region Strategic Assessment and the Great Barrier Reef Coastal Zone Strategic Assessment were released for public comment. At the request of Department of the Environment, the proponent undertook a review of the consistency of PTP against the draft strategic assessment reports.

A copy of this assessment is provided in Appendix I.

If the PTP is approved under the EPBC Act it is expected that Queensland's CG will issue a Change Report under the SDPWOA that incorporates the Commonwealth's required development conditions (see also Section 1.3).

Following the Queensland's CG's Change Report, further planning and development approvals will be required from Queensland Government departments and the GRC.

1.5 Project Overview

The PTP proposal for an integrated tourism and residential development has been the subject extensive master planning with the aim of minimising disturbance to key environmental assets within and adjacent to the proposed project area. The coastline within the region is a significant attraction to the local population and provides recreational opportunities for local and more remote populations associated with the Gladstone industrial area and coal mines within the Bowen Basin to the west.

PTP incorporates a diverse range of tourist accommodation including resort style hotels, holiday units, camping grounds, residential housing, and a town centre. The PTP also includes research/education facilities, beach access, an 18-hole golf course and sporting facilities. All of these facilities will be accessible to tourists, residents of PTP and adjoining communities.

The PTP community will consist of an estimated 2,700 tourists and 1,200 residents. This population will be achieved when PTP is fully developed over a period of 16 years. Residential uses in PTP are estimated to be 30% of all accommodation and the majority of these are expected to be occupied by the 700 full time workers employed on PTP and their families.

The $956 million private sector project is of both state and regional significance with the potential to be the focal point for tourism, and act as a catalyst to a range of other tourism investment in the Gladstone region. This level of capital investment will allow for the appropriate funding of the environmental protection controls both during construction and ongoing operation of the proposed action.

PTP will directly generate over 3,200 jobs during the development period. New positions in planning, design, environmental management, engineering, construction supervision, contracting, skilled trades, equipment operation, building and landscaping will be created, including a strong component of apprenticeships. The Proponent intends to use local contractors and tradesmen providing significant employment opportunities in the local community.

Over 700 permanent jobs in tourism and supporting industries will be generated when the project is completed. Flow-on expenditure from the PTP, particularly from tourism, is expected to generate substantial job opportunities in both the local and regional labour markets. At the state level, tourism expenditure from the project is estimated to generate up to 850 flow-on jobs per annum by 2029. In particular the Project will provide employment opportunities for young people in the region thereby mitigating youth migration.

The Proponent will provide all required infrastructure for the PTP as well as contributions for external infrastructure, so that State and regional infrastructure providers are not affected. The Project will not require any public sector investment.

PTP will be developed to the highest environmental standards, utilising state-of-the-art engineering and architectural solutions to minimize impacts on the local environment, to minimise the demand for (and use of) natural resources and to ensure long-term environmental sustainability of the development. Environmental management plans will be prepared to monitor and manage any impacts on the surrounding environment identified in the EIS during construction, operation and decommissioning.

A Cultural Heritage Management Plan has been agreed between the Traditional Owners and the Proponent to protect the cultural heritage values of HHI.

The development will avoid areas of ‘endangered’ regional ecosystems and threatened ecological communities. Areas of ‘of concern’ or ‘not of concern’ Regional Ecosystems that would be disturbed for development will be managed to maximise preservation and maintenance of existing ecological functions such as riparian corridors to provide fauna movement through the proposed development. Further vegetation management will occur at the individual Lot level with covenants requiring building footprints to be less than 50% of the Lot area and the retention of existing habitat trees outside this area.

The Master Plan of the PTP is presented in Figure 1.2.

The development boundary encompasses an area 465 ha, including 307 ha of actual development footprint and 158 ha for open space, golf course and vegetation buffers. The Master Plan has been developed over a series of iterations to maximise use of cleared and disturbed areas, make best use of the natural assets of the Special Lease and minimise impacts on key environmental values. The PTP includes a number of development precincts as summarised below.

1.5.1 Headland Resort Precinct

The Headland Resort Precinct, located to the west of the headland incorporates:

- A four star resort hotel with 240 guest rooms, a convention centre, specialty restaurants, bars, entertainment facilities, gymnasium, swimming pools and hotel shops
- 450 resort villas and apartments offering ocean and parkland views
- Controlled pedestrian access to the beach across the fore dunes.

1.5.2 Beach and Golf Course Precinct

The Beach and Golf Course Precinct, located behind the western beach on the northern side of the project area will include:

- A five star resort hotel with 150 rooms, restaurants, bars, gymnasium, tennis courts and swimming pool
- An 18 hole golf course
- 830 villas and apartments
- Controlled pedestrian access to the beach across the fore dunes.

1.5.3 Village Precinct

The Resort Village Precinct will provide a central focus to the PTP, catering to tourists, day visitors and local residents. Key features of the resort village precinct are:

- A retail and commercial centre providing shopping, restaurants and office areas
- A 70 room motel
- Apartment complex with 110 apartments
- A family oriented tourist park and camping area
- A surf life-saving club and pavilion that will provide a combined safety, recreation and social function
- A Community Services Centre which may include medical and allied health services as well being a focus for information and activities
- A network of walking and cycling paths linking to the adjacent tourist precincts
- Controlled access to the beach and barbecue, picnic and toilet facilities.

1.5.4 Ocean View Precinct

The Ocean View Precinct is located on the eastern side of the main ridge across the island and will incorporate:

- A 20 suite well-being studio retreat with resort style accommodation
- 120 tourist villas
- Public open space and viewing areas on Hummock Hill.

1.5.5 Bushland Precinct

Components in this precinct include:

- 160 villas in natural bushland settings
- 245 villas on sloping sites with views over Colosseum Inlet
- Colosseum village with retail facilities, a tourist information centre, indigenous cultural centre and an ecological design and display centre.
- 120 apartments located in the village
- Native plant nursery
- Airstrip and helipad
- Boat ramp and storage facilities for trailerable boats
- Terrestrial and marine research centre
- Island services area including water treatment plants, wastewater treatment plant, electricity substation, general maintenance depot, solar array and LPG gas tanks.
- A network of walking/running/cycling paths.

1.5.6 Other Project Infrastructure

Other infrastructure required for the PTP will include:

- Existing access road, Clarke's Road, connecting Foreshores Road to the site
- A new bridge crossing Boyne Creek
- A network of internal primary and secondary roads within PTP
- Water reticulation
- Sewerage systems
- Stormwater collection and treatment systems
- Electrical power from the mainland and/or renewable energy generation facilities
- Telecommunications.

1.5.7 Tourism Activities

Given its location within the GBRWHA and the potential for nature based tourism in the area, the Proponent will utilise certification schemes such as that developed by Eco-tourism Australia (http://www.ecotourism.org.au) to set requirements for tour operators, accommodation providers and tourism facilities proposing to operate at the PTP. Eaton Place is a gold member of Eco-tourism Australia.

Traditional Owners have indicated interest in participating in training programs in relation to tourism occupations that would including a ranger program associated with the cultural heritage and environmental management of the undeveloped areas of HHI. The Proponent will work with the Traditional Owners to develop and implement these programs.

1.5.8 Conservation Area and Habitat Management Area

An agreement is in place with the Queensland Government that the undeveloped areas of HHI will be designated as a Conservation Area under the Queensland *Nature Conservation Act 1992* (NC Act). The Proponent will be responsible for land management of the conservation area of the island during the period of the development. The long-term management of the conservation area will be guided by an EMP to be implemented by a professional management contract. Funding will come from a conservation levy to be imposed on all occupants of the PTP. In the initial years, when there is insufficient occupancy to fully fund management, the Proponent will provide funding and direct the management, with the goal of handing over the management to GRC under a permanent and sustainable management arrangement within 12 to 16 years.

Within the development footprint, the Proponent will manage habitat and ecological values through a Wildlife Habitat Management Plan which will manage connectivity and fauna corridors, habitat values such as large trees and access to ecologically sensitive locations as well as the interface between the development and the adjacent managed conservation area.

1.6 Objectives of the EIS

The objective of this EIS is to present the environmental, social, cultural, heritage and economic studies that have been undertaken to allow the Minister for Environment to assess impacts and mitigation measures and decide on the appropriateness of the construction and operation of the PTP.

The EIS:

- Addresses the assessment requirements specified in Section 102 of the EPBC Act and Schedule 4 of the *Environment Protection and Biodiversity Regulations 2000* (EPBC Regulations)
- Provides information on which the public and government decision-makers will assess the potential environmental impacts of the proposal

- Investigates and analyses all relevant impacts of the PTP proposal on MNES and provides mitigation measures and project commitments to avoid, mitigate and offset any adverse impacts
- Identifies necessary licences, planning and environmental approvals including approval requirements pursuant to the EPBC Act, *Integrated Planning Act 1997* (IP Act) and *Sustainable Planning Act 2009* (SP Act), *Environmental Protection Act 1994* (EP Act), *Coastal Protection and Management Act 1995*, *Fisheries Act 1994* (Fisheries Act), NC Act, *Vegetation Management Act 1999* (VM Act), *Electricity Act 1994*, other relevant legislation and the provisions of the Gladstone Regional Council Planning Scheme
- Provides input to the decision making process, assisting with the determination of whether to accept or modify the Project, approve with conditions or carry out further studies.

1.7 EIS Methodology

1.7.1 Overview of Methodological Approach

The EPBC assessment guidelines require a systematic method for evaluating potential impacts on MNES as follows:

> *The EIS must present an evaluation of the potential environmental impacts using an accepted risk-based methodology and describe proposed measures to avoid, minimise or offset the expected, likely, or potential impacts (Section 4.1).*

As there are no formal EPBC guidelines available to guide what is an accepted risk-based methodology, a tailored impact assessment methodology has been developed drawing on international best practice (for example, IAIA 1999, Asian Development Bank 1999, Noble 2011).

The approach centres on:

- Understanding the existing environmental values, systems and interactions, particularly in relation to MNES values
- Identifying the extent to which the proposed development will cause direct and indirect changes to environmental values and systems as these relate to MNES
- Determining whether these changes will cause significant and/or unacceptable impacts to MNES values
- Identifying whether reliable and practical measures are available to mitigate significant and/or unacceptable impacts such that these are acceptable with mitigation measures applied.

The overall methodological approach to identifying and evaluating impacts on MNES is shown in Figure 1.3 which also provides cross references to where each step in the methodological approach is addressed within this EIS.

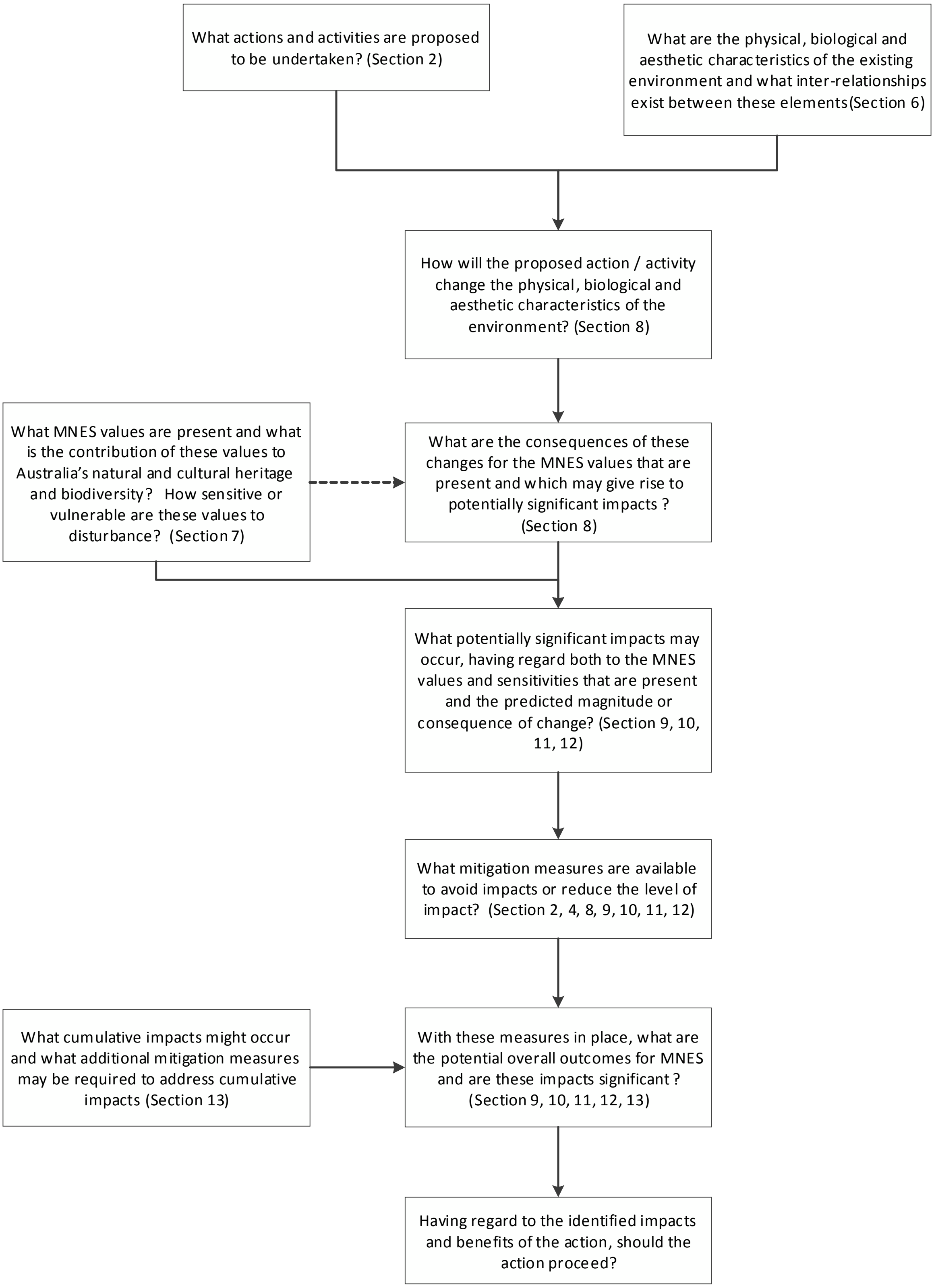

Figure 1.3 - MNES Impact Assessment Methodology

1.7.2 Study Area

The study area consists of the following areas (Figure 1.4):

- The land areas of HHI
- The land area of the mainland at and in the immediate vicinity of the existing causeway
- Supratidal and intertidal flats surrounding HHI
- For the purposes of migratory bird assessments, a broader study area has been adopted as the Mundoolin/Colosseum area defined in migratory shorebird studies undertaken for Gladstone Ports Corporation (GPC) (see also Section 7.5.2)
- Estuarine waters of Colosseum Inlet, Boyne Creek and Seven Mile Creek. This area is collectively referred to as Colosseum Inlet estuary by OzCoasts and is also collectively part of the Colosseum Inlet Fish Habitat Area
- Rodds Bay, being roughly defined as the waters between Rodds Peninsula, Seal Rocks and HHI
- Port Curtis, being the Gladstone Port area extending south to Wild Cattle Island and Seal Rocks.

Names used in referring to locations within the Study Area are consistent with those used in the GBRMPA 2011 zoning maps (http://www.gbrmpa.gov.au/zoning-permits-and-plans/zoning/zoning-maps).

Note that road access routes on the mainland have not been included in the study area as there is existing council road access to the landward side of the causeway.

When considering values and impacts, the local and regional context is described in Table 1.1.

Table 1.1 - Local and Regional Context for MNES values

	Species	Communities	GBRWHA/GBRMP
Regional context	• Terrestrial – bioregion 12 (south-east Queensland) • Marine – Mackay-Capricorn region of the GBRMP	• Bioregion 12 – south-east Queensland	• Entire WHA
Local context	• Terrestrial – HHI • Marine –Colosseum Inlet, Boyne Creek and Seven Mile Creek and ocean waters within approximately 3 km of HHI	• HHI	• Mackay-Capricorn Region

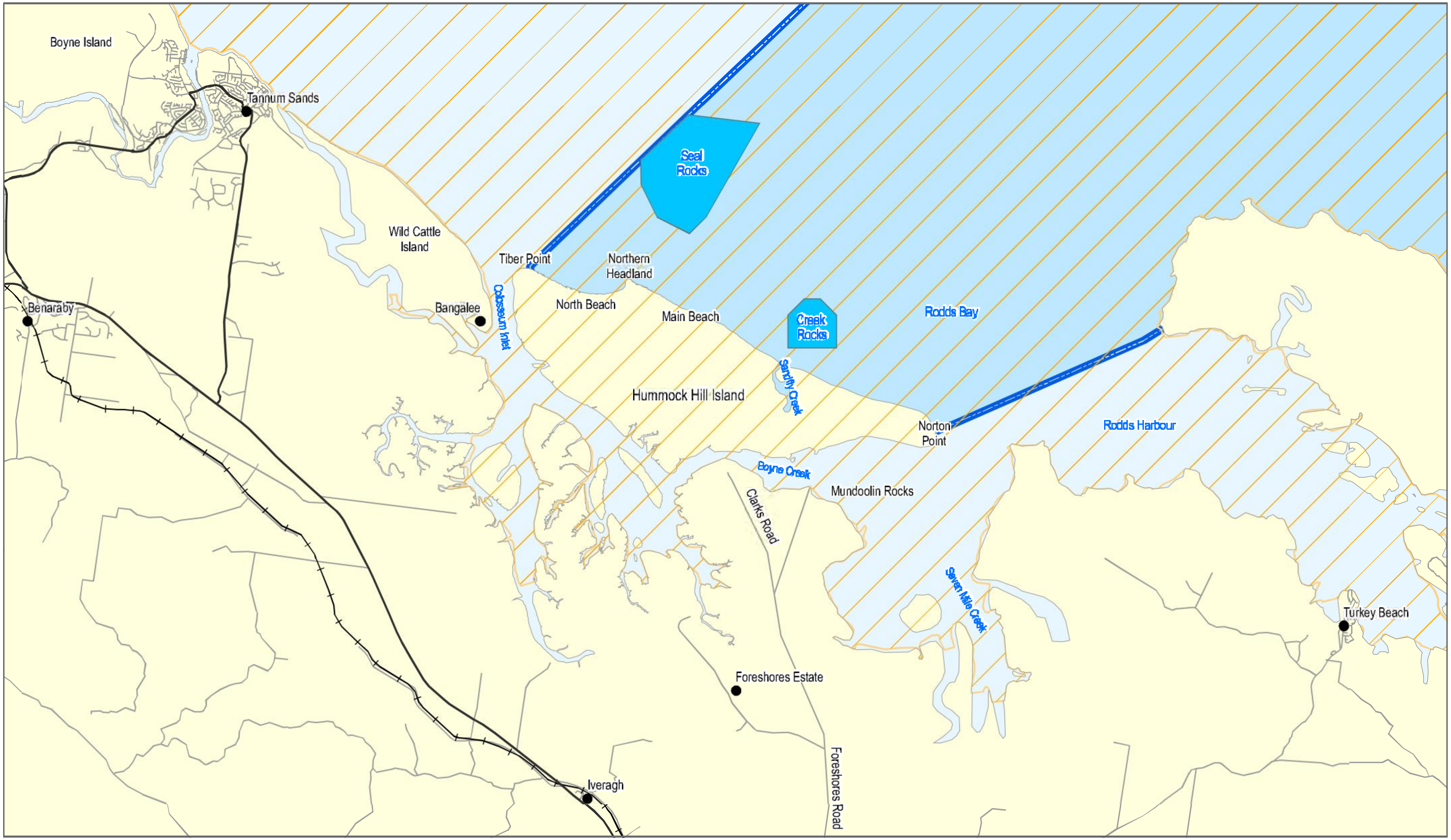

Figure 1.4 - Study Area For The Pacificus Tourism Project

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

I:\QENV2\Projects\QE99099\Spatial\ArcGIS\Figures\01_Final_Figures\Chapter_01\Figure1.4_StudyAreaForThePacificusTourismProject_v2.mxd Date: 7/11/2013

1.7.3 Identifying Impacts and Hazards

The methodology adopted for this EIS is based on a two-step process for identifying and evaluating impacts.

Firstly, the full range of potential changes to environmental values, systems and processes that might arise from the proposed PTP were identified and described. An initial assessment of the potential significance of impacts was undertaken, using the impact significance methodology set out in Section 1.7.4. Where impacts on MNES values were potentially significant, either because of the importance of the value present, the severity of the impact or a combination of the two factors, these impacts were identified for further assessment. This initial phase of impact assessment is presented in Section 8.

Secondly, for those impacts identified as potentially significant, a more detailed assessment of each impact was undertaken. These assessments are presented in Section 9 (listed threatened species and ecological communities), Section 10 (migratory species), Section 11 (World Heritage/National Heritage) and Section 12 (GBRMP).

A distinction is made between impacts, being those consequences of the proposal that are reasonably expected to occur, and hazards, being unplanned or unforseen events that may also occur as a result of the development. Examples of hazards include accidental spills of hazardous substances and mortality of animals due to vehicle or vessel strike. Hazards are assessed using a conventional risk assessment methodology, which considers the risk associated with a hazard. Risk is the product of likelihood of the hazard event occurring and the consequence of the hazard event, if it does occur.

1.7.4 Impact Significance

1.7.4.1 Impact Significance Framework

Integral to evaluating the potential significance of an impact is a rational framework setting out criteria that can be consistently applied to determine whether impacts may be significant or not. Impact significance frameworks are typically based on significance being the product of:

- Value or importance of the individual feature, resource or system that might be affected: For example, impacts on threatened are considered more severe than impacts on common species. Similarly, impacts on places or items of high habitat, biodiversity or heritage value, or on resources that are critical for ecosystem function are also more significant.
- The severity of the impact is based on consideration of the consequence of the impact on that population, resource or system. Factors affecting impact severity may include:
- Magnitude and extent of the effect, being the size of group affected or scale or size of effects in the context of the study area. Impacts affecting large proportions of population, ecosystems or resources are more significant as are impacts affecting larger areas.
- Duration and reversibility of the effect.

This approach is consistent with accepted practice, for example Canter and Canty 1993, Thompson 1990, Lawrence 2007, Wood 2008, European Union 2011, Gronow 2011.

This approach taken is also consistent with the definition of significant impact used by SEWPaC in the referral stage of projects:

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DEWHA 2009a).

1.7.4.2 Determining Importance of Values of MNES

Factors to consider when determining the importance of values of MNES are set out in Table 1.2.

It should be noted that as this assessment is focussed specifically on MNES, there is an underlying assumption that each MNES value has some importance since all MNES values are protected under legislation. Therefore, there is no "negligible importance" criteria, and even the "lower importance" criteria is relative to the inherent overall importance of MNES.

When dealing with World Heritage/Natural Heritage values, the proponent was advised by DotE to focus on the contribution that a particular value or feature of HHI and surrounding waters makes to the OUV of the GBRWHA. This is in line with recent work undertaken on the OUV of the GBRWHA including the Great Barrier Reef Coastal Zone Strategic Assessment (Queensland Government October 2013) and Independent review of the Port of Gladstone (SEWPaC July 2013).

Table 1.2 - Determining Importance of Values of MNES

	Listed threatened species and ecological communities (1)	Migratory Species	World Heritage Area/National Heritage Place (1)	GBRMP
Highest importance	Location for reintroduction of an "extinct in the wild" species Supports an important (2) population or significant number of individuals of a species that is critically endangered or endangered for some or all of the life cycle of that species Supports an endangered or critically endangered ecological community Supports an important (2) population of a species that is vulnerable for some or all of the life cycle of that species	Internationally important habitat for migratory shorebirds as defined in DEWHA 2009b (see Section 7) Habitat that is critically important to a regional population of marine or terrestrial migratory species for some or all of the life cycle of that species	Places or features that represent a unique or very important expression of a value that contributes to the OUV of the GBRWHA, including places or features named as examples of the listing criteria or other features that make a major contribution to the OUV of the GBRWHA (unique expression, major contribution)	Remote natural area Preservation zone Marine National Park zone Scientific Research zone Conservation Park zone
Moderate importance	Is utilised by a significant number of individuals of a species that is vulnerable for some or all stages of the species life cycle Utilised intermittently by critically endangered or endangered species or highly likely to be utilised intermittently based on habitat present	Internationally important habitat for migratory shorebirds as defined in DEWHA 2009b (see also Section 7) Habitat that is utilised by a significant proportion of the regional population of terrestrial or marine migratory species but that is readily available throughout the region	Regionally important values, where HHI or surrounds contains a significant expression of a feature that contributes to the OUV of the GBRWHA or a large proportion of features that contribute to the OUV (regionally important expression, moderate contribution)	Buffer zone Habitat Protection zone
Lower importance	Utilised intermittently by vulnerable species or highly likely to be intermittently utilised based on habitat present	Habitat that is utilised by a small proportion of the regional population of a terrestrial or marine migratory species but does not meet definitions of important habitat	Where there are features that contribute to the OUV of the GBRWHA in a minor way, values that are a minor component of total expressions within the GBRWHA (minor expression).	General Use zone
Not present	Not known or likely to be utilised by listed threatened species	Not known or likely to be utilised by migratory shorebirds, terrestrial migratory birds or marine migratory animals.	Features or values that do not make any recognisable contribution to the OUV of the GBRWHA (not represented)	Outside GBRMP

(1) Adapted from Kenchington and Hegerl, 2005

(2) Important population is defined in DEWHA 2009b and includes key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and/or populations that are near the limit of the species range.

1.7.4.3 Determining Severity of Impact

In determining the severity of impacts, consideration is given to the potential for both direct and indirect impacts. In impact assessment, the actual distinction between direct and indirect impacts can be blurred. For the purposes of this assessment, direct impact is effectively equivalent to clearing, infilling or otherwise destroying habitat. Indirect impacts are related to impacts that degrade or modify species' habitat or communities such that ecosystem functionality may be lost or impaired, either temporarily or permanently. Effectively, both direct and indirect impacts can have the same outcome; in terms of species, there is a reduction in or loss of local and regional populations and in terms of ecological communities there is a reduction in local or regional extent in vegetation that meets the qualification criteria for the ecological community.

The duration and reversibility of impacts is generally described in terms of being either effectively permanent, in that the value is destroyed, or as an impact that is reversible in the short, medium or long term. These timeframes have not been strictly defined in terms of years, as the contribution that duration of impact has to overall severity may depend on the value affected. For example, an impact that effects two or more breeding cycles for a critically endangered and/or highly isolated population, with a relatively short life span, may be effectively irreversible because the replacement rate of the population may drop below sustainable levels.

The criteria for determining severity of impact in Table 1.3 and Table 1.4 provide guidance to establishing the context in which severity levels can be assigned. There are many permutations and combinations of factors that may affect the viability and conservation status of populations and communities and these must all be considered in determining overall severity of impacts. Hence, the criteria in Table 1.3 and Table 1.4 are for guidance only, and are intended for interpretation by environmental impact assessment and ecology specialists. Further notes as to the application of the criteria are provided in the following pages.

Table 1.3 - Impact Severity - Listed flora, fauna and ecological communities, including migratory species

	Listed Flora and Fauna, including migratory species	Listed ecological communities
Severe Impact	• Interfere with any species recovery actions being undertaken at or near the site • Disrupt breeding activities of a local population for more than two breeding seasons • Severely reduce resilience of local populations to external impacts (such as severe weather conditions, climate change, disease) such that the population is unable to recover from even minor perturbations. • Destroy or cause long term degradation of: – between more than ~5% of terrestrial habitat available at a bio-regional level, or – more than ~25% of available terrestrial habitat on HHI, or – between more than ~5% of available marine habitat in Mackay/Capricorn region of GBRMP, or – more than ~25% of habitat available in waters surrounding HHI • Cause any medium to long term decrease in local population, such that the population becomes unviable, including through one or more of the following: – A mortality rate that exceeds the local population replacement rate – Increased predation – Introduction of disease – Increased competition for resources – Disruption of feeding, resting or roosting behaviours – Fragmentation or severance – Reducing resilience to external influences such as extreme weather and climate change	• Reduce regional extent of an ecological community by more than ~5% through direct clearing • Reduce local extent of an ecological community by more than ~25% • Cause indirect impacts that may result in irreversible or long term loss of ecosystem functionality, causing effective loss of more than ~25% of the local extent of a listed ecological community. Indirect impacts may include one or more of the following: – introduction of pests/invasive species – change in species composition that changes the ecological functionality of the ecosystem – change in natural fire regime – micro-climate changes (for example due to exposed edges) – habitat modification – mobilisation of contaminants into the ecological community – loss or significant modification of factors necessary for an ecological community's survival including nutrient availability, soil resources, reduction of groundwater levels, or substantial alteration of surface water drainage patterns

	Listed Flora and Fauna, including migratory species	Listed ecological communities
Moderate Impact	• Preclude future recovery plan actions for species • Disrupt breeding activities for one to two breeding seasons • Potentially reduce resilience of local populations to external impacts (such as severe weather conditions, climate change, disease) • Destroy or cause long term degradation of – between ~1% and ~5% of terrestrial habitat available at a bio-regional level – between ~5% and ~25% of available terrestrial habitat on HHI – between ~1% and ~5% of available marine habitat in Mackay/Capricorn region of GBRMP – between ~5% and ~25% of marine habitat available in waters surrounding HHI • Cause a short term (reversible) decrease in local population such that the population becomes unviable including through one or more of the following: – A mortality rate that exceeds the local population replacement rate – Increased predation – Introduction of disease – Increased competition for resources – Disruption of feeding, resting or roosting behaviours – Fragmentation or severance – Reducing resilience to external influences such as extreme weather and climate change.	• Cause a permanent or long term reduction in the regional extent of an ecological community by ~1-5% • Cause a permanent or long term reduction in the local extent of an ecological community by ~5-25% • Fragment the ecological community • Cause indirect impacts that may result in irreversible or long term loss of ecosystem functionality, causing effective loss of 1% to 5% of the local extent of critically endangered or endangered ecological community. Indirect impacts may include one or more of the following: – introduction of invasive species – change in species composition that changes the ecological functionality of the ecosystem – change in natural fire regime – micro-climate changes (for example due to exposed edges) – habitat modification – mobilisation of contaminants into the ecological community – loss or significant modification of factors necessary for an ecological community's survival including nutrient availability, soil resources, reduction of groundwater levels, or substantial alteration of surface water drainage patterns • Interfere with implementation of a recovery plan
Low Impact	• Destroy or cause long term degradation of – less than ~1% of terrestrial habitat available at a bio-regional level and/or – less than ~5% of available terrestrial habitat on HHI – less than ~1% of available marine habitat in Mackay/Capricorn region of GBRMP and/or – less than ~5% of marine habitat available in waters surrounding HHI No expected reduction in population size or resilience to external impacts	• Cause a permanent or long term reduction in the regional extent of a listed ecological community by less than ~1% through direct or indirect impacts. • Cause a permanent or long term reduction in the local extent of a listed ecological community by less than ~5% through direct or indirect impacts.
Negligible impact	No discernible change to habitat or species	No discernible change to the extent or health of ecological communities

Table 1.4 - Impact Severity - GBRWHA, national heritage place and GBRMP

	World Heritage Area/National Heritage Place	GBRMP
Severe Impact	• Views of landscapes that contribute to the OUV of the GBRWHA are severely degraded when assessed using the scenic preference rating tool (1). Severe degradation is measured by a reduction of more than 1 point on the scenic preference rating tool. • A feature or value that contributes to the OUV of the GBRWHA is lost from the World Heritage area or from the Mackay-Capricorn region • A feature or value that contributes to the OUV of the GBRWHA is so damaged, degraded or obscured that the value is no longer discernible and cannot be recovered or restored in the medium to long term.	• A change occurs which is inconsistent with objective of affected zone, and would therefore result in: - Loss of values which are sought to be protected by the zoning plan - Preclusion or severe restriction of a prescribed use of the zone
Moderate Impact	• Views of landscapes that contribute to the OUV of the GBRWHA are somewhat degraded when assessed using the scenic preference rating tool (1). Degradation is measured by a reduction of more than 2 points on the scenic preference rating tool. • A value or features that contributes to the OUV of the GBRWHA is degraded, damaged, obscured or diminished such that there is a permanent or long term reduced contribution to the outstanding universal values of the WHA	• Consistent with objective of zone but may: - reduce enjoyment of an area utilised by visitors - cause degradation of values which are sought to be protected by the zoning plan • Any direct impact such as placement of a permanent structure within the GBRMP, even if consistent with zoning objectives
Low Impact	• There is no discernible change in views of landscapes that contribute to the OUV of the GBRWHA when measured on the scenic preference rating tool (1) • Values and features that contribute to the OUV of the GBRWHA remain readily discernible, with no significant loss of form or health and contribution to the OUV of the WHA is not reduced except in the short term	• Indirect impacts may occur within GBRMP but are consistent with zoning and do not affect habitat or biodiversity values or prescribed uses in any way • No discernible change in water quality, habitat values or ecosystem services
Negligible Impact	• No discernible change to the extent to which features or values contribute to the OUV of the GBRWHA	• No discernible change to habitat or biodiversity values or allowed uses of any component of the GBRMP

(1) Based on the scenic preference rating assessment method set out in *Queensland Coastal Plan; State Planning Policy 3/11 Guideline: Coastal Protection*

This assessment framework focusses on MNES values, which by definition have a high conservation value and are vulnerable to disturbance. Hence, for impacts on habitat for species listed under the EPBC Act, or communities, the severity levels have been defined quite conservatively such that even a relatively minor loss attracts a moderate to severe impact classification. The general thresholds for significance in terms of direct loss or degradation are shown in Table 1.5. However, lower thresholds may be suitable where the overall extent of habitat or of an ecological community at a local or regional extent is low. Judgement of impact assessment and ecology specialists is required when applying the guidelines and thresholds.

Table 1.5 – Habitat loss/degradation thresholds

	Local	Regional
Severe Impact	>2%	>%
Moderate Impact	5-25%	1-5%
Low Impact	<5%	<1%

In relation to impacts on world heritage values (Table 1.5), the proponent has been advised by DotE that impact severity should be determined on the basis of the extent of reduction to the contribution that HHI and surrounding waters makes to the OUV of the GBRWHA. In practice, this requires consideration of impacts on those values or features that have been identified as making a contribution to the OUV of the GBRWHA.

Based on the EPBC significant impact guidelines (DotE 2013) and Regional Guidelines for Magnetic Island (SEWPaC 2010), the following considerations are relevant in terms of severity of impact against each of the criteria:

- Superlative natural phenomena including exceptional natural beauty and aesthetic importance:
  - Structures or other features are introduced that contrast strongly with the existing environment or would otherwise lead to change in landscape or degrade aesthetic values
  - Intrusive elements such as odours, noise, visible pollution (including litter) are introduced that detract from the natural beauty of landscapes
  - Destroy or degrade superlative natural phenomena such that the phenomenon was no longer
- Geological, geomorphological, landform and physiographic values:
  - Geological features, geomorphological formations or landforms are destroyed or damaged such that the information and insights that the formations or features provide is lost or obscured
  - Landscape scale processes that underpin geomorphological features and landforms are altered (for example accelerated or stabilised) such that the natural dynamics of systems

are altered. Flow on effects may include loss of information on natural geomorphological processes as well as changes to substrates and associated habitats and ecological niches.

- Water bodies, including rivers, wetlands and estuaries are modified
- Levels of suspended sediment are significantly increased, or other physico-chemical characteristics of waters are modified in a way that affects processes such as coral growth, formation of reefs and sediment deposition and transportation.

- Ecological and biological evolutionary processes and important and significant natural habitats for conservation of biodiversity, including threatened species
  - General diversity of plant and animals species is reduced or modified (including through introduction of new species)
  - Populations of rare, endemic and unique species decline, or become less resilient to natural and anthropogenic phenomena
  - Habitat that supports plants and animals is degraded such that overall plant and animals diversity is affected and/or individual species that are rare, endemic or unique are affected.

There is some overlap between consideration of the ecological and biological diversity values that contribute to the OUV of the GBRWHA and consideration of individual plants, animals and communities that are protected under the EPBC Act. However, as these are defined in the Act as distinct matters of NES, the significance of impacts on each aspect will be evaluated separately in this EIS.

1.7.4.4 Determining Significance and Residual Significance

As discussed in Section 1.3.3, the overall significance of an impact is based on the product of the importance of the value and the severity of the impact. Hence, clearing of a small amount of habitat for an endangered or critically endangered species may have a significant overall impact, while clearing the same area of habitat for a vulnerable species may not be considered significant. Table 1.6 provides the matrix for defining overall significance of an impact, based on evaluation of the importance of a value and the severity of an impact.

In line with definitions used in DotE guidelines (see, for example, DotE 2013), impacts are categorised into two categories; significant and not significant (see also Section 1.1.3).

Table 1.6 – Impact Significance Matrix

Importance of value → / Severity of impact ↓	Highest Importance, important contribution	Moderate Importance, Moderate Contribution	Lower Importance, Minor Contribution	Not present, Negligible Contribution
Severe	Significant	Significant	Significant	No impact
Moderate	Significant	Significant	Not significant	No impact
Low	Significant	Not significant	Not significant	No impact
Negligible	Not significant	No impact	No impact	No impact

In line with good practice EIA, impact significance is first determined based on "raw" or unmitigated impact (IAIA 1999). However, in the case of the PTP, considerable effort has been made to design the project to avoid and minimise impacts on significant environmental values, as described in Section 2 and Section 8. Hence, the impact significance is based on actual impacts of PTP, having regard to avoidance and mitigation measures that have been designed into the project description, rather than theoretical impacts with no mitigation provided.

For example, as wastewater management systems for the project have been designed to recycle all water, with no discharge proposed, there is no impact on coastal and marine water quality associated with this aspect of the proposal. Hence the project is not assessed as if there were no wastewater treatment and management as this is not a realistic scenario.

Where significant impacts are identified, and cannot be avoided through modifications to the action, additional mitigation measures may be required as discussed in Section 1.7.6. The impact significance assessment is then repeated taking into account the potential effectiveness of mitigation measures. This yields an assessment of the significance of residual impacts. Again, it should be noted that an iterative approach has been used to ensure that mitigation measures are, wherever possible, built into the design and operational mode of the PTP. Thus, the project presented in this EIS includes all mitigation measures identified in this and previous impact assessments and assessments of alternatives that have been undertaken in the past seven years.

1.7.5 Hazard and Risk

The risk associated with a hazard can be qualitatively assessed using the matrix set out in Table 1.7. This risk matrix used is generally consistent with the AS/NZS ISO 31000: 2009 Risk management – Principles and guidelines but has been adapted to remove the "almost certain" and "likely" likelihood criteria. Hazards that are "likely" or "almost certain" are effectively the same as impacts, as impacts are defined as the likely consequences of the proposed action. High likelihood hazards are assessed using the impact significance assessment technique set out in Section 1.1.4.

Consequence and likelihood descriptors are set out in Table 1.8 and Table 1.9 respectively.

Table 1.7 - Qualitative Risk Assessment Matrix

	Consequence				
Likelihood	**Major (5)**	**Severe (4)**	**Moderate (3)**	**Minor (2)**	**Insignificant (1)**
Possible (3)	High	High	Medium	Medium	Low
Unlikely (2)	High	Medium	Medium	Low	Low
Rare (1)	Medium	Medium	Medium	Low	Low

Table 1.8 - Consequence Scale Description (MNES Values)

Descriptor (Rating)	Level of Impact on MNES Values
Insignificant (1)	Negligible effect on MNES values
Minor (2)	Minor, localised environmental impact, no discernible degradation of MNES values
Moderate (3)	Moderate level of impact on the environment generally, but low or minor impact on MNES values
Severe (4)	Major impact on the environment generally, loss of some MNES values
Major (5)	Extensive, long term degradation of MNES values

Table 1.9 - Likelihood Scale Description

Descriptor (Rating)	Definition
Rare (1)	Frequency of occurrence expected to be < 1% Only likely to occur in exceptional circumstances Not likely to occur in the next 30 years
Unlikely (2)	Frequency of occurrence expected to be 1% to 20% May occur in some circumstances but not anticipated Could occur once in the next 5 to 30 years
Possible (3)	Frequency of occurrence expected to be 20% to 50% May occur some of the time but a distinct possibility it won't Could occur in the next 2 to 5 years

1.7.6 Identifying the Need for Mitigation

Wherever the initial impact significance assessment identifies significant impacts, or impacts that might, cumulatively, be significant, further mitigation measures are required to reduce the significance of the impact.

Mitigation measures will be based on the following hierarchy:

- Avoiding impacts where possible, for example through relocation or other design measures to avoid direct and indirect disturbance to sensitive areas
- Minimising impacts which cannot be avoided, for example by reducing the duration of an activity, reducing the footprint of a component of the project or retaining some habitat features

- Rehabilitating disturbed areas, for example, through replanting native vegetation on completion of construction
- Managing impacts, for example through implementation of erosion and sediment control plans.

Where residual impacts on MNES remain significant, offsetting or compensating for impacts, for example through provision of biodiversity offsets, may be required. In line with the EPBC Act offsets policy (SEWPaC 2012), offsets are not considered to make unacceptable impacts acceptable, but may be used to compensate for residual impacts that cannot be otherwise avoided or minimised.

As discussed in Section 1.1.6, mitigation measures to avoid or minimise impacts have been included in the design of PTP through an iterative approach and these mitigation measures will be considered in the assessment of significance of impacts. These mitigation measures were described in the referral document (2012) and are also described in Section 2 and Section 8 of this EIS. As the project has been developed to minimise impacts on existing values, and has undergone an extensive constraints based review and previous environmental impact assessment, the project presented in this EIS reflects all those mitigation measure identified in the past seven years that can be incorporated into project design and operational mode.

1.7.7 Determining Whether Residual Impacts and Acceptable or Unnacceptable

While not formally defined in the EPBC Act, decisions on approvals of projects tend to rest on whether or not impacts are deemed acceptable and the proponent has been informed that the acceptability of residual impacts must be discussed in the EIS (A Lea and A Hazel, pers com 23 January 2013, see also Section 5.10 of the guidelines).

While the EPBC referral guidelines (DEWHA 2009a, DotE 2013) provide some guidance on how to determine whether or not an impact is significant at the referral stage, there is no guidance available to proponents on what constitutes an acceptable or unacceptable impact. Hence, the assessment set out in this document is based on the significance assessment framework that has been tailored for PTP. The final outcome of this assessment will be an identification of those impacts which remain significant, even with mitigation or offsetting, based on consideration of the importance of the value affected and the scale and consequence of the impact. It is expected that this outcome will then allow the decision maker to determine whether impacts of the proposal are acceptable or unacceptable, having regard to the matters for consideration set out in Section 136 of the EPBC Act.

1.7.8 Dealing with Uncertainty in Prediction of Impacts

Impacts are those outcomes of an action that are reasonably likely to happen if the action goes ahead. When dealing with direct impacts it is generally clear whether or not the impact will occur. However, given the complex cause and effect pathways through which indirect impacts may occur, it will not always be possible to predict the final environmental outcome, particularly where there are a number of steps in the cause and effect pathways. Uncertainty may also arise where there is insufficient data on the presence or absence of particular values or a limited understanding of the inter-relationships within systems.

Where analysis indicates some uncertainty in predicting outcomes, both the conservative or worst case scenario and also the likely case scenario, based on expert judgement of reasonably likely consequences, will be explored. For example:

- Where it is uncertain whether a particular listed species or other value is present or absent, the evaluation of impacts will consider what impacts might occur in the worst case scenario that the species or value is present
- Where it is difficult to determine the scale or magnitude of change that might occur due to an indirect impact, the impacts of potential likely worst case scenarios will be explored.

Following on from this assessment, where the worst case scenario indicates significant (or unacceptable) impacts, mitigation measures will be developed to address the worst case scenario, and these measures will preferably seek to prevent the impact from occurring.

Where there is uncertainty in relation to impacts, an adaptive management process may be appropriate. This requires a robust monitoring program to validate the predicted outcome and trigger additional mitigation measures where monitoring indicates that unacceptable impact thresholds may be exceeded.

Impacts should be distinguished from hazards, which are unplanned and unintended consequences. These are discussed in Section 8.2.2.

1.7.9 Cumulative Impacts

The guidelines require cumulative impacts to be evaluated “where potential project impacts are in addition to existing impacts of other activities (including known current and potential future expansions or developments by the proponent and other proponents in the region and vicinity)”. Cumulative impact assessment must include cumulative impacts on ecosystem resilience and cumulative impacts from climate change and extreme weather events.

The approach to cumulative impact assessment of the PTP and other existing and proposed actions is to:

- Identify residual impacts of the PTP on MNES values, including impacts which, when considered only in relation to PTP may not be significant, but which may be significant when considered in the context of combined impacts from other actions
- Identify existing activities and known proposed developments that may also impact on a particular MNES value
- Examine whether there is potential for cumulative impacts on a particular MNES value to occur, considering additive, compound and synergistic impacts.
- Where potential cumulative impacts may occur, determine whether the impact may be significant, based on the criteria set out in Sections 1.1.4, 1.1.5 and 1.1.6.

- Where impacts may be significant, identify further mitigation measures that the proponent can implement to address any proportional contribution to cumulative impacts.

This approach is based on recently released good practice assessment guidelines from the International Finance Corporation (IFC 2013).

In relation to impacts on ecosystem resilience from climate change and extreme weather events, the approach is to identify where the PTP may reduce ecosystem resilience, then consider whether this incremental reduction in ecosystem resilience may then make ecosystems more vulnerable to effects of climate change or extreme weather events.

1.7.10 Consequential Impacts

Section 527E of the EPBC Act notes that impacts include impacts arising from "an event or circumstance that is an indirect consequence of the action". For developments such as the PTP, consequential impacts may include:

- Impacts associated with the provision of infrastructure and services to the PTP by third parties (private and public sector) where, but for PTP, that infrastructure or service would not be required
- Impacts arising from other developments on HHI that could not go ahead were it not for the construction of a bridge and/or provision of other infrastructure and services.

The process for assessing consequential impacts in relation to the proposed PTP is as follows:

- Identify actions, events or circumstances that, while not directly incorporated into the PTP, may arise from the PTP, and would not or could not otherwise arise, if the PTP did not take place
- Broad identification of the range of impacts that might arise from these actions, events or circumstances
- Review of the legislative and policy frameworks and approvals requirements that these actions, events or circumstances would be subject to, and whether this provides an adequate mechanism for protection of MNES values
- Identification of mitigation measures that the Proponent might need to undertake to address consequential impacts where legislative and policy requirements may be insufficient to provide an adequate level of environmental protection, and specifically protection of MNES values.

1.7.11 Data Sources

Key data sources used in preparation of this EIS include:

- An EIS prepared in 1993 (AGC Woodward Clyde 1993), and associated supplementary EIS prepared in 1995 (Dames and Moore 1995). This EIS was prepared in relation to a residential development that took up most of the area of the special lease. As this assessment is relatively old and survey methods, classification and assessment requirements have changed since the early 1990s, this EIS/Supplementary EIS is used with caution, however it does provide useful historical context, particularly in relation to soils, landform, geology and geomorphology and longitudinal information on flora and fauna

- An EIS prepared for the HHID in 2007 (SKM 2007). This EIS was prepared under the requirements of the EPBC Act and the SDPWO Act. Field surveys complied with survey requirements in place at the time and remain largely contemporary. The EIS was reviewed by the then Federal Department of the Environment and Heritage (later the Department of Environment, Water, Heritage and the Arts and later SEWPaC), Queensland government agencies with responsibilities for environmental and natural resource protection and local government. An SEIS was prepared in response to issues raised by these agencies and other stakeholders. The Queensland government considered the assessment adequate and recommended that the project proceed subject to conditions (Queensland Coordinator-General, 2011).
- Information on listed threatened species, ecological communities and migratory species contained within the Australian government Species Profile and Threats Database http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.
- Detailed onsite mapping of vegetation and Regional Ecosystems for the preparation of an offset proposal under the Queensland VM Act - Greening Australia 2008 - 2010
- Seagrasses of Port Curtis and Rodds Bay and long term seagrass monitoring, 2002 -2012 (Rasheed *et al*. 2003, Thomas *et al*. 2010, McCormack *et al*. 2013, Amies *et al*. 2013)
- Ecological Studies undertaken by the Glasdstone Port Corporation (GPC) including:

- Resident and Migratory Shorebird Surveys BAAM - 2011-2012
- Marine Megafauna and Acoustic Survey GHD -November 2011.
- Port Curtis Integrated Monitoring Program (PCIMP)

Additional data sources and references are referenced throughout the text.

1.8 Further Project Development Approvals

If the PTP is approved under the EPBC Act it is expected that Queensland's Coordinator-General will compile a Change Report to the original approval under SDPWOA. The report will incorporate the Commonwealth Ministers required development conditions. The change report will be referred to relevant Qld government departments including:

- State Development Infrastructure and Planning
- Education, Training and Employment
- Transport and Main Roads
- Agriculture Fisheries and Forestry
- Environment and Heritage Protection
- Natural Resources and Mines

- Energy and Water Supply
- Local Government
- Tourism, Major Events Small Business
- The Gladstone Regional Council.

Further detail on project approvals is contained in Section 3.

1.9 Cross reference Table

A cross reference table that demonstrated compliance with the EIS Guidelines is included as Appendix B.

PACIFICUS
TOURISM PROJECT

SECTION 2
Project Description

PACIFICUS
TOURISM PROJECT

Contents

2. Project Description

2.1 Introduction

HHI provides one of Australia's prime tourist development opportunities. The site is strategically located 30 km south of Gladstone, 35 minutes by road from the Gladstone Regional Airport and major regional, retail, commercial and social services including hospitals, specialist health professionals, high schools, university campus and port and marina facilities see Figure 1.1). The project is in the Gladstone Regional Council (GRC) area and will significantly expand the availability and variety of quality tourism facilities in this region.

Visitors will enjoy a warm climate and ocean views and have access to ocean views, a varied natural landscape and the best beaches in the region. The island offers access to local and regional tourism attractions including world class fishing, calm waters for swimming and bushwalks with many great picnic spots. The project will have a variety of quality restaurants, cafes, clothes boutiques, tourist shops, local handcrafted wares and artworks. Visitors will also be able to experience local Aboriginal culture and historical sites, through the proposed Indigenous Cultural Centre.

The $956 million, private sector, project is of both state and regional significance with the potential to be the focal point for tourism, and act as a catalyst to a range of other tourism investment in the Gladstone region. The Proponent will provide all necessary infrastructure for the Project as well as contributions for external infrastructure so that local and State government infrastructure providers are not affected. The project will not require Government or public sector funding.

Avoidance and minimisation of environmental impacts has been at the forefront of project master planning and conceptualisation and the footprint has been designed specifically to avoid direct and indirect impacts on environmental values of the Island and surrounding waters. The Project will be planned, constructed and operated to the highest environmental standards, using state-of-the-art engineering and architectural designs to avoid or minimise impacts to the local environment, to minimise the demand for (and use of) scarce natural resources and to ensure long term environmental sustainability of the development. Ecologically Sustainable Development (ESD) principles are the driver behind the design.

PTP has been specifically planned and designed to not adversely impact on the World Heritage values of the Great Barrier Reef World Heritage Area or the environmental values of the Great Barrier Reef Marine Park. Less than 10% of the island will be developed.

The undeveloped areas of the island outside the Project boundary will be given protected status under Queensland State Government legislation. The Proponent will be responsible for land management of the protected areas of the island during the period of the Development. The long-term management of the undeveloped areas will be guided by an Environmental Management Plan to be implemented by a professional environmental management company under contract to the proponent. The costs of long term management will covered by a special area environmental charge to be paid by the land owners on the island through Gladstone Regional Council's rates system.

To maximise outcomes for environmental, social and economic aspects of the project, the following development goals have been identified:

- Retain and protect all features that contribute to the OUV of the GBRWHA and other MNES
- Maintain, protect and enhance the natural environment and cultural values so that areas and features of conservation and cultural significance are retained and the human population can enjoy living in close proximity to, and harmony with the natural ecosystems
- Provide a social environment based on a vibrant, dynamic and diverse community that has strong environmental awareness and is committed to sustainable living and self-development
- Enable visitors to experience holiday and recreational opportunities focussed on family and outdoor activities
- Provide a built environment, appropriate to the scale of the Project and the natural environmental setting
- Provide infrastructure based on latest advances in sustainable living but suitable for management and basic maintenance by the occupiers.

Development principles will be incorporated into design, construction and operation phases of the project, with particular emphasis on the design phase. This approach recognises that the most effective means to minimise negative impacts associated with any development is to incorporate measures to avoid or reduce impacts into project design. Environmental impacts that cannot be "designed out" will then be addressed through appropriate management during construction and operation. These management measures are discussed throughout this EIS.

Section 2.2 addresses each of these development goals and identifies performance targets and development principles to achieve the stated goals.

2.2 Development Principles

2.2.1 Introduction

The Proponent recognises the OUV of the GBRWHA and the need to minimise impacts on all MNES, including listed threatened species and communities and listed migratory species. The many elements of the PTP have been located with careful consideration to the existing conservation values, topography of the site, utilisation of views and vistas, and integration within the natural landscape. The Project has been designed to fit in and around the existing environment, with minimal disturbance, and to achieve sustainable outcomes with regard to services and infrastructure. More information is provided in Section 4 of how constraints and opportunities were taken into consideration in developing the proposed development footprint, components, precincts and development controls.

With this in mind, and to maximise outcomes for environmental, social, cultural and economic aspects of PTP, the following development goals have been identified:

- Natural environment will be maintained, protected and enhanced so that areas and features of conservation significance are retained and the human population can enjoy living in close proximity to, and harmony with the natural ecosystems
- Social environment will be based on a vibrant, dynamic and diverse community that has a strong environmental awareness and is committed to sustainable living and self-development
- Built environment will be appropriate to the scale of the Project and the natural environmental setting. Infrastructure systems will be based on latest advances in sustainable living, but will be suitable for management and basic maintenance by the occupiers.

The following sections address each of these development goals and identify performance targets and development principles to achieve the stated goals.

The development principles are incorporated into design, construction and operation phases of the project, with particular emphasis on the design phase. This approach recognises that the most effective means to minimise negative impacts associated with any development is to incorporate measures to avoid or reduce impacts into project design. Environmental impacts that cannot be “designed out” must then be addressed through appropriate management during construction and operation. These are further discussed in Section 8, 9, 10 and 11.

2.2.2 Natural Environment

HHI is a continental island separated from the mainland by Boyne Creek an inter-tidal channel connecting Colosseum Inlet to the west and Seven Mile Creek to the east (see Figure 1.4). A causeway has been constructed across the channel from logs and borrowed fill material that remains partly or wholly submerged on all but spring low tides (see Figure 2.1).

Figure 2.1 - Boyne Creek Causeway at Low Tide

Colosseum Inlet runs between the western side of Hummock Hill Island and the southern end of Wild Cattle Island. Colosseum Inlet is a deep sandy estuary with shallower sand bars at its mouth. North and north east of Hummock Hill Island is Rodds Bay. These features are shown on Figure 1.4.

The southern coastline of Hummock Hill Island is fringed with mangroves and supra-tidal salt flats while the western and northern coastline features sandy beaches. There is a prominent rocky headland on the north coast.

A series of pastoral leases were granted over the Island from 1887 to 1991. As part of the lease renewals, "improvements" were required, resulting in applications for land-clearing and ring-barking of trees (refer to Section 6.1). Modification to the Island environment during pastoral activity has resulted in a patchwork of cleared land and regrowth vegetation with grazing activity occurring over the entire Island at one point or another. Lantana infestation occurred over much of the western portion of the Island in the early part of the 1900's with Government intervention during the 1930's to halt the infestation. HHI was also logged to obtain timber for railway sleepers and other uses. Pastoral activity legacies include dams, fences, a cattle dip, a house, several sheds and other remnants of this activity. Access tracks remain in reasonable condition and a grass airstrip is still discernible on aerial photographs and on the ground.

A dam located in a saddle of the main ridge bisecting the Island, appears to hold water for much of the dry season. A number of other turkey nest dams have been created on the site but do not hold permanent water. There are no permanent water courses or natural freshwater wetlands on the Island although there are some low-lying areas that retain surface run off after rain events.

The natural systems and features of HHI vary with soil types and topography and include:

- A range of hills running north-south across the Island, separating the western third from the eastern two thirds
- Low frontal dune & beach system with sparse *Casuarina spp*. and *Pandanus spp*. with a sparse ground cover of *Spinefex spp*
- Undulating low dunes and relict beach ridges with intervening depressional swales, with moderate dense coastal vine thicket, large emergent Melaleuca spp. and Moreton Bay Ash
- Coastal wetlands, consisting of supratidal saltpans and mangrove forests adjacent to sheltered estuaries
- Open and closed woodland including endangered and of concern regional ecosystems.

While vegetation is reasonably diverse, the range of native animals on the Island is limited, with most diversity seen in bird populations (see also Section 6.7). Salt flats to the south-east of Hummock Hill Island are part of an international and nationally important conglomerate of roosting and feeding sites for listed migratory shorebird species (see Sections 6.5 and 7.5).

Flora and fauna surveys have identified ecological and vegetation communities protected under Commonwealth and State legislation. Beaches along the northern side of Hummock Hill Island are considered suitable for marine turtle nesting, with intermittent, very low density nesting recorded (see also Sections 6.6.4 and 7.4.4.3).

Figure 2.2 – Typical Vegetation within the Centre of the Lease Area

Although within the GBRWHA/NHP, Hummock Hill Island does not have any formal conservation status (ie National park), nor has it come under any kind of management plan in relation to its World Heritage status. The adjacent Wild Cattle Island is a National Park but does not have any formal management plan.

The Island is surrounded by the Great Barrier Reef Coastal Marine Park (State) and is bounded by the Great Barrier Reef Marine Park (Commonwealth) along the low water mark of the northern coastline (see Figure 1.4).

Colosseum Fish Habitat Area includes Wild Cattle Creek, Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek. Estuarine and marine waters surrounding Hummock Hill Island are part of the larger Rodds Bay Dugong Protection Area (see Figure 1.4).

Waters around HHI provide habitat for dugong and some species of marine turtles.

Air quality in the area is very good, being typical of relatively undeveloped coastal areas. Prevailing south-easterly winds carry emissions from industrial developments in Gladstone away from HHI.

Overall Hummock Hill Island offers a natural setting for coastal development which, if targeted to more tolerant locations on the Island, can be achieved with minimal loss of the particular environmental values of the Island itself, and also without impact on the ecosystems of the surrounding waters. The area's natural assets then become an important feature of the development, both highlighting the benefits of sustainable infrastructure and enhancing lifestyles of the Island's residents and visitors. The value of 'inclusiveness' of such natural assets is now recognised as an intrinsic component of property development, such that development does not result in loss of conservation values.

PTP will avoid areas of critically endangered threatened ecological communities and also Queensland listed 'endangered' regional ecosystems. Other areas of vegetation that are disturbed for development will be managed to maximise preservation and maintenance of existing ecological functions and biodiversity such that all vegetation communities and habitat types represented on HHI are retained. The proposed development also remains highly permeable to wildlife such that ecological communities and habitats remain connected.

The design of the Project has been based on the need to avoid, mitigate and minimise impacts on MNES features of the island, including those features that contribute to the OUV of the GBRWHA and the surrounding coastal and marine environment by:

- Preserving threatened ecological communities and other conservation significant vegetation communities and habitats for listed threatened and migratory species intact
- Keeping the Project footprint to 10% of the total island area
- Maintaining interfaces between development and sensitive vegetation communities and habitats (see also 2.6.3)
- Maintaining a high level of permeability to wildlife movement and providing wild life corridors to ensure connectivity between habitats across the island
- Requiring building footprints to be less than 50% of each lot area and retaining existing habitat trees outside the building footprint
- Locating the access road across the island in currently cleared areas and dividing the road into 2 separate single carriageways to lessen impacts on wild life movements and visual amenity
- Focussing development on areas of lower ecological significance
- Consolidating tourism elements to the northern coastline of the island and amalgamating major tourist accommodation and attractions
- Maintaining the riparian zone along ephemeral watercourses and continuing existing stormwater flow regimes
- Mimicking existing runoff and stormwater flow regimes in relation to quality and quantity. This includes provision of stormwater retention basins to attenuate flows and maintain pre-development flow regimes into receiving coastal waters and stormwater quality improvement devices to remove potential contaminants
- Controlling access to areas that are tolerant of access and restricting access to high sensitivity areas such as intertidal habitats, beaches occasionally used by turtles for nesting and coastal vine thicket habitat
- Installing cattle grid or similar device on the bridge to the island with self-closing gates across the pedestrian walkway to prevent access to the island by feral animals.

The project proposes to provide permanent professional management of both the developed and undeveloped areas of the island, with undeveloped areas of the island to be given protected area status under Qld legislation. This is discussed further in Section 2.11.6 and Sections 8.3.8 and 8.3.9.

This holistic approach is the underlying philosophy of the development strategy for Hummock Hill Island. Specific responses to natural environmental features are described in Table 2.1 in the form of performance targets and development principles for the proposed development.

Table 2.1 – Natural Environmental Development Principles

Feature	Performance Targets	Development Principles	Development Strategies
Outstanding Universal Value of the GBRWHA	Contribution of HHI to the OUV of the GBRWHA is not degraded	Recognise, documented, protect and enhance features of HHI and surrounding waters that contribute to the OUV of the GBRWHA Conserve Biodiversity on the island Protect the surrounding marine environment Conserve areas of exceptional natural beauty and aesthetic importance to the island	Limit development to 10% of the total island area Preserve and managed threatened ecological communities and other high conservation significance communities and habitats Limit clearing within the development footprint Maximise preservation of mature trees Control access to environmentally sensitive and protected areas of the island Control the built form of the development through a statutory Plan of Development that controls building heights and appearance. Limit boat speeds around the island Avoid development or activity within the intertidal zone
Beaches and active dunes	Erosion prone areas are secured and protected from disturbance. Functions of beaches and active dune systems in protecting inland development from erosional forces are maintained. Biophysical values of active coastal dune systems are conserved. Recreational access and enjoyment of beach is catered for.	Avoid direct disturbance to beaches or active coastal dunes. Avoid interference with coastal processes that regulate beach formation. Create controlled public access to beaches through controlled beach access points through littoral rainforest and dune systems and restrict access to sensitive areas. Low key public facilities (barbecue, shelters, picnic areas) to be provided away from erosion prone coastal areas.	Master Plan and project footprint avoids active dune systems and remains outside defined erosion prone areas and the coastal management district. Controlled beach access points along the northern coastline are for pedestrian access only. Open Space Development Code in Plan of Development addresses activities and uses in coastal zone.

Feature	Performance Targets	Development Principles	Development Strategies
Terrestrial native vegetation including listed threatened ecological communities and other ecological communities of conservation significance	Clearing of vegetation is minimised. Clearing of vegetation does not reduce biodiversity. Examples of all vegetation communities are retained in ecologically viable form New weeds are not introduced and extent of existing weeds is reduced. Development landscaping utilises native species on the Island.	Maximise use of already cleared or degraded areas. Avoid disturbance to threatened ecological communities and Queensland endangered regional ecosystems (dominant). Minimise disturbance to areas where dominant Qld regional ecosystem is of concern. Where subdominant ecosystem is "endangered" or "of concern", protect these areas and linkages between them and manage for habitat value. Provide guidelines for plant selection gardens. Include weed control in maintenance programs. Protect remnant vegetation through actively managed conservation areas. Provide controlled access to designated conservation areas to ensure that the community can enjoy these areas without damaging them.	Overall area of development is 10% of Island area Master Plan and Project footprint avoids threatened ecological communities and endangered regional ecosystems. Development Codes for residential development include max of 50% building footprint on every Lot and minimum clearing of native vegetation. Landscape plan specifies planting in public open space and residential and commercial premises; planting of local indigenous species only. Landscape plan addresses weed maintenance. Conservation precinct code in Plan of Development addresses use and management of remnant vegetation on HHI. SE Qld Regional Vegetation Management Code performance requirements are met. Riparian vegetation maintained in accordance with SE Qld RVMC 'endangered', 'of concern' and threshold remnant vegetation off-set in accordance with SE Qld RVMC
Native animals, including species listed under the EPBC Act Roosting and foraging habitat for migratory shorebirds Potential nesting habitat for marine turtles.	Diversity of species occurring on Hummock Hill Island is not reduced Individual native animals are not killed or injured. Examples of all habitats are retained in ecologically viable form Animal nesting, roosting, feeding and reproductive activities are not disrupted by noise or physical disturbance. Potential for marine turtles to use beaches for nesting is not reduced.	Retain and enhance wildlife corridors to connect habitat areas and Maximise permeability of development footprint to wildlife Establish conservation areas and manage for habitat value. Control access to conservation areas. Establish fauna management controls for vegetation clearing.	East-west habitat linkages maintained through retention of trees, retention of wildlife corridors and golf course. Bird movements maintained by use of native vegetation in landscaping. Ground dwelling fauna is minimal, and traffic levels are low, so fauna crossings of roads are not proposed; can be provided later if road deaths are a problem. Ephemeral watercourse crossings will include fauna passage within riparian corridor. Conservation precinct code in Plan of Development addresses maintenance of wildlife corridors. Residential precinct code addresses effects of residential development on adjacent conservation areas. Signs and written information provided to recreational boaters regarding important marine and

Feature	Performance Targets	Development Principles	Development Strategies
			coastal habitats. Lighting mitigation on headland, development to protect low density turtle nesting
Slopes, hills and drainage	Topographic and geomorphic features are retained. Ephemeral watercourse systems are not altered. Use of natural features is maximised.	Design and conduct earthworks to avoid significant changes to topography and minimise cut and fill. Natural catchments and flows are maintained through earthworks and stormwater management. Principles of Water Sensitive Urban Design are followed for all stormwater management. Clearing is minimised in areas that are naturally waterlogged. Unstable slopes are avoided. Views from headland and Hummock Hill are retained and public viewing areas provided.	Master Plan avoids disturbance of steep slopes. Hillsides and ridgelines are not altered by bulk earthworks. Stormwater management system maintains existing quality and quantity of flow. Public access is to headland and hill top areas in accordance with Code for Conservation Precinct. Erosion prone area and estuarine area is retained as an undeveloped corridor.
Soil resources	Soil resources are not lost or degraded. Acid sulphate soils are not disturbed.	Residual soil contamination does not occur following remediation. Existing soil contamination is not mobilised to the environment prior to or during remediation. Soil is not exposed to erosive forces unless erosion and sediment control devices are implemented. Mechanical clearing does not occur on slopes >30%. Clearing is minimised in groundwater discharge zones. Good Quality Agricultural Land not lost. Development in areas of acid sulphate soils is avoided except for public boat ramp and bridge. Acid sulphate soils at boat ramp and bridge are managed to avoid any acidic releases to the environment. Erosion and sediment control plans are used during any earthworks.	Development codes include an earthworks code. Erosion and sediment controls are designed in accordance with International Erosion and Sediment Control Association (Australasia) *Best Practice Erosion and Sediment Control Guidelines* (2008) Maximum retention of vegetation in identified discharge zones. Development footprint avoids all potential acid sulfate soil areas except for the access bridge and public boat ramp – minor quantities only and will be managed in accordance with SPP2/02 and Queensland Technical Guidelines for Acid Sulfate Soils.

Feature	Performance Targets	Development Principles	Development Strategies
Groundwater resources	Groundwater quality is not degraded. Groundwater recharge is not changed.	Groundwater is not used for water supply Potential groundwater contaminants are strictly controlled from entering estuarine and marine waters of the GBR WHA. Permeability of ground surface over recharge areas is not altered. Development at toe of slopes does not affect discharge zones in the golf course area.	Water supply options excludes groundwater. 50% site cover over potable sandy aquifer within lease, no development over this aquifer outside Special Lease Area. Development on groundwater recharge and discharge zones is avoided and/or minimised.
Marine plants and aquatic habitat. Coastal wetlands. Colosseum Fish Habitat Area.	Extent of marine plants and fish habitat is not significantly reduced. Water quality in coastal wetlands of Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek is not changed from current conditions	Development does not take place in within Colosseum FHA, and disturbance to intertidal and subtidal areas occurs only for bridge, public boat ramp and associated pontoons. Development does not occur in mangroves Clearing does not occur within 100 m of any coastal wetland. Access to mangroves is not increased. No significant change in volume of discharge up to and including the Q100 rainfall event. Water quality and sediment quality is not degraded	Footprint of Project avoids all coastal and palustrine wetlands (no freshwater wetlands on Island). Ephemeral watercourse discharges to coastal areas are maintained. Nutrient levels slightly reduced adjacent to developed areas, reductions in suspended solids after development. Only minimal clearing of mangroves for bridge and boat ramp (outside Colosseum FHA) – negligible in terms of overall area of mangroves, utilises existing disturbed area. Discharge of treated wastewater occurs only in extreme rainfall events greater than the 3 times average dry weather flow storage capacity and plant redundancy failure. Designed stormwater drainage system will be based on Water Sensitive Urban Design Principles in accordance with Healthy Waterways WSUD Guidelines (2009).
Air Quality	Air quality is maintained to protect ecosystem functioning.	Air pollutants do not exceed NEPM (Air) guidelines for sensitive vegetation. Dust deposition does not affect plant growth.	No impacts predicted. Compliance with construction environmental management plans
Noise	Amenity of GBRMP and GBRWHA is retained	Noise levels are consistent with Queensland Environmental Protection (Noise) Policy 2008 in relation to urban areas and conservation areas.	Noise

Feature	Performance Targets	Development Principles	Development Strategies
Resource use and waste	Consumption of non-renewable resources is minimised during Construction and operation. Consumption of renewable resources is within sustainable yield. Waste is not released to the environment except in accordance with conditions of Development Approvals.	Use of renewable energy sources is maximised, including solar and wind at the Island scale. Water harvesting and consumption is strictly controlled. Wastewater is treated and reused. Waste avoidance and reduction strategies are introduced. Buildings conform to 5 star sustainable design standard.	Mains power is proposed supplemented by renewable energy sources. No harvesting of surface water flows. Water cycle includes 100% reuse of grey water, rainwater tanks and potable top up from desalination plant. Plan of Development includes requirements for water and energy efficiency. Greenhouse emissions from the Project are minimised by maximising renewable energy sources.

D = Development Phase; C = Construction Phase, O = Operation Phase

2.2.3 Social Environment

Hummock Hill Island is in the Gladstone Regional Council area. The proposed tourism development will provide Gladstone and the mining areas of Central Queensland with a quality tourist, residential and recreational facility that, as recognised in the Central Queensland Tourism Opportunity Plan (2009-2019), is not currently available in the region.

The Gladstone Region is centred on the Port of Gladstone, one of the largest ports in Australia, and the Gladstone State Development Area, a 29,000 ha area of land designated for industrial development and associated infrastructure. Gladstone is considered by both the Queensland Government and the Commonwealth Government to be one of Australia's most important and strategic industrial development regions. Several major mineral processing facilities are located in Gladstone, including the Boyne Island aluminium smelter, Queensland Alumina Limited refinery and Rio Tinto's alumina refinery. Gladstone is also an important centre for commercial and light industrial activities servicing industrial development in Gladstone and mining in Central Queensland.

Future regional economic growth is focussed on the development of major industrial projects. Plants currently under construction in the Gladstone region, including coal seam gas plants and major port and coal handling expansions have a financial investment of approximately $55 billion with a further $30 billion of proposed projects in the pipeline. These projects will bring major population growth, economic development and employment. The Gladstone Economic Investment Development Board estimates that investment in project construction, infrastructure and future operations will create over 20,000 local job opportunities over the next 20 years. The estimated residential population of GRC at 30 June 2011 was 62,300. Projections released in 2011 estimate that by 2016 the population will be between 71,000 and 78,000 and by 2031 will reach between 93,000 and 123,000 persons.

To successfully compete for business investment and attract people to work in the region, Gladstone must present an exceptional social climate as well as a good business climate. The social climate would include access to good social, cultural and recreational services, a high quality urban lifestyle and a good physical environment. These elements are particularly important for an industrial city like Gladstone, where a high quality of life can attract a diversity of business people and skilled workers in spite of the significant industrial landscape. The coastal areas adjacent to the major industrial centre will serve as an escape destination for regional residents. These outcomes been recognised in preparation of the Central Queensland Regional Plan (http://www.dsdip.qld.gov.au/resources/plan/central-queensland/).

Hummock Hill Island has suitable natural attributes and topography for a major resort and recreational development. The scenic amenity of the Island with its beaches and warm seas, elevated hillsides with wide ranging views, natural bushland and calm waterways in a protected estuary will attract international, interstate and regional visitors and holiday makers. The PTP will provide public access to arguably the best beaches between 1770 and the Capricorn Coast. The Project will also offer high quality leisure and accommodation opportunities for regional population.

The Island offers the only real opportunity for a major seaside tourism, holiday and recreational development in the Gladstone region. The coast from 1770 to Gladstone is mostly protected as National Park and the coast north of Gladstone is quarantined for industrial development and oil shale exploitation. The Project will provide public access to a coastline that is presently only accessible by boat.

Regional tourism expenditure totalled $270 million in 2009/10. The PTP, as a stand-alone international standard tourist destination, will support the current growth in tourist markets and also create its own market. The project has the potential to be the focal point for tourism in the region, acting as a catalyst to a range of other tourism investment, marketing and product development. The $956 million Project will diversify the regional economic base, injecting $55 million per annum in tourism expenditure by 2022 and over $95 million by 2030. The construction of the Project will add $390 million to the regional economy and $460 million to the Queensland economy. On completion, the Project will value-add $810 million to the regional economy from tourism expenditure.

Construction of the Project will directly employ an average of 190 persons per annum over a 20 year period and the completed project will employ over 700 permanent full time positions in tourism and supporting businesses on the island.

HHI is currently uninhabited. Historically the Island has been subject to pastoral activities under a pastoral lease with associated clearing and logging since the 1880's to the early 1980's. A homestead and associated workers accommodation was previously located on the northern headland. The Island is used informally by a small number of local visitors for camping and day visits, with visitors accessing the Island by boat. The nearest settlement, consisting of a number of coastal holiday houses, is located at Bangalee on the northern side of Colosseum Inlet, on the southern tip of Wild Cattle Island. A small settlement of around seven houses is located at Mundoolin Rocks east of Clarks Road on the mainland. A rural residential subdivision of about 50 lots has been developed along Foreshores Road and Intrepid Drive and is known as the Foreshores Estate (see Figure 1.1).

Tannum Sands/Boyne Island has become a significant suburb for Gladstone. The urban area of Tannum Sands includes a major shopping centre, high school and range of community services and facilities. The beach at Tannum Sands is the region's only easily accessible swimming beach. Tannum Sands is has continuing development south of the current Town and west of Wild Cattle Creek. Limited opportunity for further expansion southwards of Tannum Sands is available due to the proximity of Colosseum Inlet.

Apart from Tannum Sands, the nearest settlements to Hummock Hill Island are:

- Turkey Beach, a small coastal community of about 200 permanent people with a general store and public boat ramp; and
- The towns of Miriam Vale and Bororen on the Bruce Highway. These towns have basic shops and service stations as well as primary schools, and in the case of Miriam Vale, a lower Secondary School.

Table 2.2 lists the development principles of PTP in relation to the social environment.

Table 2.2 – Social Environment Development Principles

Feature	Performance Targets	Development Principles	Development Strategies
Coastal setting and visual amenity	Visual amenity is maintained. Visual amenity of the GBRWHA is not degraded. Landscape characteristics are retained as good quality rural/coastal/vegetat ed landform.	Remnant vegetation is retained as much as possible throughout the development. Landscaping uses indigenous native species. Height controls ensure that views of the Island are not degraded. Building materials and designs blend with natural environment setting. Infrastructure is located so as to be as unobtrusive as possible	Retention of coastal vegetation Retention of 505 of trees within the project Limiting building heights to below the tree canopy top Specifying building materials and colours to blend into the existing landscape Using native vegetation in landscaping
Existing and proposed communities	Economic and social benefits to local and regional communities are maximised. Development of PTP enhances opportunities available to local and regional communities. Negative impacts on local and regional communities are avoided or offset by benefits. A diverse and sustainable community is created on Hummock Hill Island.	Availability of low income housing is not compromised. Participation of local and regional businesses is maximised. Employment opportunities for local and regional population are maximised. The range of housing and accommodation types available complements local and regional demographic profile. Outdoor and recreational opportunities (formal and informal) are maximised. High quality educational opportunities that meet regional needs are provided. Access to the coast is enhanced. Community services (including health, education, and recreation) are available for temporary and permanent residents of the PTP and existing residents of the region.	Contracting arrangements during construction will maximise local labour opportunities. Plan of Development controls development design and maintains development principles Master Plan includes educational and research facilities plus essential services such as a medical centre and centre for emergency services. Range of housing types and affordability including housing for workers on the Island).
Amenity	Tourism and residential amenity on Hummock Hill Island is very high.	Noise levels are below background + 10 dB(A) in accommodation and recreational areas. Noise levels are below background + 10 dB(A) in commercial and retail areas. Air pollutants do not exceed NEPM/ EPP(Air) targets for human health	Noise levels will achieve required levels in accordance Construction EMP and relevant Codes. Plan of Development Codes require development to consider noise impacts on adjacent developed areas and conservation areas. Construction and operational air quality will achieve required targets in accordance with EMP and relevant Codes.

2.2.4 Built Environment

Road access to PTP will be via existing gazetted roads; from Bruce Highway, Turkey Beach Road, Foreshores Road and Clarks Road. Foreshores Road provides access to the Foreshores Estate, a rural residential subdivision that is the closest settlement to Hummock Hill Island. Clarks Road is a dirt track in poor condition, providing access to several private properties at Mundoolin Rocks and ultimately to the causeway to Hummock Hill Island. The Island itself is separated from the mainland by Boyne Creek and there are no road reserves on the Island. A dirt track connects the causeway at the south of the Island to the northern headland.

Power is available to Foreshores Estate and houses along Foreshores Road. The nearest power station is the coal fired Calliope Power Station at Gladstone and there are high voltage power lines running near the Project on the western side of Foreshores Road.

There is no water supply to Hummock Hill Island; the nearest reticulated water supply is at Miriam Vale township, however this does not have capacity to be extended to service any other developments in the area. Most of the hamlets and houses in the southern part of GRC rely on household level rainwater collection. This is not due to a shortage in water supply in the region, but to the cost of supplying reticulated water over large areas of low rural residential densities.

The main source of regional water supply is Awoonga Dam, operated by the Gladstone Area Water Board (GAWB). Awoonga Dam has a storage capacity of 777,000 ML. The current [licenced] yield of the dam is 78,000 ML per year and GAWB anticipates that demand will reach this level in about 2022/23. About 16% of the region's water demand is from residential and light industrial uses. The remainder of the demand is from power generation and heavy industrial development in the Gladstone State Development Area.

Reticulated wastewater collection and treatment is available at smaller communities such as Bororen and Miriam Vale with areas such as Foreshores Estate and Turkey Beach relying on household level septic tank systems.

There is a disused air strip on the Island which is overgrown with pasture grasses. The nearest commercial airport is at Gladstone which provides frequent connections to Brisbane, Sydney and regional cities to the north. Gladstone airport also provides access to several offshore island resorts, including Heron Island. There is a private airstrip at Agnes Water.

The daily Brisbane-Rockhampton tilt train services stops at Miriam Vale and Bororen. Regional and interstate buses also service Miriam Vale and other towns along the Bruce Highway.

Kerbside waste and recycled material collection is a sub-contracted service of GRC, occurring in the Foreshores and Turkey Beach area on a weekly basis. Collected waste is currently transported to the GRC's Benaraby Landfill.

Table 2.3 summarises the development principles related to the built environment.

Table 2.3 – Built Environment Development Principles

Feature	Performance Targets	Development Principles	Development Strategies
Roads and traffic	Internal and external road systems are safe and efficient. Construction and operation does not harm the environment.	Roads conform to Main Roads Road Planning and Design Manual and Queensland Streets Design Guidelines. Greenhouse gas emissions are minimised.	External road network meets required Queensland Department of Transport and Main Roads performance requirements Internal road network meets design guidelines and Planning Scheme requirements Island Road system provided for wildlife corridors
Energy	A reliable power supply is available. Availability of power to existing regional residents is not compromised. Carbon footprint is minimised.	Use of renewable energy sources is maximised, including solar, wind and gas energy.	Solar hot water systems at the household level. Energy efficient natural gas for cooking and heating. Gas supply to be considered for supplying power and cooling resort facilities. Mains power to provide reliable base load supply. Construction based on Building Codes of Australia energy efficiency measures to reduce energy consumption during construction and operation.
Water and wastewater	A reliable water supply is provided. Quality of water is appropriate for designated uses. Natural hydrological cycles are not undermined. Environmental quality is not degraded. Water management infrastructure meets best practice urban design standards.	Natural catchments and flows are maintained through earthworks and stormwater management. Principles of Water Sensitive Urban Design are followed for all stormwater management. Groundwater is not used for water supply. No significant change in volume of discharge up to and including the Q100 rainfall event. Quality of stormwater input to coastal wetlands is not changed. No discharge of treated wastewater Water harvesting and consumption is strictly controlled. Wastewater is treated and reused. Limited reliance on water resources from the mainland. Provision of a safe potable water supply that meets Australian Drinking Water Quality Guidelines. Site based water management is maximised including collection from roof catchments and reuse	Existing ephemeral watercourses on the Island are maintained unchanged with appropriate riparian vegetation management zones. Permanent stormwater management utilises existing drainage pathways and is based on Water Sensitive Urban Design principles (Healthy Waterways, 2006) Stormwater discharges to ephemeral watercourses will meet existing water quality of receiving estuarine and marine waters Treated wastewater is irrigated to green space at sustainable rates Potable water is supplied from reliable and sustainable source such as desalination plant (with zero brine discharge to waters). Rainwater tanks are included at the household and commercial level to provide supplementary non-potable

Feature	Performance Targets	Development Principles	Development Strategies
		of wastewater. A reliable water supply is available for fire fighting.	water.
Telecommunications	Reliable telecommunications systems are available.	Residents have access to latest technology for telephone, internet, television, radio and other communications means.	Microwave relay tower proposed.
Waste Management	Waste collection and disposal to licensed off-site facility for construction, commercial and domestic waste.	Waste avoidance and reduction strategies are introduced.	Waste collection services are implemented in accordance with the Waste Management Plan. Construction waste management will be based on Waste Reduction Guidelines (DEH, 2010)

2.2.5 Ecologically Sustainable Development

The PTP is designed from the ground up on Ecologically Sustainable Development (ESD) principles. Economic, social, environmental and cultural values and potential impacts have been considered and incorporated into the master planned project from the design stage. ESD design principles are addressed in Section 8.12.

2.3 Master Plan

2.3.1 Overview

The Master Plan of the Project is presented in Figure 2.3.

Accommodation facilities will include:

- 240 room 4 Star hotel
- 150 room 5 Star hotel
- 20 room Health Spa
- 70 room Motel
- Caravan Park and Camping Ground
- Holiday apartments and villas
- Residential accommodation.

Recreational and leisure opportunities and facilities will arise both from the natural environmental setting and elements to be provided as part of PTP:

- White sand beaches
- Restaurants / Bars/Cafes
- Indigenous Cultural Centre
- International standard Golf Course
- Sports Centre and Facilities
- Retail shops
- Terrestrial and Marine Centre
- Boat ramp and boat hire.

The Project will also deliver a range of community facilities which will be accessible to residents of Hummock Hill Island and adjoining communities, who currently lack easy access to these facilities. The community and support facilities include:

- Surf Lifesaving Club
- Tourist Information Centre
- Medical Centre
- Emergency services
- Community Markets
- Conference Centre
- Picnic and Barbecue Areas
- Ecological Design and Display Centre
- Retail Shops
- Service station
- Bus Services to Gladstone
- Staff and residential accommodation
- Airstrip
- Helipad.

The Proponent is committed to providing at least 15 per cent of any permanent residential accommodation for low-medium income households. Among other things this will to cater to young people attracted to the island by opportunities to work in the tourism industry.

The proposed community facilities will be developed by the Proponent and then maintained and operated or subsidised by the Proponent until the costs of operation are matched by income from local government rates and levies or from commercial operation of the facility. This is discussed further in Section 2.6.4

2.3.2 Master Planning Approach

The Master Planning approach includes different types of development “precincts” which will provide a combination of high, medium and lower density development and various recreational, educational and commercial activity centres which have been arranged to fit with the natural environmental features. The parameters for building design and construction for PTP will be established through a Plan of Development (PoD) under the GRC Planning Scheme and through architectural guidelines and/or covenants specific to the development type.

The guidelines will function as instruments to assist developers/owners, establishing a high quality of construction and a cohesive architectural character. They will be integrated with marketing strategies promoting a ‘user friendly’ philosophy. The basic intent of the guidelines will be to provide information regarding acceptable choices of materials, finishes and architectural character, as well as building constraints such as setbacks and building envelopes. Controls over on-going construction in neighbourhoods will preserve the established lifestyle during development phases. They will provide options for dealing with distinctive site characteristics such as sloping sites, beach front sensitivity, hydrological issues, geotechnical conditions and soil types.

The Guidelines will also provide guidance for (ESD) principles and compliance with broader sustainability issues and infrastructure. Design principles for each of the key components are discussed further below.

2.3.2.1 Overall Development

Building development will be designed to avoid erosion prone areas on the ocean front, coastal wetland areas and ecological communities and habitats of conservation significance. The interface between the proposed development and sensitive vegetation communities and habitats will be actively managed to minimise edge effects (see also Section 8.3.8, 8.3.9, 8.4.2 and 8.4.9). Areas within the Project footprint will be planned and managed to maximise preservation of habitat features, maintain existing ecological systems and avoid alteration to identified ephemeral creeks. Guidelines will be developed for builders and occupants and to provide strategies and methods to reduce disturbance to a minimum and these will be implemented through the Plan of Development. In particular, in woodland and forest areas, tree clearing will be limited to 50% of habitat trees. Where disturbance does occur the areas will be rehabilitated with native plantings and maintained under a Protected Area Maintenance Plan.

The Project is founded on principles of sustainability at a location ideally situated with respect to existing and emerging economic centres and communities. With this in mind, and to maximise outcomes for environmental, social and economic aspects of the project, the following development goals have been identified:

- Natural environment is maintained, protected and enhanced so that areas and features of conservation significance are retained and the human population can enjoy living in close proximity to, and harmony with the natural ecosystems

- Social environment will be based on a vibrant, dynamic and diverse community that has a strong environmental awareness and is committed to sustainable living and self-development. Individuals and households will come to Hummock Hill Island seeking quality of life in its fullest sense and fulfilling educational and outdoor recreational experiences. Visitors will include residents of the region and will experience holiday and recreational opportunities focussed on family and outdoor activities
- Built environment will be appropriate to the scale of the Project and the natural environmental setting. Infrastructure systems will be based on latest advances in sustainable living, but will be suitable for management and basic maintenance by the occupiers.

2.3.2.2 Sustainable Buildings

PTP is committed to being a model sustainable community, a with the smallest eco footprint possible and largely self-sufficient in water and energy.

2.3.2.3 Architectural guidelines

Architectural guidelines and covenants will be enforced through the Plan of Development to preserve a 21st century economic, social and aesthetic vision for the Island. The guidelines will:

- assist developers/owners to produce a high quality level of construction and a cohesive architectural character
- provide information on acceptable choices of materials, finishes and architectural character
- provide options for dealing with distinctive site characteristics such as sloping sites, beach front sensitivity, hydrological issues, geotechnical conditions and soil types
- provide guidance on (ESD) principles and compliance with the selected 6-Star Green Star and NABERS standards.

The Guidelines will specifically address:

- Energy use and conservation
- Water use, including use of recycled water for toilet flushing and external uses
- Specifications for rainwater tanks
- Natural cooling methods for housing
- Building materials to be used for strength, fire resistance, low embodied energy, low transport energy and resource sustainability
- Use of recyclable materials
- Landscaping
- Requirements for solar hot water heating with a gas boosters
- Use of water-saving technologies to reduce hot water consumption

- Space conditioning - passive design to minimise requirements for space heating and associated electrical demands
- Use of energy efficient lighting and minimisation of obtrusive effects of lighting

Development principles will be incorporated into design, construction and operation phases of the project, with particular emphasis on the design phase. This approach recognises that the most effective means to minimise negative impacts associated with any development is to incorporate measures to avoid or reduce impacts into project design. Environmental impacts that cannot be "designed out" must then be addressed through appropriate management during construction and operation. Design and operations guidelines for all buildings will be prepared by the Proponent. The guidelines will include:

- Sustainable, smart housing design principles;
- Height and bulk, colours and energy efficiency for individual buildings;
- Photo-voltaic electricity and solar hot water generation requirements for each building;
- Communications infrastructure;
- Bush fire management practices and fire protection protocols;
- Landscape design and vegetation management;
- Requirements for commercial buildings to capture rainwater from roof areas for irrigation of gardens and cleaning of public areas
- Heights of buildings (limited to three levels and below tree line or ridge crest level)
- Exterior colours and finishes for buildings (to blend in with the natural bush colours of the surrounding area)

The guidelines will form the basis of building covenants that will be attached to all land titles and contracts of sale of land.

2.3.2.4 Landscape Strategy

The Project footprint will only occur on 10% of the total island on an old grazing lease with grassy woodland on undulating plains, ridgeline vegetation communities, open eucalypt woodland and the already cleared headland.

The proposed landscape strategy is concordant with the overall intent to develop Hummock Hill Island in an environmentally respectful way, preserving all significant habitat and natural features, linking this patchwork of parcels of significant habitat through the open space network, and developing the remaining land in a "least disturbance approach".

In keeping with this guiding principle, landscape strategies have been developed and incorporated into the master planning for each Precinct and will endeavour to minimise impact on the environment, while creating an attractive and unique place in which to live and holiday. Proposed landscaping strategies will be incorporated into each precinct or feature description to ensure that:

- Visual amenity of the Great Barrier Reef WHA is not degraded
- Landscape characteristics are retained as high quality rural/coastal/vegetated landform
- Ridgelines are not altered
- Visual impacts will be mitigated through maintaining existing screening vegetation
- Remnant vegetation is retained as much as possible throughout the development
- Indigenous native species are used in landscaping.

Height controls on buildings will ensure that structural elements do not protrude significantly above the natural topography and treeline and building materials and designs will blend the buildings into the natural environment setting such that views of the Island in the context of the GBRWHA are not degraded.

2.3.3 Key Plan Elements

2.3.3.1 Headland Resort Precinct

The Headland Resort Precinct includes:

Component	Use	No of Units	Total GFA* (m^2)	Number of Levels	Land Area (ha)
Headland Resort Hotel (H1)	T	240	38000	3	3.00
Headland Holiday Homes (H2)	R	36	16200	2	3.50
Headland Holiday Apartments (H3)	T	130	32500	3	2.60
Headland Holiday Cottages (H4)	T	220	77000	2	11.50
Foreshore Homes (H5)	R	64	28800	2	6.25

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

The 4 Star hotel will be located behind the beach to the west of the headland in close proximity to the Resort Village. The hotel site area will be approximately 3ha. While the detailed configuration of the resort would ultimately be determined by the operator, it is planned to be 3 storeys along the street address and within the site. The hotel will include central facilities, convention facilities, specialty dining restaurants, recreational activities and guest wings.

The central facilities would include a porte cochere, reception, and coffee shop/restaurant and associated back of house requirements. The convention/seminar facilities would be located on the ground floor with a separate entry and basement parking. A speciality restaurant would be located within the site to best showcase the landscaped gardens and the ocean views. Recreational facilities would include tennis courts, pools and gymnasium. Guest wings would accommodate 240 guest rooms and would be planned to create landscaped passive recreational courtyard spaces and activity zones including pool environments. Depending on the operator, the suites would be single and dual key and designed to address the ocean views and internal landscaping.

The architectural style would be contemporary, sensitive to subtropical environment, feature balconies that provide privacy, weather and shade protection and contribute to the principles of energy efficiency. The construction would require light coloured external finishes and low pitch roofs.

The hotel will have frontage to the Village centre with a retail component on the ground level consisting of a tavern, food & beverage, souvenirs, etc. Parking for guests would be provided in basements with surface visitor parking and bus circulation/parking adequately screened.

The hotel will be designed for maximum self-sufficiency in water management with rainwater harvesting and grey water re-use. The architectural designs would incorporate energy efficiency measures including solar management, orientation of buildings and natural ventilation where achievable. The design will recognise regional material availability and construction opportunities and constraints in a practical and beneficial manner. The selection and installation of materials and products will recognise the importance of carbon emissions.

The headland holiday homes will offer absolute ocean views. The foreshore homes on the eastern side of the headland will be located on the crest of the small hill 100m behind the littoral vine thicket that dominates the inland side of the fore dune of the oceanfront beach. Their location in close proximity to the Resort Village Centre allows for easy access to services and facilities. The average lot size of 750 square metres allows for a low impact, low density residential outcomes to be achieved. Prime views will be available to seaside vistas, beaches and bays. Building covenants will be created to ensure that the building footprint is less than 50% of the lot and clearing of significant native vegetation will not be permitted prior to approval being attained from the appropriate authority. This will assist with visual amelioration of the villas from the water, and provide habitat retention throughout the precinct. In common with all other low rise areas within the development, the street scaping shall include random copses of native street trees in the verges, under-planted with indigenous groundcovers. Access ways to the beach will not be permitted from individual villas. Public access ways will be constructed to prevent informal paths to the beach being created. These pathways will be limited in number, positioned to avoid the loss of specimen plants within the vine thicket, and be of low impact construction. Construction will include sand ladders at the beach access points, and short sections of boardwalk through particularly vulnerable areas such as natural flow paths.

Headland Holiday Apartments will have ocean views, linked to the Town Centre and beaches by a pedestrian network. These apartments offer the visitor an alternative to the 'resort' style hotel accommodation adjacent. A three storey maximum building height applies to this form of development. Basement car parks will be provided to accommodate resident and visitor requirements.

The Headland Holiday cottages are located on the open woodland previously cleared for grazing. The smaller lot size provides an opportunity to create low maintenance, compact seaside dwellings of an affordable nature and adds to the mix of accommodation types offered at PTP. Although differing in size of allotment, the rationale for the landscape of the cottages and the beachfront homes is consistent. Within allotments building covenants will be created to ensure that the building footprint is less than 50% of the lot and clearing of significant native vegetation will not be permitted prior to approval being attained from the appropriate authority. This will assist with visual amelioration of the beachfront homes from the water, and provide habitat retention throughout the precinct.

Sub-tropical, "resort style" landscaping will planted throughout this precinct. Landscaping will include a mixture of native and exotic planting, with covenants placed on planting design with regard to exotic species. The limitations will ensure that plants with the potential to negatively impact upon the existing habitat are precluded. The informality of the streetscape undertaken in other areas of the precincts will continue, with emphasis on hardy, salt tolerant, native trees and groundcovers. Within the public open spaces, the planting will be designed to assist in visual amelioration of the proposed built environment over the medium to long term. This will include the planting of a homogenous mix of medium to large trees native to the immediate region. This planting will be undertaken prior to the development of this precinct of the Island, to allow the trees to gain as much height as possible before construction on the headland commences.

2.3.3.2 Golf and Beach Resort Precinct

The Golf and Beach Resort Precinct includes:

Component	Use	No of Units	Total GFA (m^2)	Number of Levels	Land Area (ha)
Beachfront Tourist Hotel (G1))	T	150	24,000	3	2.25
Beachfront Villas (G2)	T	220	99,000	2	21.50
Beachfront Apartments (G3)	T	70	17,500	3	1.40
Golf Course Villas (G4)	R	130	58,500	2	12.70
Golf Course Cottages (G5)	R	180	63,000	2	9.40
Golf Course Apartments (G6)	T	230	57,500	3	4.60
Golf Club House (G7)		1	1,000	1	0.40

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

The 150 room 5 Star Beachfront Resort Hotel, the second 'resort' style hotel proposed for the development, will also be the centre of golf and sport on the island. The hotel will include a, gymnasium, indoor pool, flood lit tennis courts and lawn bowling rinks. A specialty restaurant and beach bar will address the beach to the north. The guest wings would address the beach or the golf course or overlook secluded pools. The accommodation may be single and/or dual key. The resort is separated from the beach by a 100 m development exclusion zone, which will be preserved and enhanced by dune revegetation where necessary. Limited access ways will be constructed to prevent informal paths to the beach being created by Hotel visitors. Construction will include sand ladders at the beach access points, and short sections of boardwalk through any vulnerable ecological features. The emphasis on public interaction would be limited to the golf course, restaurants and seminar facilities. The Golf Club House and golf pro shop will be located to the south west of the hotel. However these facilities will be under the hotel management. Parking for guests would be provided in basements with surface visitor parking and bus circulation/parking adequately screened. Visitor parking and bus circulation would be located adjacent to the Golf Club House to the south.

The villas and apartments within this precinct are located along the beachfront and scattered around the golf course, providing a more secluded holiday destination whilst still allowing pedestrian connections to the beach and Village centre. The planning emphasis will be to highlight ocean and golf course views and intimate landscape environments of lagoons and recreational facilities.

The low elevation of the site and location behind the dense vegetation behind the beach within the Coastal Management District render the proposed building locations of little concern with regard to visual impact external to the site. The proposed height of development in 2 and 3 storey configurations is keeping with the low impact goals of the development

The proposed architecture will be contemporary, with a tropical character that blended with the environment utilising a mix of masonry and timber elements to reinforce the relationship. Building design will be sensitive to the subtropical environment, featuring balconies that provide privacy, weather of shade protection and contribute to the principles of energy efficiency. The construction would most likely be light coloured rendered masonry with low pitch roofs.

The buildings will aim for maximum self-sufficiency in water management with rainwater harvesting and grey water re-use. Architectural designs will incorporate energy efficiency measures including solar management, orientation of buildings and natural ventilation where achievable. The design will use regional materials where ever possible. The selection and installation of materials and products would recognise the importance of carbon emissions.

The 18 hole, par 72, links style will be designed and constructed in accordance with the general principles of the *Society of Australian Golf Course Architects (SAGCA)* (see also Section 2.8.4). The "Wild" Golf Course will be an important community facility as well as a significant tourist development in the Gladstone region. The course will be open to the tourists and the public for a daily fee. Club memberships will be also available to residents of the Island and the adjacent region.

Operation of the proposed golf course will be based on current and future best management practices including the Australian Golf Course Superintendents Association (AGCSA) (2001) Guidelines and e-par®, which is an ISO 14001-based EMS specifically designed for golf courses by AGCSA. No runoff will be created from irrigation practices, and so no fertilisers should reach a watercourse at the time of their application. Because the possibility exists that runoff from natural rainfall would re-entrain applied chemicals, the golf course will be designed in order to limit this Any overland flow that does result from rainfall events would be directed towards WSUD devices and then into the large storm water retention basins that will run through the golf course. Management of irrigation and runoff from the golf course is discussed further in Sections 8.5.6, 8.5.7 and 8.5.12.

2.3.3.3 Resort Village Precinct

The Resort Village Precinct will include:

Component	Use	No of Units	Total GFA (m^2)	Number of Levels	Land Area (ha)
Motel (V1)	T	70	5600	2	0.30
Village Apartments (V2)	R	120	99000	2	4.40
Caravan Park and Camping (V3)	T	170 sites		NA	4.00
Village Retail and Commercial (V4)			5000	2	1.00
Community Services Centre			1200	1	0.24
Life Saving Club			400	1	0.08
Public Parking				NA	1.20

T –tourist accommodation, R – residential accommodation, GFA –gross floor area

The Resort Village Centre will be designed to function as a multi-purpose environment catering for tourists, local residents, visitors, special interests groups and related commercial activities. The centre will create a development anchor and focal point, positioned to promote and sustain highly visible activity and community services for permanent or holiday residents.

The Centre, located in the south east of the headland, will re-create the traditional small town 'Main Street' with adequate street parking, blended pedestrian movement, ample shade structures and trees. This main street will feature various retail outlets including those associated with the hotel which will address the street rather than face inward. This strategy enriches the street activity and conforms to the resort hotels' operations. Shared traffic arrangements, incorporating 'slow zones', will allow for the safe integration of pedestrians with vehicles. Adequate on-street and off-street parking areas in close proximity to the Town Centre will be allowed for in the design.

The range of facilities envisaged for the Village Centre includes:

- Food & Beverage
- Convenience retail
- Tourist retail
- Supermarket
- Beachfront Restaurant
- Medical Centre
- Community Services Centre.

As the retail and holiday accommodation hub of the Island, the Resort Village will be the focus of a wide range of activities centred on a traditional "Main Street".

Urban design features of the Village Centre will focus on their strategic location as the hub for activity throughout the island. The Village Centre is positioned to enhance the experience of a seaside village with commercial, retail, resort and educational facilities clustered around public open spaces.

Buildings within the Village Precinct will be generally one or two storey and because the site is below the level of the headland the buildings will be screened from the sea by natural vegetation vine thicket and eucalypt vegetation when viewed from the sea.

The architecture will reflect contemporary lifestyles and promote economic, social and environmental sustainability. Emphasis will be placed on:

- Climate comfort, including street and footpath shading, utilising landscaping, large overhangs, awnings
- Good visual access to and from the town centre and village centre
- Lightweight construction where appropriate
- Pedestrian permeability and safety
- Landscaping to enhance and integrate the Project with the environment
- A distinctive architectural character to create a unique island identity.

The Motel is aimed at providing budget accommodation for travellers to the area, but will also provide 'spillover' lodgings for persons attending the conference centre attached to the Headland Resort Hotel. Centrally located to allow for walkable access to the Resort Village Centre and its various services, the Motel provides a further accommodation option on the island. The proposed 70 room building will be single storey in height and architecturally designed to integrate with the surrounding built form and environment.

The Caravan Park and Camp Ground, located on southern edge of the village, offers a budget priced, family oriented holiday option. Facilities will include tent and caravan sites and associated amenities. Sites will be located wherever possible to keep as much of the existing vegetation intact as practicable. This will benefit the existing ecosystem and will also assist in the shading of the sites. Only local provenance species will be selected for landscape works. Irrigation harvesting will be undertaken from hard surfaces within the park for the planting to the surrounds of the common buildings.

The apartments within the Resort Village Precinct are oriented toward people who will be living and working on the Island. The proposed height of apartment buildings will be three storeys high in keeping with the low impact goals of the development.

Public amenities, including BBQ areas, beach access points, toilets and public parks will be located at strategic points throughout the precinct. A surf lifesaving club and beach pavilion will be located at the base of the headland near the Village centre to provide facilities for beach safety and public amenities.

The landscape of the village centre will reflect the relaxed seaside village character- constructed with high quality materials, with an emphasis on the colour and light of the beach. The “hardscape” of the main street will be constructed with natural, tactile materials such as light coloured stone and weathered timbers, taking advantage of their ability to look better over time, low maintenance requirements, and ease on bare feet. The “softscape” will be designed for shade and coolness, with shade trees incorporated into the street profile as a dominant attribute of the streetscape. Native trees and palms will form the canopy, complimented with the mass planting of non-invasive, drought tolerant exotic shrubs and groundcovers, combined with hardy varieties of native shrubs and groundcovers. Although a shared precinct, pedestrian movement will take precedence over vehicular traffic. This will be reflected in the design of the pavements and street furniture.

2.3.3.4 Ocean View Precinct

The Ocean View Precinct will include:

Component		**No of Units**	**Total GFA (m^2)**	**Number of Levels**	**Land Area (ha)**
Spa Retreat (S(1)	T	20	5000	1	2.00
Ocean View Villas (S2)	R	120	42000	2	60.00

T –tousist accommodation
R – residential accommodation
GFA –gross floor area

A specialty wellbeing spar retreat with 20 studio apartments will be located in a garden setting to the east of the main ridge line that runs across the island.

The Ocean View Villas are sited to overlook Rodds Bay to the north east. The individual sites occupy the eastern slope and northern slopes of the central spine of the Island and Hummock Hill to take advantage of the outstanding ocean and coastal views. These premium sites have been located with consideration to the natural topography and landscape. The disturbed areas shall be replanted using native trees, under-planted with indigenous groundcovers. The muted colours of the native plants will assist in lessening the visual impact of the development.

Drainage flow paths will be retained between sites in the form of natural swales. These swales will be stabilised with on-site rock where necessary, and planted with native grasses to replicate natural, dry creeks. Proposed swales will help slow the stormwater flowing downhill in rain events, assist the efficiency of the natural “soaks” at the base of the hill, and preserve open space linkages/corridors throughout the precinct. Significant tree specimens will be retained in the open spaces to assist in the filtering of views of the proposed homes from vantage points external to the site.

Within individual sites building covenants will be created to ensure that building footprints are no greater than 50% of the lot and clearing of significant native vegetation will not be permitted prior to approval being attained from the appropriate authority. Roofline must be maintained below the tree canopy on the uphill side of each lot and below ridgelines to minimise visual impacts of the

Project when viewed from the sea. Architectural guidelines will specify building materials and colour.

2.3.3.5 Colosseum Precinct

The Colosseum Precinct includes the following:

Component	Use	No of Units	Total GFA (m^2)	Number of Levels	Land Area (ha)
Bushland Holiday villas (B1)	T	160	40000	1 and 2	32.00
Colosseum Village Apartments (B2)	R	120	30000	2	4.80
Colosseum Villas (B3)	T	245	61250	2	49.00
Colosseum Village (B4) ▪ Retail ▪ Ecological Design Centre ▪ Tourist information Centre ▪ Aboriginal Cultural Centre ▪ Native plant Nursery			 2500 1200 150 800 150	 1 2 1 1	 1.50 0.20 0.01 0.20 2.50
Terrestrial and Marine Research (B5)			500	2	1.0
Boat Ramp (B6)				NA	1.50
Airstrip (B7)			250	NA	10.00
Island Services (B8) ▪ Desalination Plant ▪ Salt Evaporation Ponds ▪ Waste Water Treatment Plant ▪ Maintenance Depot ▪ Electricity Sub-station ▪ Emergency Generator ▪ Service Station and Fuel Storage ▪ LPG tank				 2 Max NA NA NA 1 max NA 1 Max NA	7.00

T –tourist accommodation
R – residential accommodation
GFA –gross floor area

Bushland and Colosseum Villas

The proposed neighbourhoods consist of lots that benefit from the retention and enhancement of the existing natural vegetation. A mix of single and two storey dwellings will be constructed throughout this precinct in order to integrate with the natural environment and assist in providing a low visual impact within the landscape. The lots are set back from the conservation area to provide a sense of privacy and to integrate with nature. The incorporation of building materials and colours that complement the natural surrounds will be a feature to these single and two storey buildings. The vegetation for much of this site is typical to the islands interior dominated by Eucalypt woodland common to the region, with specimen plants not evident. Swales will meander throughout the open space network and will serve as an integral part of the stormwater control of the development. They will also form wildlife corridors, serving to connect the mosaic of habitats which will be preserved and protected throughout the development.

Within lots, building covenants will be created to ensure that outside the building footprint, clearing of significant native vegetation will not be permitted prior to approval being attained from the appropriate authority. This will assist in enhancing the native bushland setting and will further serve as the major initiative in habitat retention. A pathway network with public access will be created through the precinct and into the protected areas of the island to control bushwalking through sensitive areas.

Colosseum Village Apartments

Colosseum Apartments located in Colosseum Village will be affordable accommodation targeted at the development's workforce. The low elevation of the site and location toward the centre of the Island result in the proposed apartment locations having low visual impact external to the site. The proposed height of apartment buildings will be 2 storeys high in keeping with the low impact goals of the development.

Colosseum Village

The proposed Entry Village is located at the southern end of the airstrip near the dam, located in a saddle of the main ridge bisecting the Island,. Typical of the lower lying areas of the area to the east of the central spine, the site to be occupied by the village centre has been previously cleared for grazing. The village will provide retail facilities for the islands residents and as well as tourist attractions including a Tourist Information Centre , Indigenous Cultural Centre and an Ecological Design and Display Centre.

The buildings in the village will be one storey in height and of a style that is contemporary yet domestic in scale. As the “entry” point to the project, the landscape associated with this area will exemplify the relaxed, coastal village aesthetic, balanced with the highest standards of quality development. This will be demonstrated by high quality, natural finishes in the hardscape, and a sub-tropical, “resort’ style softscape.

Native Plant Nursery

The Native Plant Nursery will display and sell plantings for endemic shade trees, medium sized native street trees; native palms, hardy, native shrubs and groundcovers non-invasive, drought tolerant, low maintenance exotic shrubs and groundcovers for use throughout the development.

Indigenous Cultural Centre

The Project will involve the local Traditional Owners the Gooreng Gooreng and Gurang. The Proponent, working with the Traditional Owners, has a Cultural Heritage Management Plan registered with the Queensland Department of Environment and Heritage Protection (DEHP). An Indigenous Cultural Centre will be established in PTP, offering an important tourist attraction for both foreign and domestic visitors, creating a unique attraction otherwise currently not found in the Gladstone region.

The Centre will provide cultural experiences and would include the following:

- Displays and information on the aboriginal history of the island
- Interpretative walks/hikes around the island through designated sensory trails
- An indigenous/traditional camping grounds to accommodate excursion students and visitors
- Packages and programs for schools to educate students on Indigenous culture
- Lectures and presentations in keys aspects of the indigenous culture.

The Indigenous Cultural Centre will work with the islands resorts to match employment opportunities with the local indigenous community. During the development period the proponent will commit to provide training for up to 100 young members of the Indigenous community, based on the level of interest registered. In the early stages of the Project this training would be focussed on operation and construction occupations and then later in a wider range of development and tourism occupations, including as rangers for the managed conservation area.

Terrestrial and Marine Research Centre

An environmental education facility is proposed to encourage community awareness, appreciation and understanding of native wildlife and to promote the GBRWHA to visitors and residents of the Island, in particular highlighting local and regional features that contribute to the OUV of the GBRWHA. Discussions are underway with leading Queensland universities to enable the centre to contribute to academic and scientific research in relation to development in the region.

Extension programs will be implemented to support the management of the conservation areas and the interaction of residents within those areas. The programs will promote an understanding of the environmental values of the island, the GBRWHA and the GBRMP and will include both voluntary conservation works and environmental education.

The Centre will undertake:

- Ecological and environmental monitoring programs that aim to inform land care and other conservation activities
- Terrestrial and Marine Research with focus on local environmental works and land care activities
- Development and management of programs that contribute to the ongoing operation of a marine mammal and turtle monitoring program aimed specifically at the Rodds Bay Dugong Protection Area
- Development and management of the Marine Ecological Monitoring Plan (MEMP) to map and monitor key marine communities in the area including coral communities, seagrass beds, and mangroves.

Environmental education and extension programs will be developed to provide practical advice on interaction of the community with the GBRWHA. The programs will include school level education programs that engage participants in improved management and understanding of the threatening processes that impact the local catchments and their outflow to the GBRMP and WHA. Areas of interest will include appropriate fire management, soil conservation, interacting and living with wildlife and landscape function. The programs will include ecological and environmental monitoring programs that aim to inform landcare and other conservation activities in the region with a particular emphasis on the values of the GBRWHA

The Centre will be initially funded by the proponent and then the local community through the proposed "Environment Levy" on businesses, tourists and residents.

Airstrip

The area to be used as the airstrip lies parallel to, and east of the central spine of the Island. The area has been cleared previously, both for grazing and as an airstrip, and is not of significant ecological conservation value. It is therefore ideally suited to task. At this early stage prior to detailed design, little clearing is proposed to locate the airstrip in approximately its previous location, where the clearing of trees has already been undertaken for this same purpose. Landscaping to the Airport Services facility will be in keeping with general public facilities/ major roadway landscaping. Planting will consist of copses of endemic shade trees to open spaces; medium sized native street trees; native palms to focal points; and hardy, native shrubs and groundcovers to mass planted garden beds and medians.

Island Services

The services compound area is located at the south east corner of the project. The perimeter of the area will be planted with locally endemic plant species to provide screening. The Island Services Area will include:

- The desalination plant
- The wastewater treatment plant and associated recycled water treatment plant
- An electricity substation housed in a 50 sq m building with a roof height of 4m
- Maintenance equipment depot
- Solar array
- LPG tanks.

Buildings and other structures within the Services Area will be a maximum of two storeys in height and, in the case of buildings, be built to the same architectural standards as the other commercial buildings on the island.

2.4 Population

The master plan for the Project incorporates a diverse range of tourist facilities and accommodation including resort hotels, holiday units, camping grounds, holiday housing, boating facilities, golf course and recreational facilities and a town centre based around retail and educational services that will cater for a broad range of people. The community will consist of an estimated 2,700 tourists during peak periods and 1,200 residents when the township is fully developed over a period of 16 years.

The projected growth in population during the development period is shown in Figure 2.4 and the seasonal variation in population when the Project is fully completed is shown in Figure 2.5. The projected seasonal variations in the numbers of tourist, staff and residents on the island shown in Figure 2.5 are based on historical records of popular tourist periods in the region and projected school holiday periods.

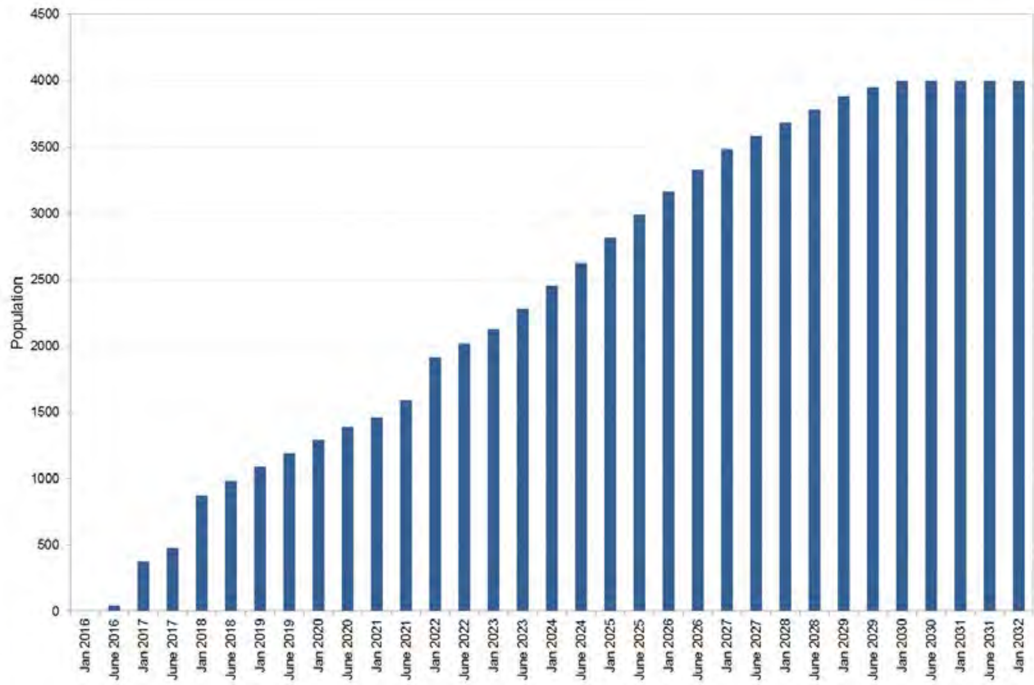

Figure 2.4 - Projected growth in population during the development period

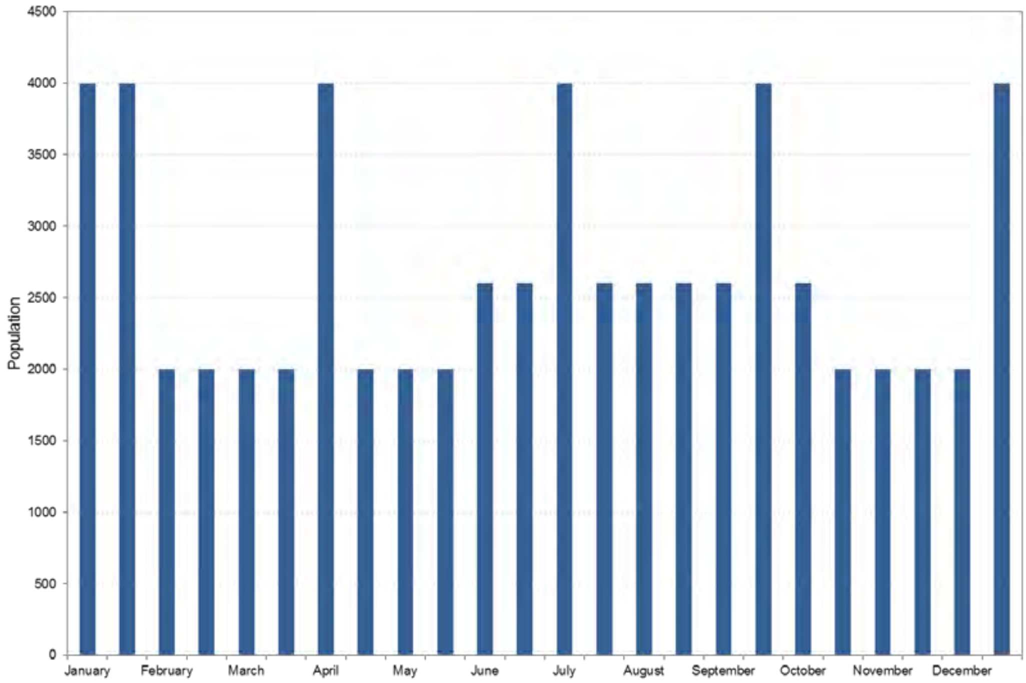

Figure 2.5 - Projected seasonal variations in the numbers of tourist, staff and residents on the island

2.5 Plan of Development

A Plan of Development has been approved by the Queensland CoG to guide future development on Hummock Hill Island. It provides specific direction on how development should occur, to achieve environmental protection and a sustainable and vibrant community.

The Plan of Development sets out the approvals frameworks that will apply to the PTP and is consistent with the requirements of GRC Planning Scheme.

Following the completion of the EIS process and approval from both Queensland Government (CoGs Report with Conditions, Queensland Coordinator-General, 2011) and the Commonwealth Government's approval under the EPBC Act, the Project will still require approval under the GRC Planning Scheme.

The GRC will be assessment manager under the IP Act / SP Act for a Material Change of Use Application under the Planning Scheme (see also Section 3.3.2).

The Plan of Development sets out the assessment framework that will apply to the PTP and incorporates the definitions of the Planning Scheme and references the relevant codes from the Planning Scheme. The Plan of Development includes Assessment Tables (Plan of Development) and Precinct Codes and the PTP Overlays (Plan of Development Overlays) and Overlays Codes.

Buildings must comply with the conditions of the Plan of Development (POD), which is a site specific planning document that specifies codes of development under the GRC Planning Scheme. The POD will specify, amongst other things, the form and height of buildings and the use of building materials. The Plan of Development provides certainty that buildings will be developed to approved standards.

The Plan of Development specifically addresses building designs and specifications including:

- Establishing building envelopes that, for most building types, require at least 50% of habitat trees to be retained on each lot
- Building heights, consistent with tree height and the height of the ridgeline which bisects HHI
- Contemporary architecture with a tropical character, utilising a blend of masonry and timber
- Use of low pitch roofs
- Selection of light, natural colours and non-reflective building materials
- Avoidance of “blocky” structures and outlines that will contrast with the natural shapes of the area
- Compliance with Green Building Council of Australia “green star” rating schemes or Australian Building Code energy efficiency requirements, particularly in relation to:
    - Maximising natural ventilation and cooling
    - Selecting sustainable building materials
    - Use of locally or regionally made building materials where possible
    - Use of shade trees to minimise artificial cooling requirements
    - Minimisation of light spill to the surrounding environment
    - Solar panels where this is appropriate to the building function
    - “Third pipe” treated wastewater reuse where this is appropriate to the building function.

The overall outcomes of the Draft Plan of Development for Hummock Hill Island are that the:

- Areas of conservation significance, including those features that contribute significantly to the OUV of the GBRWHA are retained and the human population can enjoy living in close proximity to, and harmony with the natural ecosystems
- A vibrant, dynamic and diverse community is developed that has a strong environmental awareness and is committed to sustainable living and self-development. Individuals and households will come to Hummock Hill Island seeking quality of life in its fullest sense and fulfilling educational and outdoor recreational experiences
- Built environment is appropriate to the scale of the Project and the natural environmental setting. Infrastructure systems will be based on latest advances in sustainable living, but will be suitable for management and basic maintenance by the householders.

The Plan of Development also establishes Development Codes that guide any development on the island and includes overlays which describe constraints on development.

2.6 Land Tenure

2.6.1 Current Land Tenure

The proposed PTP is within Lot 3 on FD841442 which is leasehold land. Lot 3 is subject to Special Lease SL/52155 which covers the entire area of Lot 3 (Refer to Figure 2.6).

The Island consists of 11 Lots, including Lot 3 as described in Table 2.4 and shown on Figure 2.6. Erosion prone areas and estuarine wetland and coastal zones adjacent Boyne Creek, Yacht Creek and Sandfly Creek are located on separate land tenure from Lot 3 and the Special Lease.

Table 2.4 - Lot and Plan Descriptions for Hummock Hill Island and Access Road

Lot No.	Plan	Area (Ha)	Location
Hummock Hill Island			
1	FD841442	310	Western Section of the Island
2	FD841442	30	Tidal area west of the northern headland
3	FD841442	1160	Special Lease SL/52155 (proposed Project area)
4	FD841442	560	Eastern end of the Island
5	FD841442	7	Tidal Flat area at east end of Yacht Creek
6	FD841442	-	Tidal flat area east of Lot 3
7	FD841442	12	Erosion prone area behind North Beach
8	FD841442	28	Erosion prone area behind Main Beach
9	FD841442	30	Coastal zone east of Lot 3 next to Sandfly Creek
10	FD841442	100	Coastal zone along southern edge of Lot 3
11	FD841442	15	Coastal zone between Lot 3 and Yacht Creek
Land Adjacent to Clarks Road			
1	USL43258	2.46	Small island at the end of Clarks Road
6	SP129343	114	East and North of Clarks Road
7	SP100501	681.1	East of Clarks Road
8	SP100501	665.62	West of Clarks Road

The Project will take place entirely within Lot 3 on FD841442, with the exception of the bridge across Boyne Creek and associated approach roads. Pedestrian access to beaches will also involve installation of elevated boardwalks through the erosion prone areas (see also Section 8.10.2).

It is noted that the access road to the development, Clarks Road, is currently nominated as a dedicated road reserve extending from Foreshores Road to the current causeway. This will be extended to cover the bridge across to Hummock Hill Island. Native title has been extinguished over Lot 3 (i.e. the Special Lease) and an approved cultural heritage management plan is in place. Infrastructure such as the bridge and road corridors outside the lease area will be dedicated as public or road reserves and thus native title will be suppressed over these areas.

LEGEND

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Figure 2.6 - Land Tenure Boundaries

This figure must be read in conjunction with the data disclaimers located at the front of this report . The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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2.6.2 Proposed Land Tenure

The PTP area will cover 465 hectares within the Special Lease, consisting of 307 hectares for the Project footprint and 158 hectares for open space, golf course and parkland. Conditions of the Special Lease include the right to convert land within the Special Lease to freehold title, subject to the lease conditions. Hence, all land within the special lease area that is to be developed for tourism, industrial, commercial and residential use (including the golf course) is proposed to be held under freehold title. A number of these freehold precincts, including the hotels, apartments and retails centres, will be developed under group or strata title. All other accommodation units will be located on individual titles. All land developed for public facilities including roads, drainage, water supply, power, sewerage, solid waste, public parkland, beach access, public boat ramp, educational facilities will be dedicated to the GRC.

The balance of the Special Lease area (which coincides with Lot 3) will be undeveloped. The Proponent has committed to surrender the balance of the Special Lease and it is expected that the State government will convert this area, and the remaining land on HHI to a conservation area. This area is shown on Figure 2.7. The proposed conservation area will therefore consist of all of the undeveloped balance of Lot 3 on FD 841442, an area of approximately 695 ha and Lots 1, 2, 4, 5, 6, 7, 8, 9, 10 and 11 on FD 841442 as per Figure 2.6.

The coastal boundaries of the lots on HHI are set by mean high water springs (the mean height of the highest high water at spring tide) and hence, are contiguous with the boundary of the Great Barrier Reef Coast Marine Park (GBRCMP) which is defined as the upper bounds of mean high water springs.

2.6.3 Conservation Area

An agreement is in place with the Queensland Government that the remainder of the Special Lease, an area of approximately 695 ha and other lots on HHI will be designated as a Conservation Area under the *Queensland Nature Conservation Act 1992*. In this regard, the following condition of approval were imposed on the HHID by the Queensland Coordinator-General:

> Schedule 2, Condition 30:
>
> *The proponent must enter into an infrastructure agreement with GRC for the rehabilitation, ongoing management and conservation of all parts of HHI not allocated for urban purposes for not less than 17 years or until such time as the income from GRC's rates and services charges applied to the developed land allows GRC to take over responsibility of management and funding of these areas. The agreement must be submitted to GRC for approval prior to making an application for a development permit for material change of use within the HHID.*

The area to be managed as a conservation area is bounded by mean high water springs and is entirely within the GBRWHA and contiguous with the GBRCMP.

This condition makes the Proponent responsible for management of the balance of the island for conservation values from commencement of development of PTP and throughout the development period. The management of the conservation area will be guided by an Environmental Management Plan to be implemented by a professional management contract.

On completion of the Project it is proposed that the conservation area be managed by Gladstone Regional Council. Funding will come from a conservation levy to be imposed on all occupants of the PTP. In the initial years, when there is insufficient occupancy to fully fund management, the Proponent will provide funding and direct the management, with the goal of handing over the management to a permanent and sustainable management body within 12 to 16 years. Further discussion on the conservation area and complementary Wildlife Habitat Management Plan which relates to management of habitat values and the interface with development within the development footprint is provided in Section 8.3.8 and 8.3.9.

2.7 Infrastructure

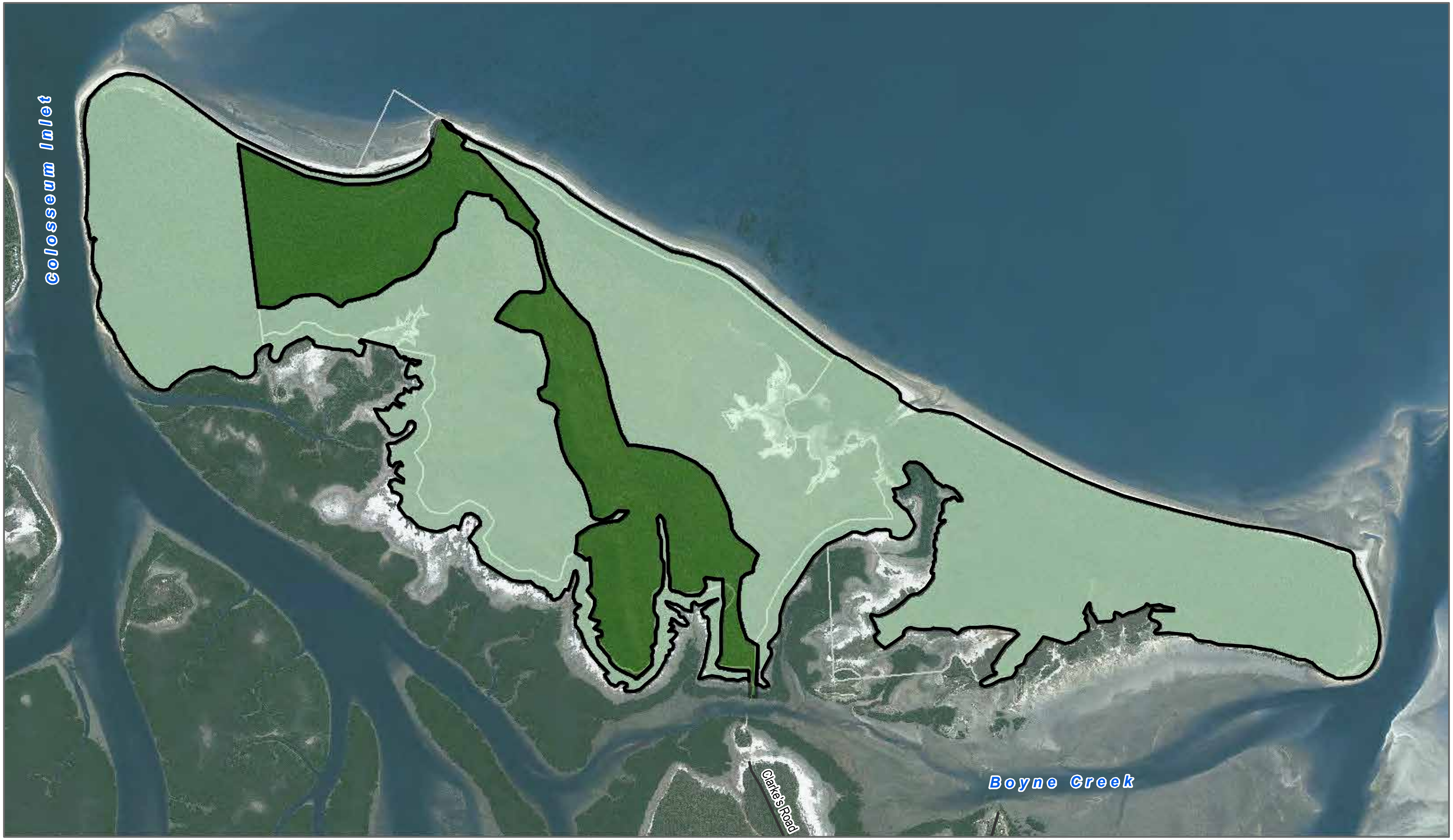
The Proponent will provide all necessary infrastructure for the Project as well as contributions for external infrastructure so that local and State infrastructure providers are not affected.

The proposal includes the design, construction and operation of all site works associated with this process including:

- upgrading of an existing access road
- construction of a bridge across Boyne Creek
- provision of water supply and sewerage headworks
- provision of electrical power from the mainland to the Island
- all associated infrastructure on the island for transportation (car, bicycle, pedestrian), distribution of water and power and management of wastewater and solid waste.

Management of water, wastewater and energy supply services will be controlled at the household and local community levels, taking advantage of a number of innovative technologies and supporting infrastructure that will reduce consumption of energy and resources.

The development of PTP's infrastructure will be undertaken under a BTO (Build-Transfer-Operate) agreement with the Gladstone Regional Council. Under this arrangement the Proponent will build the infrastructure, maintain the infrastructure for a period of 12 months after construction is completed and then transfer ownership of the infrastructure to the Gladstone Regional Council. The Proponent will then enter into a contractual agreement with GRC to manage, maintain and operate the infrastructure for a period of ten years or until the income received from rates and charges exceeds the costs of operation and maintenance.



LEGEND

Road

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Development Area

Managed Conservation Area

Figure 2.7 - Conservation Management Area

This figure must be read in conjunction with the data disclaimers located at the front of this report . The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Leading edge but proven technologies are being proposed for water supply and wastewater treatment and have been selected based on reliably providing a closed-loop water management system with no need to discharge treated wastewater to the environment. At the detailed design phase of the Project the Proponent will again investigate the technologies for water and waste water treatment, renewable energy and storm water management to ensure the most efficient and effective systems are being used. All of the infrastructure proposals will be approved by GRC.

2.7.1 Access Road and Bridge

The proposed access road to PTP will follow the existing Clarks Road alignment and be contained wholly within the existing road reserve, stretching some 15 km from the Bruce Highway to the existing causeway. Vegetation is limited to regrowth along the majority of its length that resembles the vegetation predominant in the surrounding region i.e., sub-dominant Open Eucalypt Woodland and Grassy Woodland.

The concept landscape strategy will ensure that within the road reserve, minimal disturbance will be caused to existing vegetation. The culling of trees will be conducted only as necessary to satisfy safety criteria as stipulated by the Department of Main Roads. Any necessary revegetation will be limited to local provenance species with frangible stems (<80mm when reaching maturity), planted at minimum distances from the traffic lane as determined when proposed speed limits are set following the design of the roadway.

Disturbed road shoulders will be hydro seeded. The hydro-seed will consist of a grass/ groundcover mix, with grass seed to limit erosion by overland flow in the short term, and native groundcover seed to revegetate in the long term. Approaching the site, mono-specific copses of Eucalypt will be planted in the verge at focal points on bends in the road- increasing in frequency as the site is approached to give a subtle, subliminal sense of arrival. As above, the trees will be planted in accordance with Main Roads guidelines in terms of sight lines and distance from the traffic lane.

The proposed landscape strategy for the access bridge will provide a structured, progressive journey. Rather than a typical wall or signage feature at the bridge, the entry experience will be subtle, in keeping with the innovative design philosophy of the project. The approach along the access road from the highway will be planted with the stands of trees which will become more dense and more frequent as the Island draws nearer. Upon arrival at the bridge, any disturbed tidal areas surrounding the boat ramp and bridge will be revegetated with mangroves, and the abutments of the bridge will be planted with deep green, evergreen native trees. This will lessen the visual impact of the built form upon the channel, and create a cool green visual landscape to welcome residents and visitors to the Island. It will not be until crossing the bridge and entering the village that the more obvious visual hardscape features will provide a welcoming sub-tropical, sea-side village entry to Hummock Hill Island, reflecting the relaxed coastal character of the development.

2.7.2 Water Supply, Waste Water and Recycling

Cardno has completed a feasibility investigation into the provision of water services to the proposed development. The study is included in Appendix D1.

2.7.2.1 Development Principles

Water and wastewater are examined together, reflecting modern approaches to water cycle management, where wastewater is as much a resource as freshwater.

Management of the water cycle for the Project is critical to managing environmental impacts and achieving sustainability. Impacts of inappropriate harvesting of water and disposal of poor quality wastewater are particularly significant for this Project as the most sensitive natural environmental features of Hummock Hill Island are its coastal wetlands and the surrounding Colosseum Fish Habitat Area and Great Barrier Reef Marine Park and Coastal Marine Park.

Relevant targets and development principles are summarised in Table 2.5.

Table 2.5 - Water Cycle Design Objectives

Design Objective/Development Principles	Response
No reliance on water resources from the mainland	Supply of potable water from a small desalination plant combined with rooftop capture and third pipe reticulation of Class A+ treated waste water for non-potable use
Provision of a safe potable water supply that meets Australian Drinking Water Quality Guidelines (ADWQG)	Potable water from desalination plant will meet ADWQG
Sustainable utilisation of on-Island water resources to ensure that groundwater and wetland resources are not depleted or degraded	Maximise opportunities for collection of rainwater at the household and commercial level
Maximisation of site based water management including collection from roof catchments and reuse of treated wastewater	Inclusion of rainwater tanks at the household and commercial level Use of treated wastewater (Class A+) for irrigation and third pipe reticulation to the household level
Protection of human health and in particular avoidance of exposure to pathogens and coliforms	Use of Class A+ treated water is suitable for intended use as irrigation of public spaces
Minimisation of discharges of treated water to natural systems, with no discharge in dry weather	Wastewater treatment plant will be designed to contain 5 times Average Dry Weather Flows (ADWF).
Maintenance of a reliable water supply for fire fighting	The potable and recycled water networks will provide sufficient water for fire fighting; this requirement will be incorporated in the design of these networks.

2.7.2.2 Water Supply Demand

Residential Supply

The bulk of water supply demand for the Project will arise from accommodation units, both tourist and permanent. Types of units range from stand-alone houses on varying lot sizes to villas, apartments and hotel rooms.

Internal water consumption for accommodation units in the Project includes water used for drinking, cooking, showers, hand basins, toilet flushing, dishwashing and laundry uses. Allowing for water efficient appliances to be installed in all household units and assuming all household units have 100% occupancy, water demands for this component of the Project are shown in Table 2.6. External water consumption is an average across the range of household lot sizes. Household sizes are assumed to be 2.2 persons/ villa, cottage and apartment.

The 177 L/p/day calculated for Hummock Hill is within the typical household consumption ranges from 170-220 L/p/d from the Planning Guidelines for Water Supply and Sewerage (Table 5.3 Typical Household Internal Water Use, DERM 2010).

Table 2.6 Water Demands – Household Type Accommodation Units (Source: Cardno, 2013)

Location		Typical Uses	Consumption	
			L/p/d	L/hh/d 1
Internal	Kitchen	Drinking, cooking	13	29
	Bathroom	Washing hands, cleaning teeth, shower	55	121
	Toilets	Toilet flushing	24	53
	Laundry	Washing Machine, hand clothes washing	27	59
	Hot Water	Shower, Dishwashing, hand basins	58	128
External	Garden	Garden irrigation		175
	Other	Car washing, other external cleaning		25
Total Use			177	589

Based on the Project population and the design parameters noted above, the estimated residential demand for the Project is provided in Table 2.7.

Table 2.7 - Residential Water Demand

Precinct	Apartment	Properties	Water Demand (kL/day)		
			Internal	External	Total
Headland Resort Precinct	Headland Holiday Homes	36	14.02	7.2	21.22
	Headland Holiday Apartments	130	34.52	0	34.52
	Headland Holiday Cottages	220	85.67	44	129.67
	Foreshore Homes	64	24.92	12.8	37.72
Village Precinct	Village Apartment	110	29.21	0	29.21
Golf and Beach Resort Precinct	Beachfront Villas	220	85.67	44	129.67
	Beachfront Apartments	70	18.59	0	18.59
	Golf Course Villas	130	50.62	26	76.62
	Golf Course Cottages	180	70.09	36	106.09
	Golf Course Apartments	90	23.90	0	23.90
Ocean Resort Precinct	Spa Retreat	20	5.31	0	5.31
	Seaview Villas	120	46.73	24	70.73
Bushland Precinct	Bushland Holiday Villas	160	62.30	32	94.30
	Colosseum Village Apartments	120	31.86	0	31.86
	Colosseum Villas	245	95.40	49	144.40
TOTAL		1915	678.80	275	953.80

Non-household Demand

Non-household uses include:

- Commercial and retail components, including offices;
- Golf course and other external recreation areas;
- Caravan park; and
- Airstrip.

Non-residential demand calculations are based on rates from the Department of Natural Resources Planning Guidelines for Water Supply and Sewerage (2010). The Golf Course irrigation demands have been based on the sustainable irrigation rates for the site soils. The demand estimates are shown in Table 2.8.

Table 2.8 - Non-Residential Design Parameters

Location	Typical Uses	Category	Rate	Demand (kL/day)
Golf course	Irrigation of course	External	14 kL/ha/d	630
	Club House - Toilet flushing	Internal	150 L/d/100sqm	0.45
	Club House - Drinking, cooking, showers, etc.	Internal	350 L/d/100sqm	1.05
Hotels	Irrigation of grounds	External	5 kL/ha/d	10
	Toilet flushing	Internal	50 L/rm/d	23
	Hot water	Internal	130 L/rm/d	59.8
	Drinking, food prep, etc.	Internal	120 L/rm/d	55.2
Airstrip	Irrigation of strip and surrounds	External	As required	0
	Facility use	Internal	200 L/d/100sqm	0.4
Tourist Park	Drinking, food prep, toilet flushing	Internal / External	300 L/site/d	51
Town Centre		Internal / External	500 L/d/100sqm	23.15
Marine Centre & Retail		Internal / External	500 L/d/100sqm	4.4
Resort & Other Retail		Internal / External	500 L/d/100sqm	9.5
Other (Tourist Information Centre, Cultural Centre etc.)		Internal / External	250 L/d/100sqm	0.75
Total Non-Residential Demand				877.7 kL/day

In terms of water demands for the proposed development, three levels of water quality have been identified, being:

- Potable water, that meets ADWQG
- High contact water, where water does not need to meet ADWQG but must be low in human health risk factors such as pathogens
- Irrigation water, where some human contact occurs and where environmental risk factors such as nutrients and heavy metals become important.

The estimated demands for each of the above classifications are based on an ultimate population of 3,900 persons.

Table 2.9 - Quantity of Water Required

Required Quality	Demand (kL/day)	Annual Demand (ML/yr)	% of Total
Potable	415	152	23%
High Contact	536	196	29%
Irrigation and toilets – low contact	881	321	480%
Total	1831	668	100%

Less than one quarter of the total demand for the Project is for potable supply. This provides the opportunity to supply over 75% of the water requirements for the Project from Class A+ recycled and untreated sources of water such as rainwater tanks.

2.7.2.3 Wastewater Generation

Wastewater is the liquid waste matter from commercial, industrial and domestic sources. While traditional management of wastewater treats all wastewater as one stream, management options can be broadened significantly if wastewater is separated into component streams, typically greywater, blackwater and industrial wastewater as follows:

- Greywater is wastewater from household bathrooms and laundries. It contains cleaning products such as soaps and detergents, which may also be high in phosphorous, but is not contaminated with human wastes or pathogens (unless babies' nappies are being washed)
- Blackwater is proportion of the wastewater that contains human wastes or food wastes, typically arising from toilets and kitchen sinks. It contains high levels of nutrients and bacteria/pathogens
- Industrial wastewater can have widely varying properties depending on the type of industry. At Hummock Hill Island, the only likely industrial activities are related to car and boat servicing, where volumes of wastewater generation are low and the main contaminant in wastewater is hydrocarbons. Note that if carwash facilities were provided, these would be of the modern type where water/wastewater is fully re-circulated.

Blackwater and greywater flows are calculated in Table 2.10 on the following basis:

- For residential properties, sewage flows include all internal uses (177 L/p/d)
- Residential greywater flows are based on the internal uses excluding kitchen and toilet wastes (140 L/p/d)
- For non-residential properties, sewage flows include 100% of internal usage. Where separate internal and external water demands have not been identified, sewage flow represents 80% of the total water consumption
- Non-residential greywater flows include 90% of internal flows, or 80% of the total water demand where internal demands have not been specified (Cardno, 2013).

Table 2.10 - Blackwater and Greywater Volumes (Source: Cardno, 2013)

Required Quality	Blackwater (kL/day)	Greywater (kL/day)	Total Sewage (kL/day)
Residential	142	537	679
Non-Residential	38	173	211

Industrial wastewater, i.e. wastewater from boat and car servicing is not included in these calculations as quantities are low and these wastes would not be discharged to sewer. These wastewater streams will be treated on site prior to collection by a waste contractor.

2.7.2.4 Water Supply Strategy

The overall strategy for water supply to the proposed PTP is one of self-sufficiency and independence from mainland supply. The preferred water supply system for the proposed Project is an integrated system comprising of:

- Rainwater tanks for non-potable household uses (shower, laundry)
- Rainwater can be used for potable uses (drinking, kitchen) if UV or filtration units are installed at the tank; this will be optional for all households
- Recycled water from treatment of wastewater is used for toilet flushing and all external uses
- Recycled water is also used for irrigation of public open space and the golf course
- Potable water (drinking and kitchen) and/or top up of rainwater tanks are provided from a small desalination plant. Desalination water will be circulated in a reticulation system throughout the proposed development
- Mandated water efficient devices are installed in all buildings.

A particular advantage of the integrated system is that it is only partly dependent on rainfall, and thus much less vulnerable to extended drought conditions than systems relying on capture of rainwater, either in dams or tanks. In the event of a prolonged drought, water restrictions may be required as rainwater tanks run dry, however, the desalination plant combined with water recycling would allow most uses of water to be maintained in particular potable water.

Water management is emphasised at a household level, such that households are responsible for balancing water use and supply. Desalination water will be priced in accordance with the cost of production, thus encouraging residents and business operators to rely more heavily on rainwater.

The three main components of the integrated system are discussed in more detail below.

Rainwater Tanks

The water supply strategy seeks to maximise supply from rainwater tanks as energy efficient and sustainable means of supplying water to the proposed development. However, 100% rainwater supply is considered impractical for the entire development. In order to achieve the required level of reliability at this location, tank sizes would be impractically large for normal size residential lots and townhouses, with 140 kL tanks required to meet reliability requirements. Much larger tanks would be required for commercial, apartment and hotel components of the proposed development.

Cardno (2013) has calculated that, for a standard residential house, a 45 kL rainwater tank will provide about 215 ML/day reliably. In wetter years, it would provide a much higher yield. Minimum tank sizes will be mandated for all residential properties (whether permanent or visitor accommodation) based on the above volumes and a consideration of roof size. Individuals may install larger or additional tanks at their discretion and will benefit from reduced water costs if reliance on alternative supplies is reduced. Tanks of this size are typically installed underground. GRC will require a minimum 22 kL tank to be installed in each new residential property.

For commercial properties, hotels, apartments and similar high density accommodation, larger tanks in the order of 3-5 ML will be required and will be installed underground during building construction.

Final tank sizes for all components of the Project will depend on lot size and roof area and will be subject to design rules to be imposed on all buildings in the development.

Rainwater tanks are not suitable for potable water unless fitted with a disinfection or filtration system. Installation of individual filters and/or UV units to rainwater tanks will be at the discretion of individuals. This, combined with larger tank sizes, will reduce reliance on the proposed potable water supply system, and hence, reduce costs associated with water consumption.

Desalination

It is proposed that the required 475 kl/d potable water requirement (at full capacity) will be derived from a small desalination plant. Desalination produces potable quality water from seawater (or brackish water). For a small scale application such as Hummock Hill Island, a Mechanical Vapour Compression (MVC) desalination process could prove to be the most appropriate technology. This type of desalination plant uses the principles of a heat pump to evaporate and then condense water, separate salt water into freshwater and saline concentrate streams. The heat transfer and recovery system is very efficient for this scale of application, with energy consumption in the order of around 10 kWh per kilolitre of water produced. The water provided by the desalination plant will meet the requirements of the Australian Drinking Water Guidelines (2004) and the *Water Supply (Safety and Reliability) Act 2008*. Comprehensive Hazard Analysis and Critical Control Point (HACCP) assessments will be undertaken and drinking water management plans prepared to ensure that any potential human health impacts are managed throughout the design and operation of the plant.

MVC is the second most popular desalination technology used in Australia, behind reverse osmosis, and is particularly well suited to small scale applications. At the scale required for the Island, energy consumption is comparable to reverse osmosis. Other advantages of MVC for this application are:

- Pre-treatment requirements are minimal and requirement for chemical addition is also minimal compared to most other water treatment technologies involving both desalination and conventional treatment

- Operation is simple and low maintenance
- Reliability is very high
- Product water quality is very high
- Production rate can be varied to suit demand
- The plant is easy and quick to power up and down and can be shut down without any special requirements
- Corrosiveness of product water can be managed through blending small quantities of unprocessed feedwater or concentrate rather than addition of chemicals.

A process diagram of the MVC desalination process is provided in Figure 2.8.

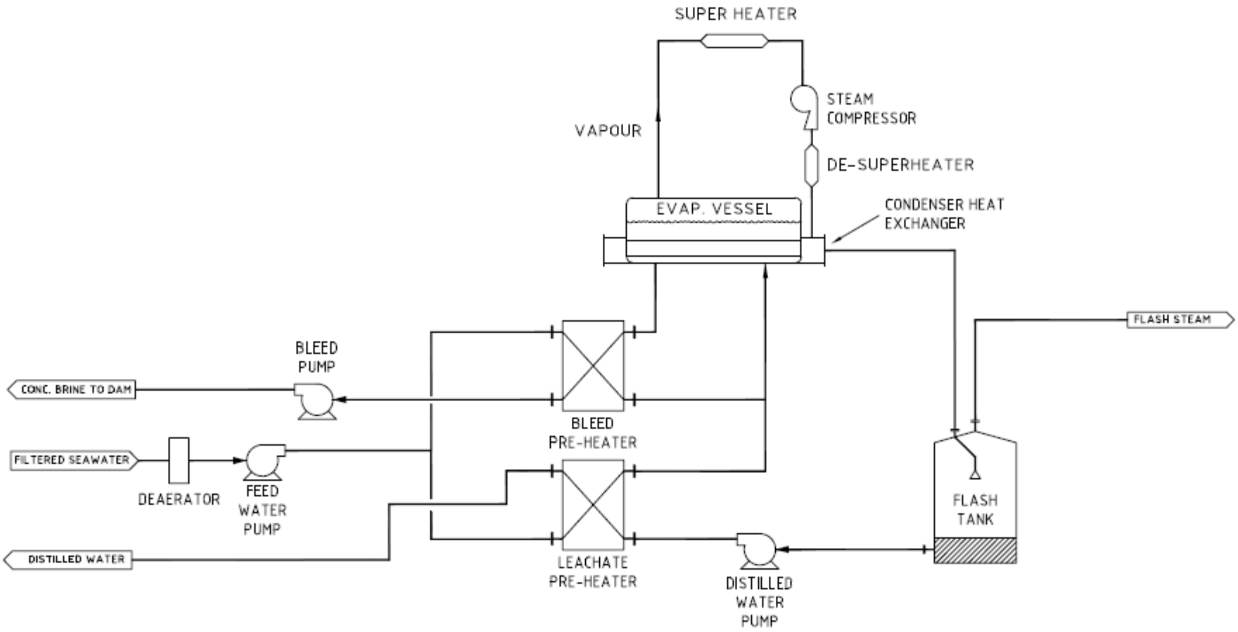


Figure 2.8 - Process Diagram for MVC Desalination Process

It should be noted that the MVC process is only one potentially viable technology; a range of suitable technologies will be considered during the detailed planning and design phases to ensure that the most appropriate technology is utilised.

The overall MVC process proposed for desalination at Hummock Hill Island is as follows:

- At full capacity, 600 kL/d of 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. A stainless steel submersible pump will be screened to prevent the ingress of debris and organisms into the pipeline. Flows into the pump will be quite low compared to currents in the Boyne Channel and are not expected to entrap marine organisms

- Raw seawater will be pumped to a 1 ML settlement and hydraulic balance tank at the desalination plant site
- From the balance tank, the water is pumped through a filter to remove suspended solids/particulates from the feedwater that would otherwise foul the pipe work and heat exchangers. The filter is self-cleaning and a small volume of sludge is generated from cleaning. The sludge consists of particulate matter from the marine environment and will be disposed of at landfill. Filter backwash water will be returned to the balance tank
- Filtered feed water is pumped through a de-aerator to remove oxygen and other gaseous components that may affect condensation
- Filtered feedwater is pre-heated in heat exchangers using waste heat from the product and concentrate streams
- Preheated feedwater is then pumped to an evaporator where it is heated to a temperature which allows evaporation of fresh water as water vapour (steam). Heat from the water vapour is then recovered by compressing the vapour; this causes it to condense and give up heat energy in a condensing heat exchanger. This heat is then reused to heat untreated feedwater to boiling point
- Condensate, or distilled water, is cooled by reducing pressure; heat from the cooling process is captured for preheating of raw water
- The “salt” component of the feedwater is left behind in the evaporation process and removed as concentrate; this is also hot when removed and is cooled through a heat exchanger so that heat can also be reused to preheat feedwater. Concentrate has exactly the same chemical composition as seawater except that each component is about twice as concentrated. No chemicals are added to the concentrate, and no chemical transformations take place during the MVC process.
- Condensate (product water) is fed into two batch testing tanks where automatic testing of the treated water can be undertaken to ensure quality
- Once tested for quality, product water is pumped to a 1.5 ML potable water storage. This storage will be covered and will be located at approximately 110m AHD to allow gravity feed of reticulated water supply throughout the proposed development. Reservoir will be located near the summit of Hummock Hill and has been sited to minimise visual impact
- As with any reticulated water supply, chlorination will be undertaken to control bacterial levels. Emerging technology allows manufacture of hypochlorite from the concentrate stream; this would avoid the need to transport and store hypochlorite. This option will be investigated as part of the detail design phase
- Concentrated brine (125 kL/day) will be discharged to a series of evaporation ponds located adjacent to the desalination plant. The concentrated solution water will be naturally evaporated leaving a residue of crude sea salt which requires intermittent removal. The total area required for evaporation is calculated to be approximately 16,000m^2 and this would most likely be achieved by constructing four ponds. By utilising the natural evaporation pond there is no requirement for discharge of concentrate back into the estuary or the ocean. Sea salt

collected from the evaporation ponds may be disposed of at the Benaraby Landfill, and will also be suitable for commercial processing if a suitable arrangement can be made with a commercial salt manufacturer. The Benaraby Landfill in Gladstone is licensed to accept some regulated wastes and therefore may accept the crystalized material following chemical testing. Alternatively several regulated waste companies operate in the Gladstone area and can provide a viable disposal option. Evaporation ponds will be lined to prevent leaching of saline concentrate to groundwater or leakage to surface waters. The ponds will be designed to contain rainfall events up to the Q100 event. Monitoring of the ponds will be undertaken to manage available storage capacity and salinity levels. If salinity levels in the ponds are equal to or less than seawater due to dilution by rainwater, the water will be recycled through the desalination plant or released to Boyne Channel via existing flow paths. This issue is also discussed in Section 2.11.1 and 8.5.10.

It is expected that the construction of the desalination plant will be installed in two stages, ultimately comprising two by 237.5kL/d modules. This allows for the staggered increase in demand expected in the early years of development, and in addition creates flexibility for future staging based on water cycle balance monitoring for HHI. It is anticipated that the desalination plant and associated infrastructure will ultimately encompass an area of less than 2ha, including evaporation ponds. The proposed desalination plant will be located within the Island Services compound, indicated as area B8 in Figure 2.3.

It is proposed that the water and sewerage networks would be operated and maintained under a contract arrangement with a private service provider (registered as a Water Service Provider via the Queensland Department of Energy and Water Supply). The service contract would be awarded either as a component of the design and construction of these facilities or as a combined service contract covering a wider range of services (including waste management) across the island.

Under such a contract, the service provider would be required to prepare asset management plans, contingency plans and meet all of the relevant regulatory requirements.

Consultation with Gladstone Regional Council will be undertaken during the planning, design and tendering phases of the projects to ensure that a suitable contractor is selected, and that the proposed solution is compatible with Gladstone Regional Council's desired vision for the future maintenance arrangements on the island.

The proposed desalination plant will be classified as an Environmentally Relevant Activity (ERA) 64 as prescribed in Schedule 2 of the Queensland *Environmental Protection Regulation, 2008*. Application for an environmental authority and development permit will be lodged when the detailed design is completed (see also Section 2.8.1). Matters to be resolved during detailed design include:

- Exact capacity of the MVC plant, storage tanks, pipework and other fittings
- Detailed characterisation of feedwater
- Potential for hypochlorite to be manufactured from concentrate

- Blending requirements to stabilise corrosiveness in the product water.

Recycled Water

The final stage in the integrated water management cycle for the proposed Project is recycling of wastewater (grey water and black water) for non-drinking water use in:

- Toilet flushing
- External uses such as car washing and garden watering
- Irrigation of golf course and public open spaces, as a lower priority
- Fire fighting.

The *Water Supply (Safety and Reliability) Act 2008* provides for the safety and reliability of water supply. The primary aims of the recycled water provisions are to protect public health and to ensure continuity of operation of the scheme to meet the essential water supply needs of the community.

Table 2.11 provides a summary of the recycled water quality requirements for various applications, as specified in the Public Health Regulations 2005 and the Water Quality Guidelines for Recycled Water Schemes.

Table 2.11 - Quantity of Water Required

Class	E. Coli (cfu/100mL) median
A+	<1
A	<10
B	<100
C	<1000
D	< 10,000

Dual Reticulation can only use Class A+ Recycled Water and the annual values for bacteriological quality parameters for Class A+ are listed below:

- Chlorine>0.5mg/L in 95% of samples
- Clostridium perfringens<1 cfu/100 mL in 95% of samples
- E.coli <1 cfu/100 mL in 95% of samples
- F-RNA bacteriophages <1 pfu/100 mL in 95% of samples
- Somatic coliphages <1 pfu/100 mL in 95% of samples
- Turbidity <2 NTU in 95% of samples.

In addition to the above, the Water Quality Guidelines for Recycled Water Schemes (2008) sets out the specific log reductions required for the validation of Class A+ recycled water schemes. The treatment train needs to be adequate to achieve a 5 log reduction in Bacteria, Protozoa and Helminths and a 6.5 log reduction of viruses.

A range of quality classes could be suitable for various uses within the proposed Hummock Hill Island Development. Where public access can be controlled, such as the golf course and airstrip, Class C recycled water could be utilised for irrigation. Where control of public access is difficult such as public open space, Class C recycled water can be sub-surface irrigated. Class A recycled water would be required where none of these controls can be maintained, and Class A+ is required for reticulation via dual reticulation.

Nutrient levels are not controlled for recycled water. Therefore, for Class A+ recycled water, nutrient levels of < 5 mg/L Total Nitrogen and < 1 mg/L Total Phosphorus have been adopted to manage nutrients within the reticulation system and storages. Adopting these low nutrient levels for the recycled water also provides benefits from the point of view of minimising nutrient loads that may ultimately be released to the environment.

In evaluating recycled water schemes involving irrigation, the suitability of the soils to manage the nutrient loading needs to be considered. A preliminary assessment for the PTP has indicated that the soils on the island are generally suitable for irrigation with recycled water. The education of users is also a key factor which needs to be appropriately managed. All users of recycled water must be aware of the controls required for its safe and sustainable management. Where recycled water is delivered to households by dual reticulation, it is critical to ensure that all users are aware of the permitted and prohibited uses for the water.

Estuarine water quality must also be considered when setting treated effluent standards where recycled water is released to surface waters such as during long periods of rain or major storm events.

The Class A+ recycled water will be delivered throughout the Project via a separate reticulation system from a fully enclosed recycled water tank located adjacent to the potable water storage tank. Tank capacity is a nominal 1 ML (i.e. about 1 day’s supply), with final capacity to be determined in detailed design stage.

Fire fighting water will be drawn from the recycled water supply system as the quality is very good in terms of human health risks. The need for additional dedicated fire fighting storage and fire hydrants will be assessed during detailed design and input from local emergency services will be sought.

The Queensland Recycled Water Guidelines require a recycled water management plan to be prepared in accordance with processes and standards established in these guidelines. The process for developing a recycled water management plan is set out in the Guidelines as follows:

- Establish a suitable qualified and experienced risk assessment team, representative of the range of risks likely to be associated with the recycled water system
- Fully describe the recycled water system, including all possible points of exposure for human and environmental receptors
- Identify hazards and evaluate risk associated with each hazard

- Determine appropriate controls, including process controls, quality control and other management measures. Where possible controls should be preventive and based on design mechanisms to minimise risk of human error or accident
- Establish performance requirements for each control measure and determine appropriate monitoring, measurement and validation processes for each performance requirement
- Identify corrective actions in the event that performance requirements are not met
- Prepare management procedures
- Establish documentation, record keeping, reporting, communications and other system requirements
- Document in a plan and present plan to stakeholders
- Provide for continuous improvement of plan through regular audits and updates.

As part of the approvals process for a recycled water management plan, the scheme will need to undertake a validation process, including:

- Pre-commissioning validation
- Commissioning validation
- Commissioning verification.

There are a number of validation methodologies which can be adopted and these are discussed further within the guidelines. It is proposed that the "Class A+" recycled water produced from the plant is discharged to the wet weather storage lagoons during the 13 week commissioning verification period. During this verification period it is proposed that Class A+ demands are supplemented with potable water. Following verification of the Class A+ recycled water compliance, initiation of the third pipe reticulation system can commence.

Additional uncovered, lined storages will be provided at the golf course and Colosseum Village for water in excess of residential/tourism/commercial demands. This water will be used for irrigation of the golf course and nearby airstrip. Preliminary calculations suggest wet weather storage (when irrigation will not be possible) will need to be approximately 100 ML, however, this will be confirmed during detailed planning and based on an assessment of the risk of overflows.

Assuming a required total storage volume of 1,00ML across the system, and maximum depth of 2m to minimise the potential for stratification to occur and preclude the growth of emergent macrophytes, it is estimated that the total surface area of the water storage lagoons will cover an area of approximately 5.5 hectares, with most of this area in the golf course precinct. It is envisaged that these lagoons will be created as features within the golf course precinct and as such will vary in size and number based on detailed design.

Water balance modelling undertaken with respect to the lagoons has indicated that the demand for irrigation water combined with losses due to evaporation will preclude the golf course lagoons from overtopping except in extreme wet seasons. In the unlikely event of overtopping occurring, the potential for impact in downstream areas is considered to be negligible due to the mixing that will occur with surface runoff from other catchments.

Further information on water treatment and reuse is provided in Section 8.5.6.

2.7.2.5 Wastewater Treatment

Wastewater generated by the PTP will be entirely domestic in nature. As such, it is not expected to contain high levels of potentially toxic constituents such as heavy metals and pesticides. It will however contain pathogens that are harmful to human health and nutrients that may be harmful to some ecological processes.

A centralised treatment system is the most viable and sustainable treatment option for the small scale of development proposed at Hummock Hill Island. Wastewater (greywater and blackwater) will be collected from households and commercial premises via a reticulated sewerage system. The sewerage reticulation system will be fully sealed to reduce the risk of leakage to protect the island groundwater resource and to avoid unnecessary destruction of vegetation from the construction of gravity sewers in deeper trenches. A pump station will be required to transfer wastewater from the northern end of the Island as this will not be able to be gravity fed to the water recycling plant. All premises in the PTP will be connected to the reticulated sewerage system. Septic tanks will not be allowed within PTP.

High Velocity Sonic Disintegrator (HVSD) technology has been proposed for the production of high quality recycled water. This new technology has distinct advantages over conventional biological treatment plants of this size (ADWF of 1.0 ML/d). In particular the plant is not flow or temperature dependent, is highly flexible and able to treat largely fluctuating flows. The plant is highly effective in destroying pathogens and provides an effluent quality that exceeds ADWG guidelines.

Steps in the proposed treatment process are as follows:

- Blackwater and greywater (combined) is pumped via a sewerage system to an anaerobic storage tank at the treatment plant location. This tank is fully enclosed and odour is not released from the plant
- Wastewater stream passes into a Cell Destruction Unit (CDU) where mechanical processes destroy pathogens by denaturing proteins at a cellular level
- Grease and oil (e.g. from foods) are removed in an aeration tank
- The treated water is passed through zeolite filters
- Magnesium oxide is added and a crystallisation process is used to remove ammonia and phosphate as “struvite” crystals. Struvite is an ammonium magnesium phosphate (MgNH4PO4) that occurs naturally in mineral deposits.

This choice of technology is particularly effective at removing pathogens (bacteria, viruses and so on) as it destroys the individual cells, unlike more conventional treatment processes that rely on physical removal of pathogens from the treatment process. This means that, as well as producing high quality recycled water, sludge and filter residues are not contaminated with pathogens, making them safer for reuse as soil conditioners.

Struvite crystals precipitated from the process has an application as a high quality fertiliser. Zeolite can be regenerated or used as fertilizer based on the removed nutrient concentrations.

The water recycling plant will be designed to minimise odours. In particular, inlet works and digesters with odour scrubbing facilities are fully enclosed, allowing effective capture and management of odorous compounds arising from untreated wastewater. The proposed location for the recycled water plant is shown on Figure 2.3 and provides for a 100m buffer from any residential properties or recreational areas.

The sewage treatment plant will be sized to cater for an ADWF of 1.1 ML/d with additional storage provided to handle up to 3 times ADWF as per guidelines. It is proposed that the plant will be constructed in two stages of 550 kL capacity each.

The proposed technology has been shown to be very reliable and low maintenance. The plant does not rely on residence time as part of the treatment process; the treatment process takes about 30 minutes. Inlet storage will mean that wastewater can be held temporarily if either of the duplicate plants is undergoing maintenance.

The plant will be designed with two separate treatment trains to assist in managing the risk of plant failure. In the event of a breakdown of one train, flows will be held at the pump stations if possible, or otherwise discharged to a lined storage at the services precinct and stored for treatment when wastewater flows permit. In the unlikely event that both process streams are malfunctioning or one plant is unavailable for an extended period of time, tanker trucks will remove untreated sewage for treatment and disposal at mainland facilities operated by Gladstone Regional Council.

For a new sewerage system such as the one proposed, there are three scenarios that must be considered that may lead to the need for an emergency release:

- A catastrophic failure of the sewage treatment plant and/or transfer network
- A power failure
- An extreme wet weather event where rainwater may infiltrate into the sewerage system (NRMMC 2004).

A number of mechanisms have been built into the design of the sewage collection and treatment system for the proposed PTP to reduce the likelihood of an emergency release occurring:

- Provision of a minimum of four hours storage at average dry weather flow at each pump station.
- Provision of storage at the sewage treatment plant in the event of a mechanical or other failure. The amount of storage required will be determined during the detailed design process using a risk assessment approach to determine risk to the coastal environment.

- Duplication of key elements of the sewage treatment plant to reduce the likelihood of equipment or mechanical failure
- Design of the sewage reticulation system to minimise wet weather inflows. This will include use of sealed “smart sewers” that minimise the amount of infiltration into the sewerage network
- The ability to pump out sewage from the sewage treatment plant and pump stations with a vacuum truck for disposal at a regional wastewater treatment facility in the event of a prolonged power failure or plant equipment failure that exceeds the storage capacity of the system.
- Back-up diesel power generators at pump stations and the sewage treatment plant Generators will be tested as part of the regular maintenance program to ensure that they activate if required.
- 100% redundancy at pump stations, such that there is always a back-up pump available in the event of failure of the primary pump.

Regardless of these measures, engineering design standards and public health requirements for sewerage systems and sewage treatment plants require an emergency overflow point to be provided (NRMMC 2004).

With the proposed design measures in place, and a proactive maintenance program, it is highly unlikely that an emergency release of untreated sewage would occur. In the very unlikely event that such a release did occur, the volume and nature of the discharge is such that the overall load of contaminants that might be released would be low, further discussion in Section 8.5.6.2.

The risk of production of “off specification” recycled water from the HVSD plants is very low as treatment is largely by physical or chemical processes which are much more reliable compared to biological processes used in conventional wastewater treatment plants. The nature of the wastewater catchment is such that spikes of contaminants are very unlikely; spikes are usually associated with industrial inputs. Also, the recycled water is placed in storages rather then released to the environment, providing further containment in the event of any problems being detected by on-line monitoring systems.

The HVSD recycled water treatment plant is quite tolerant to small quantities of household chemicals, paints, oil and similar, however householders will be educated not to dispose of these substances to sewer. Householders and visitors will received an information package on management of the sewerage system and appropriate disposal of household hazardous chemicals.

It is anticipated that the wastewater and recycled water treatment plants, and associated infrastructure, will ultimately encompass an area of less than 2ha.

As discussed in Section 2.7.2.4, it is proposed that the water and sewer networks would be operated and maintained under a contract arrangement with a private service provider (registered as a Water

Service Provider via the Department of Energy and Water Supply). Management of sludge generated from water and wastewater treatment is discussed in 2.11.1.

The proposed water recycling plant will constitute an environmentally relevant activity 63 under Schedule 2 of the Queensland *Environmental Protection Regulation 2008* and will require an environmental authority and a development permit under the Queensland *Sustainable Planning Act 2009*. Application for these approvals will require provision of operation and maintenance procedures for the water recycling plants and sewerage system and will therefore be made during the detailed design stage (see also Section 2.8.1).

A similar water recycling system has already been approved and is in operation at Agnes Waters.

2.7.3 Stormwater

2.7.3.1 Overview

The proponent recognises that it is imperative to provide the highest standards of stormwater and wastewater management with the overriding goal that there be no measurable change in hydrology or water quality in ephemeral waterways and coastal environs arising from the proposed development. While poor quality stormwater runoff from urban areas has been identified as a significant water quality issue for the Great Barrier Reef ecosystem (GBRMPA 2009), considerable advancements have been made in management of stormwater quality.

Design of the stormwater system for PTP has been based on:

- *Urban Stormwater Quality Planning Guidelines 2010* (DERM, 2010). These guidelines support Queensland's State Planning Policy 4/10 – Healthy Waters and achievement of water quality objectives of the Queensland *Environmental Protection Act 1994*.
- Water Sensitive Urban Design principles. Water Sensitive Urban Design is an initiative of Australian and State and Territory Governments under the National Water Initiative of the National Water Commission.

Consideration has also been given to water quality objectives set out in:

- *Water Quality Guidelines for the Great Barrier Reef Marine Park – Revised edition 2010* (GBRMPA) (note however that there are no direct or indirect discharges into the GBRMP).
- *Queensland Water Quality Guidelines Version 3* (DEHP 2009)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000).

Preliminary water quality objectives are provided in Section 6.5.7.

In line with these guidelines, the design of the stormwater collection and treatment system for the Project has given careful consideration to:

- The nature and values of the receiving waters, including that the waters are part of the GBRWHA and provide habitat for several EPBC listed threatened and migratory animals
- Natural hydrology and water quality
- The importance of maintaining water quality to protect habitats and species dependent on certain water quality characteristics
- The actual mechanisms by which a proposed development will result in water quality impacts
- The spatial and temporal extent of these impacts.

The stormwater system has been designed so that any increases in runoff rate or quantity due to the increased hard surface catchment area of the PTP will not change the downstream hydrological regimes of the island.

Development principles for PTP, based on WSUD are outlined in Table 2.12.

Table 2.12 – Design Objectives for Stormwater Controls (WSUD)

Design Objective/Development Principles	Response
Protect existing natural features and ecological processes	Utilisation of stormwater treatment trains that maintain hydraulic flows and existing water quality within ephemeral watercourses in the Island, thus protecting sensitive receiving environments at watercourse discharge points
Maintain the natural hydrologic behaviour of catchments	Hydraulic characteristics of existing ephemeral watercourse catchments will remain unchanged
Protect water quality of surface and ground waters	Stormwater controls will maintain current ephemeral watercourse water quality objectives and adjacent estuarine water quality objectives
Minimise demand on the reticulated water supply system	Collected stormwater can be used as a back-up irrigation water supply minimising treated water demands
Integrate water into the landscape to enhance visual, social, cultural and ecological values	Stormwater treatments will be incorporated into the final detailed design of PTP. Treated stormwater will be discharged into existing ephemeral watercourses as required by the Special Lease.

Applying these principles to the PTP has resulted in a stormwater management system that:

- Incorporates capture of rainwater from rooftops (via rainwater tanks)
- Maintains the hydrological characteristics of catchments/subcatchments
- Removes those contaminants from stormwater that arise from urban development prior to release to surrounding environment
- Integrates water into the landscape to enhance visual, social, cultural and ecological values.

2.7.3.2 Water Sensitive Urban Design

WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. It promotes the integration of stormwater, water supply and sewage management at the development scale. Specific WSUD objectives are to:

- minimise impacts on existing natural features and ecological processes
- minimise impacts on natural hydrologic behaviour of catchments
- protect water quality of surface and ground waters
- minimise demand on the reticulated water supply system
- improve the quality of and minimise polluted water discharges to the natural environment
- incorporate collection treatment and/or reuse of runoff, including roofwater and other stormwater
- reduce run-off and peak flows from urban development
- re-use treated effluent and minimise wastewater generation
- increase social amenity in urban areas through multi-purpose greenspace, landscaping and integrating water into the landscape to enhance visual, social, cultural and ecological values
- add value while minimising development costs (e.g. drainage infrastructure costs)
- account for the nexus between water use and wider social and resource issues
- harmonise water cycle practices across and within the institutions responsible for waterway health, flood management, pollution prevention and protection of social amenity (http://waterbydesign.com.au/whatisWSUD/).

In this regard, DotE's website notes that:

> *"WSUD is a philosophy that aims to mitigate environmental impacts particularly on water quantity, water quality and receiving waterways, conventionally associated with urbanisation. WSUD incorporates holistic management measures that take into account urban planning and design, social and environmental amenity of the urban landscape and stormwater management which are integrated with stormwater conveyance by reducing peak flows, protection of natural systems and water quality, stormwater reuse and water conserving landscaping."*

The proposed stormwater management strategy for the Project will use Water Sensitive Urban Design (WSUD) for all aspects of stormwater control associated with the development. The overall objective of stormwater management will be to maintain existing water quality and nutrient loadings of existing natural systems on and around the Island.

Healthy Waterways, in its Technical Design Guidelines (2006), describe WSUD as an internationally recognised concept that offers an alternative to traditional development practices.

Hummock Hill has no permanent (perennial) fresh watercourses and few defined drainage lines. Catchments and sub-catchments on the Island are quite small, generally less than 2 km^2 within the lease area. The most well defined drainage line flows between the two ranges of hills on the Island and has been dammed in the past, presumably to supply water to cattle grazing activities. Another small dam has been created south of "Boyne Hill", the smaller peak on the southern side of the Island. Stormwater on the western end of the Island infiltrates quickly into sandy soils while, to the east of the main range, drainage is either directed to the largest dam and then to a tidal inlet of Boyne Creek or to Sandfly Creek north-east of the airstrip. The concept for PTP has been developed to avoid any changes to the hydrology or water quality of these areas.

In the proposed development, stormwater originating from all rainfall events of up to the 100-year recurrence interval will be attenuated close to the source, and released in a controlled manner which will resemble the natural drainage rates and pathways existing before development. Attenuation close to source means that stormwater systems can be installed in stages as the Project progresses.

Treatment devices, including bioretention basins and swales and permeable pavements, will ensure that pollution originating from the Project will be intercepted and removed from runoff, in all storms of up to the three-month recurrence interval (in urban areas, the three-month flows account for approximately 90% of the mean annual runoff).

Adopted stormwater quality and quantity objectives are described in Table 2.13.

Table 2.13 - Adopted Stormwater Quality and Quantity Objectives- Hummock Hill, Operational Phase

Criteria	Design Objective
Water Quality Design Objective	Treatment to provide median concentrations of sediment and nutrients similar to those predicted for existing (undeveloped) situation, and providing a load reduction in comparison to urban development without controls in place in excess of the following: • 85% reduction in Total Suspended Sediment; • 70% reduction in Total Phosphorus; • 45% reduction in Total Nitrogen; and • 90% reduction in gross pollutants.
Frequent Flow Management	Capture and manage rainfall from all impervious surfaces of the proposed development as follows: a. where the fraction of the catchment that is impervious is less than or equal to 40%, capture at least the first 10 mm of run-off from impervious surfaces b. where the fraction of the catchment that is impervious is greater than 40%, capture at least the first 15 mm of run-off from impervious surfaces c. run-off capture capacity replenished within 24 hours of the run-off event.
Waterway Stability Management	Limit the post-development peak one-year average recurrence interval (ARI) event discharge within the receiving waterway to the pre-development peak one-year ARI event discharge.
Peak Flow Management	No increase in the peak flow discharged from any part of the site for events with recurrence intervals up to 100 years.
Flow Management	No runoff from developed areas shall be allowed to discharge to the Open Coastal areas on the northern side of the island.
Golf Course Recycled Water Storages	Overtopping allowed only once every 10 wet seasons on average.

Note: Design objectives based on Table 2.2 and Table 2.4 of Urban Stormwater Quality Planning Guidelines 2010

A range of stormwater management devices was assessed in order to select a configuration that would meet the objectives in Table 2.12. To address drainage requirements for the PTP, the Project has been divided into drainage zones. This allows stormwater management to be matched to existing drainage patterns, and also for attenuation at source. Table 2.14 describes existing and proposed stormwater treatment for each drainage zone.

Table 2.14 – Proposed Stormwater Management Options

Zone	Existing Drainage	Proposed Development	Proposed Stormwater Treatment
Beach and Golf Course precinct 140ha	Flat to undulating sand ridges, sandy soil with high infiltration rate. Few defined drainage lines, no wetlands. Defined drainage line parallel to northern beach, drains to west but no defined outlet (would wash out in rain events).	Beachfront tourist hotel. Resort apartments, condominiums and villas Golf Course Stormwater retention basins	Bioretention swales/basins within the road reserve where possible. Rainwater tanks and reuse adopted for all Class 1 and 3 buildings. Lake/pond system through golf course providing irrigation and lined to prevent infiltration. Overflow channel from lagoon, south in existing channels to Colosseum Inlet
Headland Resort and Village Precincts 50 ha	Flat to gently sloping sandy soils with high infiltration rate. No defined drainage lines, no wetlands. Rises to steeper headland in West with rockier soils and lower infiltration rates. Minor drainage to west beach (west of headland). Existing (dry) drainage channel parallel to northern beach conveys some flows west, remainder discharges overland to northern western beach or via southern drainage path towards airstrip and ultimately Boyne Channel.	Resort Hotel Holiday Homes, Apartments and Cottages Foreshore Homes Motel Village Apartments Caravan Park and Camping Village Retail and Commercial Community services Centre Public Parking Resort	Bioretention swales/basins within the road reserve where possible. End-of-line bioretention / detention basins elsewhere, including areas where lots drain directly offsite, directed via a diversion swale. Rainwater tanks and reuse adopted for all Class 1 and 3 buildings, in addition to the Caravan Park (with additional apartment roof catchments)
Ocean View Precinct 60 ha	North-south ridge with relatively steep slopes Several significant gullies to the west, with more consistent topography grading to the east Small dam on the lower eastern region	Spa Retreat Ocean View Villas on east facing slopes No development on west facing slope. Main road along toe of east facing slope, also ridgetop road.	Spa and western catchment directed to end-of-line bioretention / detention basins. Eastern catchment treated by swale/basins within the main access road reserve. Southern catchment draining to village for treatment.
Bushland Precinct 110 ha	Significant ridge to the south-west of precinct, draining directly to Boyne Channel. Other moderate hilly features throughout precinct draining to lower lying areas and south to estuary. Large dam within ridge 'saddle'	Bushland Holiday Villas Colosseum Apartments and Villas Colosseum Village Research Centre Boat ramp and storage Airstrip Island services	Bioretention swales/basins within the road reserve where possible. End-of-line bioretention / detention basins elsewhere, including areas where lots drain directly offsite, directed via a diversion swale. Rainwater tanks and reuse adopted for all Class 1 and 3 buildings

2.7.3.3 Stormwater Quantity

As the catchments within the development footprint become less pervious with development, stormwater detention basins will be installed. Detention basins work by impeding flows from catchment runoff and then regulating release such that release rates mimic the rates from the pre-development scenario.

The detention basins will be located close to the source of runoff to provide at-source control wherever possible. Where topographical constraints permit, detention basins will be combined with bioretention basins such that water quality and quantity attenuation occur simultaneously.

The detention basins will also be sized to ensure that development does not cause an increase in the peak flow discharged from the site for events with recurrence intervals from 1 year to 100 years inclusive. The attenuation of runoff from the one year event will allow the waterway stability criterion defined in the Urban Stormwater Quality Planning Guidelines 2010 (DERM 2010) which deals with the limitation of flow for small rainfall events to be achieved.

An assessment was undertaken to demonstrate that adequately sized detention basins can be provided for in each area of the proposed PTP to achieve the objective of no change in peak flows in rain events with recurrence intervals from one year to 100 years inclusive. The detention basin sizing was completed using the methodology detailed in Section 5.05.1 of the Queensland Urban Drainage Manual (QUDM, 2007). Details of detention basin locations and sizing are provided in Appendix D2.

2.7.3.4 Stormwater Quality

Overview

The performance of the WSUD quality treatment train identified in Table 2.13 and Table 2.14 was modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 5.1.16) by eWater. This is an industry-standard application that estimates the annual load and concentration of contaminants from urban areas, and assesses the performance of the proposed treatment train in reducing them. The reduction in suspended solids, phosphorous and nitrogen concentrations is indicative of the efficacy of the systems with respect to other pollutants. Overall, adopted model parameters and assumptions were in accordance with Water By Design MUSIC Modelling Guidelines (Version 1, 2010). Details of the modelling approach are provided in Appendix D2. Results showing performance of the stormwater treatment systems against the design objectives set in Table 2.12. Mean concentrations of sediment, total phosphorus and total nitrogen were also calculated for each area. These can be compared to preliminary receiving water quality objectives of:

- Total suspended solids – 15 mg/L
- Total phosphorus - 0.02 mg/L
- Total nitrogen – 0.2 mg/L.

The water quality results indicate that, even without any attenuation from mixing or absorption, stormwater quality from the developed areas of the project will meet water quality objectives in the receiving environment. Details of modelling for each area are provided below.

In addition to the treatment for nutrients and suspended solids/sediment, the stormwater treatment devices will remove litter. Hydrocarbon removal may also be required in some areas such as boat storages, car parks and where any vehicle or boat maintenance activities take place. The need for this will be reviewed during detailed design and then as required as each component of the project is developed.

Headland Resort Precinct

A bioretention system incorporating 300 m^2 of filter area was adopted to treat the Headland Resort Hotel area. This total area will be divided into a number of basins to suit the layout of the hotel. The results achieved for this site are provided in Table 2.15 below.

Table 2.15 - Headland Resort Hotel (H1) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Sediment	1910	448	-77%	3.63	1.28	-65%	Yes
Total Phosphorus	4.70	1.51	-68%	0.0177	0.0106	-40%	Yes
Total Nitrogen	34.7	16.7	-52%	0.259	0.271	5%	Yes

For the Headland Holiday Homes (H2), the western and eastern catchments require a bioretention basin area of 220 m^2 and 140 m^2 respectively. It is noted that diversion swales are required to direct flows into these basins. The southern catchment requires a basin area of 100 m^2. However this treatment will be incorporated into the downstream Headland Holiday Apartments (H3) basins. The overall area results are provided in Table 2.16 below.

Table 2.16 - Headland Holiday Homes (H2) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	2760	446	-84%	3.52	1.23	-65%	Yes
Total Phosphorus	5.59	1.29	-77%	0.0171	0.0103	-40%	Yes
Total Nitrogen	30.9	13.1	-58%	0.250	0.262	5%	Yes

For the Headland Holiday Apartments, the four apartment blocks were assessed individually. In order to meet the adopted water quality objectives a total bioretention system area of 190 m^2 is required per apartment block. The bioretention systems provided to the two apartment blocks downstream of the Headland Holiday Homes (H2) southern catchment require an additional 100 m^2 of bioretention area. Table 2.17 presents the results of the MUSIC analysis.

Table 2.17 - Headland Holiday Apartments (H3) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	444	38	-91%	3.33	1.14	-66%	Yes
Total Phosphorus	1.07	0.17	-84%	0.0162	0.0097	-40%	Yes
Total Nitrogen	7.2	2.7	-62%	0.236	0.247	5%	Yes

For the Headland Holiday Cottages the proposed treatment train incorporates two configurations of bioretention systems within the road reserve. As these bioretention swales are continuous through the access road adjacent to lots, a required swale width is given (rather than an area) for each scenario:

- Scenario A – lots on either side of access road, 1.50 m width bioretention swale in centre median; and
- Scenario B – lots on one side of access road, 1.10 m width bioretention swale on non-lot (low) side of the road.

It is noted that the above widths do not include batters. Adopting the standard 1:4 (V:H) slope the overall widths equate to 3.90 m and 3.50 m for Scenario A and B respectively.

The results of the analysis are presented in Table 2.18.

Table 2.18 - Headland Holiday Cottages (H4) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	444	38	-91%	3.33	1.14	-66%	Yes
Total Phosphorus	1.07	0.17	-84%	0.0162	0.0097	-40%	Yes
Total Nitrogen	7.2	2.7	-62%	0.236	0.247	5%	Yes

For the Foreshore Homes, that part of the site nominally draining to the ocean will be treated via a bioretention system with an area of 265 m^2, directed via a diversion swale into the basin (and then inland to preclude discharge to the ocean). The inland catchment requires a filter area of 600 m^2, treated by a bioretention swale incorporated into the downstream access road reserve (approximately 500m length with a 1.2 metre filter width). The overall area results are provided in Table 2.19.

Table 2.19 - Foreshore Homes (H5) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	3470	518	-85%	3.70	1.30	-65%	Yes
Total Phosphorus	6.74	1.43	-79%	0.0180	0.0108	-40%	Yes
Total Nitrogen	37.7	15.4	-59%	0.262	0.274	5%	Yes

Village Precinct

Incorporating the rainwater tank and reuse parameters detailed in the previous section, a bioretention system incorporating 56 m^2 of filter area is required to achieve the WQOs for the Village Motel. The modelling results are provided in Table 2.20.

Table 2.20 - Village Motel (V1) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Sediment	79	16	-80%	3.180	0.695	-78%	Yes
Total Phosphorus	0.38	0.11	-72%	0.0154	0.0059	-62%	Yes
Total Nitrogen	4.5	1.7	-61%	0.225	0.150	-33%	Yes

Treatment devices will be provided to each of the seven apartment blocks making up the village apartments. In order to meet the adopted water quality objectives a total bioretention system area of 225 m^2 is required per apartment block. This area could be split into multiple systems proportionate to the contributing catchment, if desired. Table 2.21 below presents the results of the analysis.

Table 2.21 - Village Apartments (V2) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Sediment	331	29	-91%	3.320	1.150	-65%	Yes
Total Phosphorus	0.93	0.16	-83%	0.0161	0.0097	-40%	Yes
Total Nitrogen	7.9	2.9	-64%	0.236	0.247	5%	Yes

For Caravan Park and Camping area, the Incorporating bioretention basins to treat rainwater tank overflows and adjacent ground runoff (30% of total ground area), a filter area of 620 m^2 is required to treat runoff. Table 2.22 details the results.

Table 2.22 - Caravan Park and Camping (V3) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	621	123	-80%	3.530	2.300	-35%	Yes
Total Phosphorus	1.88	0.55	-71%	0.0172	0.0170	-1%	Yes
Total Nitrogen	16.4	6.2	-62%	0.251	0.263	5%	Yes

The main street of the village centre requires a bioretention filter area of 500 m^2. This will be incorporated into the street scape via a continuous bioretention swale (such as within the median, as per Plate 5.1), requiring a filter width of 2.5 m assuming a 200 m main street length.

The following filter areas are required for the other village centre development:

- Community Services Centre- 108 m^2; and
- Public Parking- 590 m^2.

Due to the standard commercial pollutant generation parameters adopted, an increased proportion of filter area is required for treatment to achieve concentration based WQOs (particularly Total Nitrogen). As a result the total treatment area represents almost 5% of overall village centre development. Overall results are presented in Table 2.23.

Table 2.23 - Village Centre (V4) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	5390	191	-96%	3.46	1.21	-65%	Yes
Total Phosphorus	10.40	0.83	-92%	0.0168	0.0102	-39%	Yes
Total Nitrogen	46.9	14.5	-69%	0.245	0.257	5%	Yes

Golf and Beach Resort Precinct

A bioretention system incorporating 275 m^2 of filter area was adopted for the Beachfront Tourist Hotel. Results obtained from modelling are provided in Table 2.24.

Table 2.24 - Beachfront Tourist Hotel (G1) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	1580	323	-80%	3.580	1.250	-65%	Yes
Total Phosphorus	3.69	1.05	-72%	0.0174	0.0104	-40%	Yes
Total Nitrogen	25.3	11.6	-54%	0.254	0.263	4%	Yes

For the Beachfront Villas, the proposed treatment train provides for two configurations of bioretention systems within the road reserve. As these bioretention swales are continuous through the access road adjacent to lots, a required swale width is given (rather than an area) for each scenario:

- Scenario A – lots on either side of access road, 1.80 m width bioretention swale between driveways (or 1.20 m width in centre median); and
- Scenario B – lots on one side of access road, 0.85 m width bioretention swale on non-lot (low) side of the road.

It is noted that the above widths do not included batters. Adopting the standard 1:4 (V:H) slope the overall widths equate to 4.20 m (3.60 m) and 3.25 m for Scenario A and B respectively.

In order to meet the adopted WQOs a total bioretention system area of 460 m^2 is required for the Beachfront Apartments. This area could be split into multiple systems proportionate to the contributing catchment, if desired. Table 2.25 presents the results of the analysis of the area.

Table 2.25 - Beachfront Apartments (G3) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	920	66	-93%	3.48	1.20	-66%	Yes
Total Phosphorus	2.29	0.36	-84%	0.0169	0.0102	-40%	Yes
Total Nitrogen	16.1	5.9	-64%	0.247	0.259	5%	Yes

The required treatment to achieve the water quality objectives for the Golf Course Villas is as per Beachfront Villas (G2).

Required treatment to achieve WQOs for the Golf Course Cottages is as per Headland Holiday Cottages (H4). The results presented in Table 2.18 are therefore appropriate to area G5.

For the Golf Course Apartments, it is proposed to provide treatment measures to each of the nine apartment blocks. In order to meet the adopted water quality objectives a total bioretention system area of 145 m^2 is required per apartment block. This area could be split into multiple systems proportionate to the contributing catchment, if desired. Table 2.26 presents the results of the analysis for the Golf Course Apartment area.

Table 2.26 - Golf Course Apartments (G6) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	372	33	-91%	3.29	1.13	-66%	Yes
Total Phosphorus	0.85	0.14	-83%	0.0159	0.0096	-40%	Yes
Total Nitrogen	5.6	2.2	-61%	0.233	0.244	5%	Yes

Club House

For the Golf Club House, due to the standard commercial pollutant generation parameters adopted, a 220 m^2 filter area is required for treatment to achieve the concentration based water quality objectives (particularly Total Nitrogen). As a result the total treatment area represents over 5% of overall lot. Overall results are presented in Table 2.27.

Table 2.27 - Golf Course Clubhouse

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	594	18	-97%	3.24	1.06	-67%	Yes
Total Phosphorus	1.54	0.11	-93%	0.0157	0.0090	-43%	Yes
Total Nitrogen	9.0	2.5	-73%	0.229	0.236	3%	Yes

First flush runoff from the golf course will be directed to the water storages that contain recycled water. As the quality of runoff will be no worse than the quality of the recycled water, additional treatment of the runoff prior to its entry to the golf course water storages is not considered to be necessary. For this reason, modelling has excluded the golf course.

Ocean View Resort Precinct

For the Spa Retreat, a filter area of 145 m^2 is required to meet the water quality objectives. Adopting a 100 m long (0.45 m width) bioretention swale parallel to the downstream lot boundary will both collect and treat runoff to the required quality. Table 2.28 presents the MUSIC results for this area.

Table 2.28 - Spa Retreat (S1)

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	575	117	-80%	3.420	1.150	-66%	Yes
Total Phosphorus	1.53	0.45	-70%	0.0166	0.0096	-42%	Yes
Total Nitrogen	12.1	6.0	-51%	0.243	0.248	2%	Yes

The western catchment of the Ocean View Villas requires a bioretention basin area of 280 m^2, with a diversion swale diverting flows into this basin. The eastern catchment of the Ocean View Villas requires a filter area of 990 m^2, treated by a bioretention swale incorporated into the downstream main access road reserve (approximately 1500m length, therefore approximately 0.65 m filter width). The southern catchment requires a basin area of 310 m^2. However this treatment will be incorporated into the downstream Colosseum Village Apartments (B2) basins. The overall area results are provided in Table 2.29.

Table 2.29 - Ocean View Villas (S2) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	9270	1420	-85%	3.78	1.34	-65%	Yes
Total Phosphorus	18.70	4.13	-78%	0.0184	0.0112	-39%	Yes
Total Nitrogen	103.0	42.6	-59%	0.269	0.282	5%	Yes

Bushland Precinct

The southern, central and northern catchments of the Bushland Holiday Villas require bioretention basin areas of 900 m^2, 185 m^2 and 1100 m^2 respectively, with a diversion swale providing flows into these basins. The overall area results are provided in Table 2.30.

Table 2.30 - Bushland Holiday Villas (B1) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	12600	1810	-86%	3.79	1.34	-65%	Yes
Total Phosphorus	25.00	5.34	-79%	0.0184	0.0112	-39%	Yes
Total Nitrogen	139.0	56.3	-60%	0.269	0.282	5%	Yes

It is proposed to provide treatment for each of the four apartment blocks of the Colosseum Village Apartments individually. In order to meet the water quality objectives a bioretention system of 320 m^2 filter area is required per apartment block. However an additional 310 m^2 also needs to be included as part of the upstream Ocean View Villas (S2). Maintaining the existing overland flow patterns between the two areas, the additional treatment area will be evenly split between the four apartment blocks. Therefore the total required filter area is 397.5 m^2 per block. Table 2.31 details the overall results.

Table 2.31 - Colosseum Village Apartments (B2) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	961	84	-91%	3.46	1.19	-66%	Yes
Total Phosphorus	2.08	0.34	-84%	0.0168	0.0101	-40%	Yes
Total Nitrogen	12.4	4.8	-61%	0.245	0.257	5%	Yes

Due to the steep site constraints in the Colosseum Villas area it is proposed to incorporate bioretention within the diversion swale in order to reduce the end-of-line detention basin dimensions required. Smaller, more numerous swale / basins have been adopted to limit the concentration of runoff and earthworks disturbance.

Therefore, for the purposes of this assessment bioretention / diversion swales and end-of-line basins are incorporated every 8 lots. This results in a required filter area of 72 m^2, equating to a 0.82 m filter width of the diversion swale when applied adjacent to length of the downstream lot boundary. The overall swale width (including batters) will be subject to local topography constraints, in addition to maintenance access requirements. Table 2.32 details the results of the 8 lot analysis of this area.

Table 2.32 - Colosseum Villas (B3) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	329	41	-88%	3.24	1.12	-65%	Yes
Total Phosphorus	0.71	0.14	-81%	0.0157	0.0094	-40%	Yes
Total Nitrogen	4.5	1.7	-62%	0.229	0.240	5%	Yes

The Colosseum Village assessment was separated into a commercial node, incorporating the information centre, indigenous cultural centre, ecological design and display centre and retail buildings, and an industrial node, including the native plant nursery. In order to achieve the adopted water quality objectives, filter areas of 300 m^2 and 240 m^2 are required for the commercial and nursery areas respectively. Table 2.33 presents the overall results. Oil/water separators may also be required, depending on the nature of activities.

Table 2.33 - Colosseum Village (B4) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	1260	225	-82%	3.50	1.14	-67%	Yes
Total Phosphorus	3.63	0.91	-75%	0.0170	0.0095	-44%	Yes
Total Nitrogen	30.5	12.4	-59%	0.249	0.241	-3%	Yes

In order to meet the adopted water quality objectives a total bioretention system area of 47 m^2 is required for the Terrestrial and Marine Centre. Table 2.34 presents the results.

Table 2.34 - Terrestrial & Marine Centre (B5) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	84	5	-95%	2.88	0.98	-66%	Yes
Total Phosphorus	0.26	0.03	-89%	0.0139	0.0083	-41%	Yes
Total Nitrogen	2.2	0.6	-72%	0.203	0.212	4%	Yes

For the Boat Ramp, the required bioretention filter area in this case is 640 m^2. This area will be divided into multiple systems proportionate to the contributing catchment. The results of the analysis are presented in Table 2.35.

Table 2.35 - Boat Ramp (B6) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	3930	133	-97%	3.50	1.23	-65%	Yes
Total Phosphorus	6.38	0.48	-93%	0.0170	0.0104	-39%	Yes
Total Nitrogen	20.5	7.2	-65%	0.248	0.260	5%	Yes

The required bioretention filter area for the Airstrip is 1,700 m^2, representing a 1.7m width bioretention swale extending the full length of the downstream boundary parallel to the runway to achieve concentration based water quality objectives. The results of the analysis for this case are presented in Table 2.36.

Table 2.36 - Airstrip (B7) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	17600	2170	-88%	3.82	1.42	-63%	Yes
Total Phosphorus	24.00	4.09	-83%	0.0186	0.0114	-39%	Yes
Total Nitrogen	104.0	45.8	-56%	0.272	0.285	5%	Yes

For the Island Services area, due to the standard industrial pollutant generation parameters adopted, a 3,150 m^2 filter area is required for treatment to achieve the concentration based water quality objectives. As a result the total treatment area is larger than required elsewhere, representing 4.5% of the overall lot. The results for this case are presented in Table 2.37. An oil/water separator may also be required depending on final uses in this area.

Table 2.37 - Airstrip (B7) Results

Pollutant	Load Based WQO			Mean Concentration WQO			WQOs met?
	Developed (kg/yr)	Mitigation (kg/yr)	Reduction	Existing (mg/L)	Mitigated (mg/L)	Difference	
Suspended Solids	6760	289	-96%	3.77	1.32	-65%	Yes
Total Phosphorus	17.60	1.75	-90%	0.0183	0.0112	-39%	Yes
Total Nitrogen	113.0	35.6	-69%	0.268	0.279	4%	Yes

2.7.3.5 Summary

The MUSIC modelling has indicated that nutrient and suspended solids contaminants can be effectively removed from stormwater from the development footprint such that stormwater runoff quality equals or betters that from the pre-development stage. A further assessment of environmental impacts associated with stormwater is provided in Section 8.5.8 and 8.5.9.

It can be noted that the results presented in this section refer to sediment and nutrients (Total Nitrogen and Total Phosphorus). This is necessary since pollutant export relationships are only available for these contaminants. Given that the majority of other potential contaminants (such as heavy metals) are adsorbed onto sediment particles, it is considered that adequate treatment with respect to sediment and nutrients will also deliver an appropriate level of treatment with respect to other contaminants.

2.7.4 Water Storage Lagoons

2.7.4.1 Introduction

The master plan for the proposed PTP includes water storage lagoons at the golf course and Bushland Precinct. The Bushland Precinct water storage will primarily be a stormwater management structure. The golf course lagoons will be used for storage of recycled water as well as stormwater management. As the bulk of recycled water produced is to be utilised for irrigation, demand for recycled water will vary depending on rainfall. The rate of production of recycled water will also vary with occupancy rates. The golf course water storages will be used to balance demand and supply.

The water storages will be designed to allow fauna access. Water storages will be lined to prevent seepage from the ponds to subsoils and groundwater and, at the golf course, prevent interaction with shallow groundwater.

Managing the variation in water level and the retention time for water within each storage will require consideration as part of detailed design. The Mackay Regional Council document *Engineering Design Guidelines, Constructed Lakes, Planning Scheme Policy No. 15.15* (March 2008) recommends (p16) that the yearly variation in water level be limited to between 0.3 and 0.4 metres below normal water level, with infrequent water level variation to 0.5 metres below normal water level once every five years and severe water level drawdown by more than 0.5 metres allowed once every 20 years on average. This standard has been adopted for PTP. More details on the water storages is provided in Appendix D2.

2.7.4.2 Bushland Precinct Water Storage

At the Bushland precinct, an area of about 40 ha drains to the water storage. Water levels in the storage will depend on stormwater inflows, which can vary significantly between seasons and years, and evaporation. Modelling was undertaken to determine an optimal size for the water storages, taking into account inflows and outflows, including loss from evaporation and to demonstrate that the variation in water level met the guidelines set by Mackay Regional Council (2008).

The average results of the water balance analysis for the Bushland Precinct water storage can be summarised as follows:

- Number of days water body dry per year: 12.4 days
- Percent of time lake level within 0.1 m of surface: 18.2 percent;
- Percent of time lake level within 0.2 m of surface: 32 percent
- Percent of time lake level within 0.3 m of surface: 45 percent
- Number of days lake level lower than 0.3 m below surface: 8 days per year
- Number of days lake level lower than 0.4 m below surface: 6.8 days per year
- Number of days lake level lower than 0.5 m below surface: 5.7 days per year.

Any overflow from the Bushland Precinct Water Storage will drain to the south-west as occurs at present. It is estimated that overflows will occur on average at least once a year.

Water balance modelling has determined that a waterbody with a surface area of up to 0.5 hectares can be accommodated within the Bushland Precinct. The water level in the waterbody will vary over time depending on rainfall and evaporation. Although the level in the waterbody will vary, it is considered that the variation calculated via the water balance model is within reasonable limits, with the lake remaining within 0.3m of the surface 45% of the time, and being more 50 cm below normal surface level less than 6 days per year.

The modelling results for the Bushland Precinct water storage indicate that long retention time may lead to algal growth and related water quality issues. To provide adequate turnover of the waterbody during periods of low rainfall, it is proposed to cycle water through a series of bio-retention systems or proprietary treatment devices capable of removing nutrients (such as the Biofilta or Stormwater360 systems). This approach will have the benefit of providing for the treatment of water stored in the waterbody while not significantly increasing evaporative losses and thereby minimising drawdown within the waterbody. The size and configuration of the bio-retention systems or other measures will be determined as part of further design.

To minimise the perception of the variation in water level, the perimeter of the lagoon will be formed by a combination of low height vertical walls (with acceptable safety drop heights) and sloping walls with fringing vegetation. The fringing vegetation will also act to maintain water quality in the lagoon and minimise the potential for colonisation of the lagoon by floating vegetation which could otherwise promote blue-green algae outbreaks. The fringing vegetation and sloping walls will also allow access to the water body by native animals.

2.7.4.3 Golf Course Water Storages

The golf course water storages double as balancing storages for recycled water and also stormwater management devices. First flush stormwater will be directed to the water storages so that any nutrients or sediment entrained in stormwater runoff is collected. A bypass system will then allow direct discharge of stormwater via existing stormwater pathways. This reduces the frequency of overflow of the water storages in severe rain events.

The overall catchment area draining to the waterbodies is approximately 197 hectares. Of this total, a significant proportion is external to the golf course and comprises poorly drained low lying areas on sandy soils. The runoff derived from this external area is therefore expected to be relatively low. Within the golf course, it is expected that the existing sandy loam soils will be used for the fairways. Although this will result in greater runoff than the external catchment, the rate of runoff will still be relatively low and a low volumetric runoff coefficient was therefore adopted for modelling purposes.

The average results of the water balance analysis can be summarised as follows:

- Number of days waterbody dry per year: 50 days
- Percent of time lake level within 0.1 m of surface: 15 percent
- Percent of time lake level within 0.2 m of surface: 19 percent
- Percent of time lake level within 0.3 m of surface: 23 percent
- Number of days lake level lower than 0.3 m below surface: 10 days per year
- Number of days lake level lower than 0.4 m below surface: 9.3 days per year

- Number of days lake level lower than 0.5 m below surface: 9.0 days per year.

Due to the relatively low volume of runoff that drains to the waterbodies, the water level in the waterbodies is significantly affected by evaporation.

Modelling was based on water storages with a combined surface area of 5.5 hectares, a maximum depth of two metres and a volume of 100 ML. Further modelling will be undertaken during detailed design to optimise the surface area and depth of the storage to achieve a balance between evaporation losses, potential for overflows, reliability for recycled water supply and construction costs. The rate of turnover of water in the water bodies is expected to exceed the 20 days recommended by Mackay Regional Council (2008). UV devices will be used to prevent algal growth.

2.7.5 Energy

2.7.5.1 Electrical Power Supply and Reticulation

Total peak electrical energy demand for the Project is expected to be 8,000 kilowatts. Growth in demand will be concurrent with development progress.

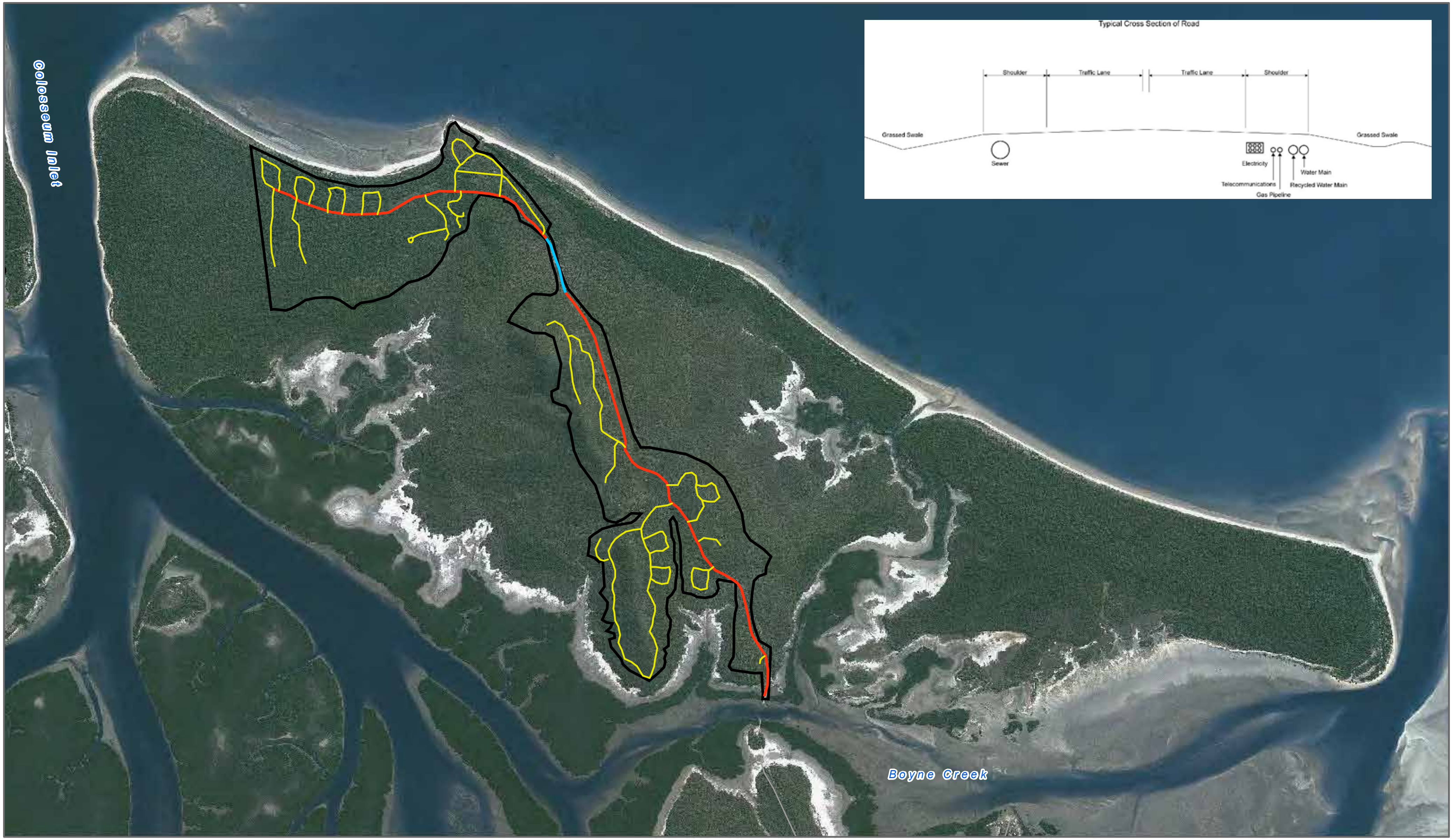
Alternative power sources investigated included:

- Mains grid connection from Ergon Energy's 22 KV network on the mainland
- On-Island generation using a gas fired cogeneration plant or diesel engine generators
- Solar/photovoltaic cell arrays
- Wind Turbines.

All alternatives investigated concluded that:

- a base load supply of electricity will be required from the mainland grid to ensure security of supply to the development and
- the base load supply could be supplemented by the other sources including those listed above.

The provision of a secure supply of electricity to the Island is a condition of the Special Lease and the Queensland Government will only grant freehold title for the Project after electricity has been provided to the Island. Ergon Energy have confirmed that power to the Island, is available from the existing network near Foreshores Estate, approximately 12 km from the Island. Consequently the proponent proposes to connect the Island to the mainland grid to supply electricity for the initial stages of the development. During detailed design of the Project infrastructure further investigations and feasibility studies will be undertaken to examine alternative electricity options for the full development. Overhead power lines will be constructed from the existing network to the bridge, following the existing road reserves. The power lines will be attached to the bridge and, once on HHI, continue underground to a substation located in the island services centre as shown on Figure 2.3. . Both HV and LV reticulation around the Project will be via underground cables, with cables placed in the road reserve as shown on Figure 2.9.



LEGEND

- PTP Trunk Road
- Two single lane carriage ways separated by a naturally vegetated strip of 50–60 metres
- Precinct Roads
- Development Footprint

This figure must be read in conjunction with the data disclaimers located at the front of this report . The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Figure 2.9 - Road Network and Typical Cross Sertion for the Pacificus Tourism Project

PACIFICUS TOURISM PROJECT

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2.7.5.2 Energy Efficiency

At a State level, as reported by Energy Efficient Strategies for the Queensland Department of Public Works (2000), electricity is the most significant operational energy source for residential buildings in Queensland, accounting for 86% of all operational energy sources. Natural gas and wood are the next biggest energy sources accounting for 5 % each, while LPG accounts for 4%. All other fuels had either a small share or were insignificant.

In terms of end use, electrical appliances and equipment and water heating are responsible for 48% and 35% of operational energy consumption in residential buildings respectively. Space heating and cooking are the next biggest end uses accounting for 7% of operational energy consumption each, followed by only 3% for space cooling. Electricity is the dominant source of greenhouse gas emissions in the Queensland residential sector, accounting for 98% of all residential operational emissions. In terms of end use share, electrical appliances and equipment dominate Queensland residential operational gas emissions in 1999, accounting for 55% of the state total. Water heating is the next most significant with 33% followed by cooking at 7%, space cooling 3% and space heating 2%, as outlined in Table 2.38.

Table 2.38 – Operational Energy Share and Greenhouse Gas Emissions by End Use – Queensland Residential Sector

End Use	Operational Energy Share (%)	Operational Greenhouse Gas Emissions (%)
Electrical Appliances and equipment	48%	55%
Water Heating	35%	33%
Cooking	7%	7%
Space Heating	7%	3%
Space Cooking	3%	2%

Whilst electricity consumption is expected to experience the strongest growth on a state wide basis, power generation in the Gladstone area will remain at its current capacity. The PTP will incorporate relevant energy efficiency strategies in its design to reduce the use of electricity and associated greenhouse gas emissions. Requirements for both the residential and commercial operational sectors are addressed below.

Residential operational emissions savings will be attained by incorporating:

- Use of energy efficient fuels in the residential sector - the Project will incorporate fuel switching from electricity to gas to reduce greenhouse gas emissions
- Hot water supply in the residential sector – the Project will incorporate solar hot water heating with a gas booster to reduce reliance on electrical water heating, reducing downstream greenhouse gas emissions from electricity generation.
- Use of water-saving technologies to reduce hot water use – for example water-saving shower heads use less hot water, reducing energy demand for hot water heating;

- Space Conditioning in the Residential Sector - passive house design will minimise requirements for space heating and associated electrical demands
- Space Conditioning in the Residential Sector - public awareness for programs especially focused on ways of avoiding the need for space cooling and energy efficient appliance
- Use of energy efficient lighting – such as fluorescent bulbs and emerging low energy LED lighting
- Encouragement of the use of energy efficient appliances at the household level.

From 1 March 2006 all new homes built in Queensland are required to install energy efficient hot water systems (solar, gas or electric heat pump) and use energy efficient lighting for at least 40% of internal floor space. All of the residences in the Project will have solar hot water systems installed.

Operational emissions savings in commercial premises will be attained by incorporating:

- Energy efficient lighting systems
- Lighting control systems – individual switching, timers, motion sensors and daylight sensors for:
  - Individual rooms, external and common areas
  - Zones within buildings
- Entire building control systems
- Daylight integration through design, roof lights, light shelves and window placement
- Improved maintenance of lighting systems
- Replacement of lower efficiency lighting for higher efficiency lighting
- Ventilation and air-conditioning (HVAC) system
- Improved calibration and maintenance of HVAC systems to ensure peak operational performance
- Improved thermal performance of building shells especially in the areas of window performance, shading and sealing
- Swimming pools with solar heating.

Incorporation of these strategies into PTP will reduce the total electrical demand, reducing the subsequent use of coal based electricity generation and the associated greenhouse gas emissions.

2.7.6 Telecommunications

A microwave relay tower will be established within PTP with direct links to the national communication network. Residents have access to latest technology for wireless telephone, internet, television, radio and other communications. Cable requirements will be placed underground in the road reserve as shown on Figure 2.9.

2.7.7 Traffic and Transportation

Within the proposed development, cycling and walking paths will be provided to encourage visitors and residents to utilise these transport modes when weather permits.

A bus station will be provided in Resort Village and bus lay-bys will also be incorporated into design of the main access road. It is expected that once population reaches a critical mass, local and regional providers will consider bus connections either from the train station at Miriam Vale or from Gladstone. Initially the proponent will provide a regular bus service between the island and Tannum Sands. The bus station and bus lay bys will also allow for safe operation of a school bus route.

Some areas of the PTP will be highly suitable for golf buggies. This form of transportation is proving effective in a number of private communities in Australia and would be appropriate at Hummock Hill Island, even though roads will be public. Road design at Hummock Hill Island will take this form of transportation into consideration to encourage residents and visitors to utilise it, provided it is acceptable to GRC.

As is the case throughout urban and rural Australia, it is expected that cars will be the major form of transportation for residents and visitors to the Island.

2.7.7.1 Traffic Predictions

Predictive modelling of traffic volumes was undertaken for the HHID (Cardno 2009) to estimate the potential increase in traffic associated with the development. Road infrastructure requirements were identified as described below. The PTP development being of similar size to HHID will have the same traffic impacts.

2.7.7.2 External Roads

The existing road network to Clarks Road is acceptable for the projected traffic volumes from Hummock Hill Island during development. Clarks Road will require upgrade to a Class 3 Rural Arterial. Clarks Road is currently located in a 40 m wide road corridor sufficient for the proposed road type and required WSUD stormwater controls. Table 2.39 outlines existing road classification and the proposed upgrade required for the projected population post development. It is a condition of the Special Lease that the proponent finances all upgrades to the access road, Clarks Road.

Table 2.39 - Existing and Proposed Road Upgrade

Road	Current Classification	Proposed Classification
Bruce Highway	National Highway	National Highway
Turkey Beach Road	Rural Arterial	Class 3 Rural Arterial
Turkey Beach Road	Rural Collector	Class 3 Rural Arterial
Foreshores Road	Rural Collector	Class 3 Rural Arterial
Clarks Road	No Classification	Class 3 Rural Arterial

2.7.7.3 Island Roads

The road network within PTP is shown on Figure 2.9 will be centred on the sub-arterial or trunk road running from the Boyne Creek Bridge to the Headland Resort and Village. The sub-arterial road will be designed to a capacity of 10-12,000 vehicles per day. The road will be a 2-lane limited access 50kph, divided road. The section of road linking the northern and southern portions of the development (around 500 metres) will remain as two separate single lane carriage ways (5-6 metres) separated by a naturally vegetated strip of 50–60 metres in width to enhance wildlife movement across the island. Tourist facilities or residential or commercial development will not front directly onto this road.

Collector streets will provide for traffic volumes of 3,000 vehicles per day and will provide access within each precinct of the proposed development. Accommodation units will generally not open directly onto collector streets. Accommodation units will be are generally arranged in pods around smaller access streets providing direct access to each dwelling or multi-unit development.

A final assessment of road capacity and design requirements will be made in the detailed design stage of the PTP when intersection treatments will also be determined. Road design and intersection design will be in accordance with design standards that are in place at the time of design and construction. Current relevant design standards are:

- Austroads Rural Road Design
- Queensland Streets design Guidelines for Subdivisional Street Works.

2.7.7.4 Boyne Creek Bridge

The proposed Boyne Creek Bridge will be a balanced cantilever structure consisting of three spans of 40 m, 70 m, and 40 m. The bridge will be launched from engineered earthen abutments utilising the existing causeway alignment. The bridge deck structure will consist of a variable depth, single cell post-tensioned concrete box girder with vertical webs.

Construction of the bridge will require a temporary access jetty across the intertidal area. Initial construction works for founding bridge abutments and piers and constructing casements will be conducted from this jetty. The jetty will be a temporary structure consisting of H-beams and steel decking.

Once the abutments and piers are constructed the bridge deck will be constructed outwards from the piers in a balanced cantilever. The piers are founded on bored piles. Pile driving is not proposed. Figure 2.10 shows an example of construction of a balanced cantilever bridge.

Figure 2.10 - Typical Balanced Cantilever Construction (Brunswick River, NSW)

Deck segments are cast using a moveable formwork traveller at each end of the cantilever. For a 70 m span the required girder depth is approximately 2,400 mm at mid-span and approximately 5,000 mm deep at the piers. The deck is either supported on pot bearings at the piers and abutments or integrally connected to the piers. Deck expansion joints are located at the abutments to accommodate the braking, temperature, creep and shrinkage movement of the deck. Deck drainage can be accommodated by a pipe, hung from the deck under the bridge.

2.7.7.5 Removal of the Causeway across Boyne Creek

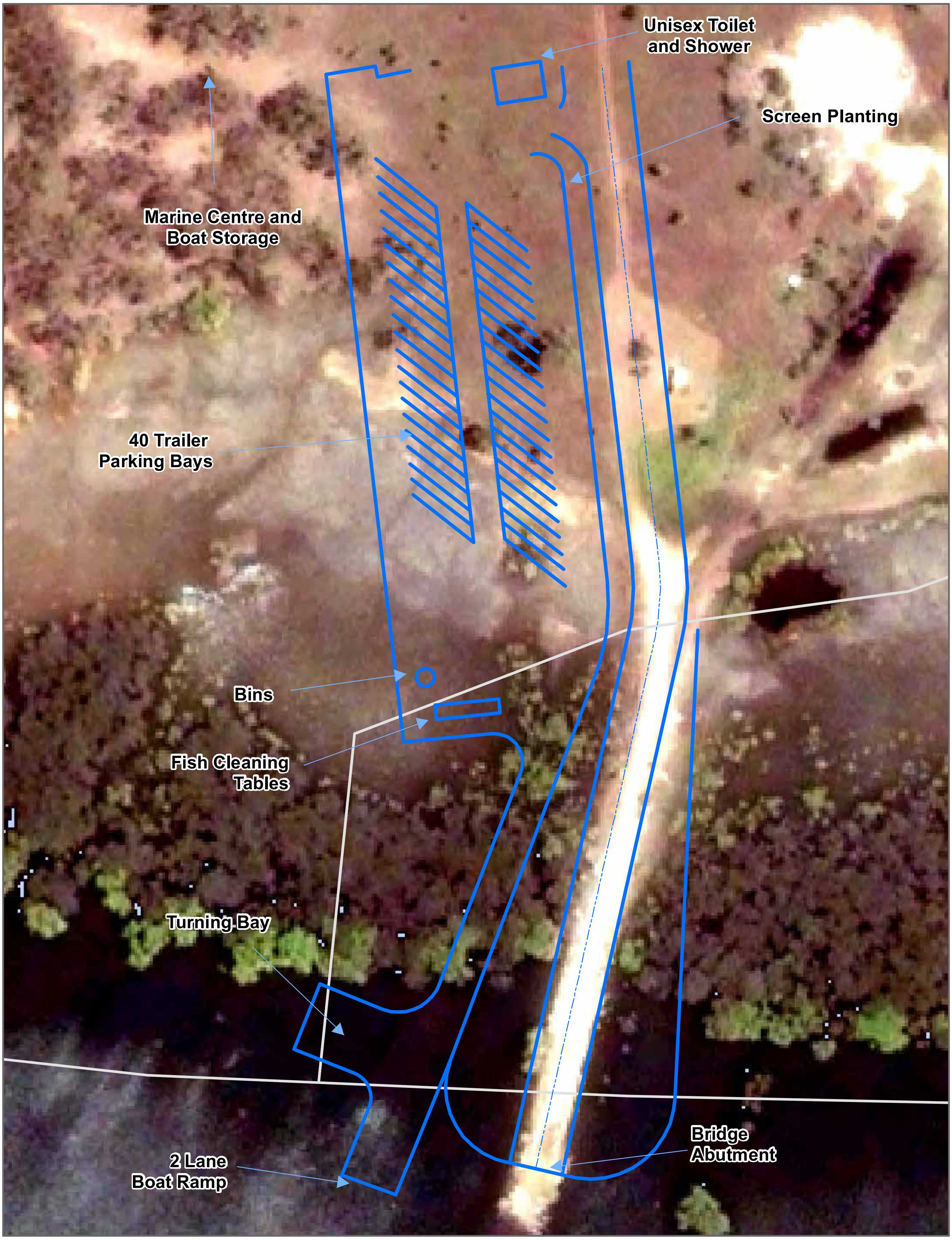
Approximately 70m of the existing rock causeway to the island, across Boyne Creek (see Figure 2.1) will be removed after the construction of the bridge and boat ramp have been completed.

The rock fill in the centre of the creek will be excavated back down to the original creek bed level. The rock will be removed by excavator at low tides, loaded into trucks and stockpiled for use in the construction of the islands roads. Approximately 500 cu m of rocky material will be removed from the causeway.

2.7.7.6 Boat Ramp

A boat ramp will be built as part of the PTP on the northern bank of Boyne Creek adjacent to the western side of the proposed bridge, as shown in Figure 2.11. The boat ramp structures will be designed in accordance with the Australian Standard – Guidelines for Design of Marinas (AS3962-2001). Reference will also be made to the relevant Queensland Transport standards for boat ramp design during detailed design.

The boat ramp will not provide all tide access to Boyne Creek, being limited to the duration of navigable water depth as dictated by the tide state. It is anticipated that water access will be achieved for approximately two thirds of the tidal cycle.



LEGEND
- Proposed Boat Ramp
- Cadastre

Figure 2.11 Layout of Boat Ramp and Bridge at Boyne Creek

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PACIFICUS TOURISM PROJECT

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2.7.7.7 Airstrip

The existing private airstrip will be re-established as part of the PTP. This airstrip is located to the east of the main ridgeline as shown on Figure 2.3 and will utilise currently cleared ground of the former homestead airstrip. The airstrip will be an un-registered airstrip for use by planes during daylight hours, with a maximum take-off weight (MTOW) of less than 5,700 kg. A helipad will also be provided within the airstrip precinct.

The runway will be designed as a grass airstrip with sufficient ground density to accommodate the designed MTOW. Detailed geotechnical assessment of the existing airstrip will be conducted prior to construction to assess the level of ground enhancement required for the runway.

Figure 2.12 outlines the above physical characteristics proposed for the airstrip.

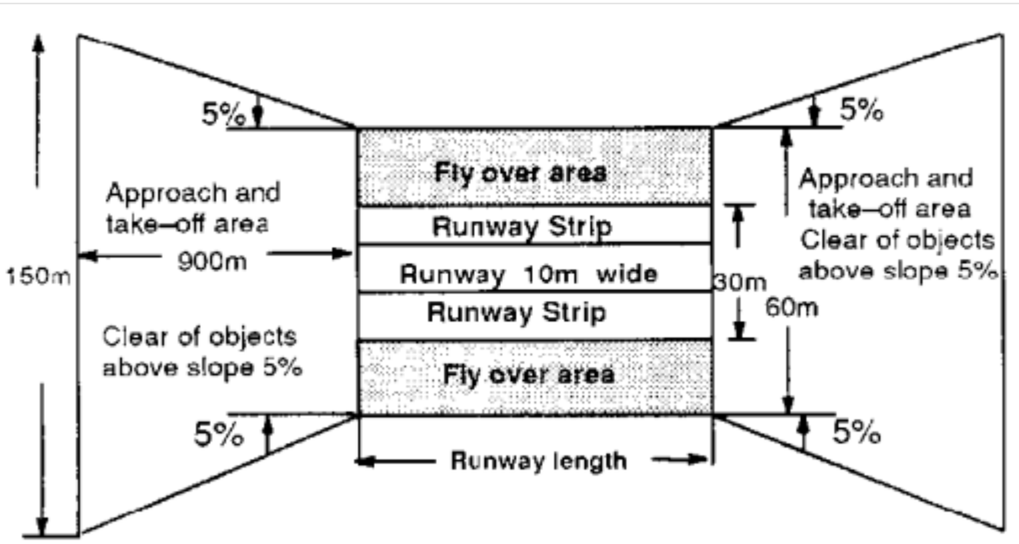


Figure 2.12 - Recommended Airstrip Physical Characteristics (Source: CAAP92-1(1))

The runway design will be in accordance with Civil Aviation Advisory Publication No: 92-1. As such the following recommended minimum physical characteristics will be:

- Runway Width = 15 m
- Runway Length = approx. 1000 m
- Longitudinal slope along the runway = <2%
- Transverse slope across the runway = 2.5%
- Approach and take off area = clear of objects above a 5% slope.

An exclusion zone will be applied to the approach/take off from the airstrip to protect migratory shore-bird habitat. This is discussed in Sections 2.11.2 and 10.2.4.4.

2.8 Construction

2.8.1 Schedule

Subject to, and following approval of the project under the EPBC Act, numerous State Government and Local Government approvals will be required before construction can commence. These approvals include approval of the detailed design of all infrastructure and major structures. Approval requirements are set out in Section 3.

Construction of PTP will be staged over a 16 year period as presented in Figure 2.13.

The conditions of the SL require the Proponent to provide all necessary infrastructure for the PTP, including the access road, bridge, power, telecommunications to the island and headworks for water supply and sewage, before having the right to purchase freehold title to the development sites. As shown on Figure 2.13, these works will all be constructed within the fists 2 years of the development program, before construction of the tourism and residential components commences on the headland. The first tourism components will be the headland resort hotel, the motel and the tourist park. The tourist facilities including park, life-saving club, retail shops and community facilities will be constructed to keep pace with the development of the resorts and residential housing.

An estimated average of 190 jobs per year would be directly generated during construction, with a peak employment of 350 persons. Employment opportunities expected to be generated during construction include both skilled and unskilled positions, including in engineering design, construction supervision and trades, earthmoving, equipment operation, transport and building and landscaping.

2.8.2 Construction Activities –Infrastructure and Services

Construction activities associated with installation of infrastructure and services are provided in Table 2.40. Co-location of linear infrastructure will minimise environmental impacts associated with construction activities, and in particular earthworks.

All construction activities will be undertaken in accordance with a Construction Environmental Management Plans (CEMP) to be prepared by Contractors and approved by the Proponent.

The majority of the construction to be undertaken for PTP will be typical of urban developments (i.e. bitumen roads, pipelines, power supply lines, drainage, works, etc). Contractors will submit their proposed construction programs and construction method statements along with a CEMP.

All contractors will be required to pre-qualify for the works to ensure suitably experienced and qualifies contractors will work on the Project.

All contractors to be employed on PTP will be ISO14000 certified or have equivalent environmental management systems in place.

All construction equipment and materials will be transported to the site via Clarkes Road and the bridge over Boyne Creek. While the bridge is being built, large items of construction equipment required for initial site works on the island will be transported across the existing causeway at low tide.

Table 2.40 - Construction Activities – Infrastructure and Services

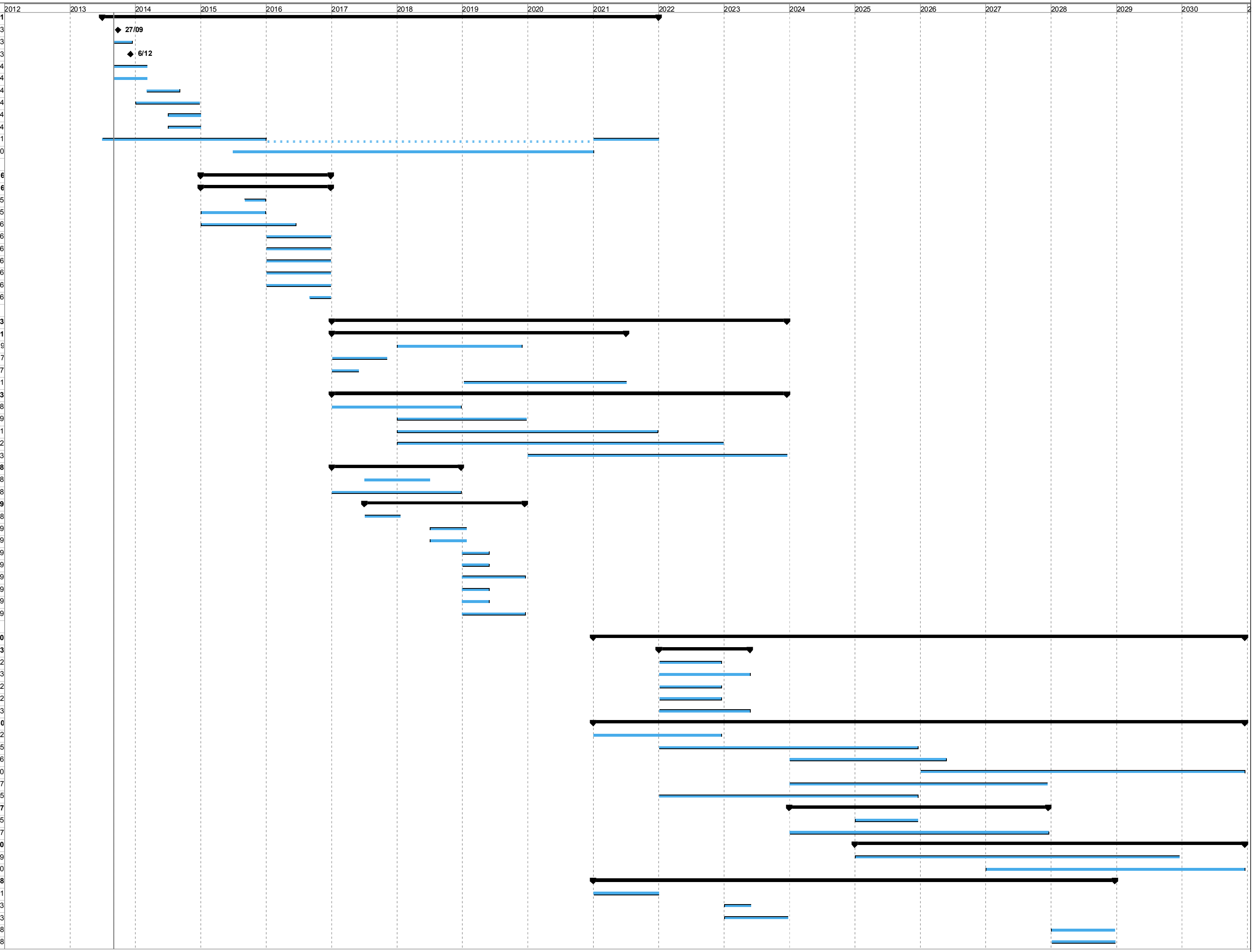
Component	Timeframe	Construction Activities
Upgrade of external (mainland) road network including Foreshores Road and Clarks Road Upgrade Bruce Highway intersection Upgrade Turkey Beach Road Intersection	Phase 1 – Years 1-3 Phase 3 - Years 8-9	Confirm design parameters, including design standard and service requirements with GRC/DMR. Conduct survey and geotechnical investigations. Prepare detailed design. Obtain permit to clear assessable vegetation (Vegetation Management Act). Prepare Erosion and Sediment Control plan and install devices as per identified schedule. Prepare CEMP. Prepare and implement Cultural Heritage Management Plan (CHMP) (also covering external power and gas supply). Clear vegetation as required within road reserve. Vegetation to be retained for use in rehabilitation. Grade road reserve as per detailed design. Install culverts and drainage systems. Install road base, bitumen surface, shoulder treatments (shoulder treatments to minimise risk of sheet erosion). Reinstate remaining areas within road reserve with native vegetation compatible with road safety requirements.
Bridge over Boyne Creek	Phase 1 – Years 1-3	Confirm design parameters, including design standard and service requirements with GRC. Conduct survey and geotechnical investigations (including acid sulfate soil identification). Prepare detailed design. Obtain Operational Works permit for works in a tidal zone, to destroy marine plants and to clear assessable vegetation. Prepare Erosion and Sediment Control plan and install devices as per identified schedule. Prepare Acid Sulfate Soil management plan and construct treatment areas. Prepare CEMP. Remove mangroves from construction area. Excavate for bridge foundations as per design, treating acid sulfate soil as per management plan. Install bridge foundations and construct roadway. Reinstate disturbed areas and monitor for mangrove regeneration.
Internal road network - Trans-Island boulevard and associated services Minor road network (collector and access streets)	Phase 1 – Years 1-3 As required to service development modules during phases 2 and 3	Confirm design parameters, including design standard and service requirements with GRC. Conduct survey and geotechnical investigations. Prepare detailed design. Obtain permit to clear assessable vegetation (Vegetation Management Act). Prepare Erosion and Sediment Control plan and install devices as per identified schedule.

Component	Timeframe	Construction Activities
		Prepare CEMP. Clear vegetation as required within identified road alignment. Vegetation to be retained for use in rehabilitation. Grade road reserve as per detailed design. Install culverts and drainage systems. Install road base, bitumen surface, shoulder treatments (shoulder treatments to minimise risk of sheet erosion). Reinstate remaining disturbed areas within road alignment with native vegetation compatible with road safety requirements.
Power Supply – external, above ground power lines, 12 km	Phase 1 – Years 1-3 (in conjunction with upgrade of Foreshores Road and Clarks Road) Phase 2 – years 8-9	Confirm design parameters including exact alignment of power lines. Vegetation clearing to be undertaken in conjunction with clearing required for road upgrades. Prepare CEMP. Install poles and transmission line. Install transformers and other equipment at connection point. Make connection.
Power supply – internal (underground) Water and wastewater reticulation Gas reticulation	As required to service development modules during phases 1, 2 and 3 Coordinated with road installation wherever co-located	Confirm design parameters, including design standard and service requirements with GRC and relevant power and gas authorities. Conduct survey and geotechnical investigations. Prepare detailed designs. Obtain permit to clear assessable vegetation (Vegetation Management Act). Prepare CEMP. Prepare Erosion and Sediment Control plan and install devices as per identified schedule. Clear vegetation as required within specified alignment. Vegetation to be retained for use in rehabilitation. Clear topsoil and set aside for reuse. Excavate trenches and install power/gas/water as per design. Back fill trenches. Dispose of excess spoil to regional landfill or beneficial reuse if available. Replace topsoil and reinstate in accordance with design (compatible with road design requirements)
Water and wastewater treatment plants and evaporation ponds	First units in years 1-3 (phase 1). Subsequent units as required to meet population growth	Confirm location and design parameters. Conduct survey and geotechnical investigations. Prepare detailed design. Obtain permit to destroy assessable vegetation (if required). Prepare Erosion and Sediment Control plan and install devices as per identified schedule. Clear vegetation and strip topsoil – stockpile for later use in landscaping. Conduct any excavations and remove subsoil for use at regional landfill or other beneficial reuse as available. Install plant as per design. Install evaporation pond as per design. Use topsoil and cleared vegetation for landscaping around

Component	Timeframe	Construction Activities
		plant location and evaporation pond.
Boat Ramp – Boyne Channel Associated boat/trailer parking	Boyne Creek public Boat Ramp and parking in Year 3	Confirm design parameters, including design standard and service requirements with GRC and Queensland Transport. Conduct survey and geotechnical investigations (including acid sulfate soil identification). Prepare detailed design. Obtain permit to destroy marine plants and assessable vegetation. Prepare Erosion and Sediment Control plan and install devices as per identified schedule. Prepare Acid Sulfate Soil management plan and construct treatment areas. Remove mangroves from construction area. Excavate for boat ramp foundations as per design, treating acid sulfate soil as per management plan. Install boat ramp and queuing pontoons. Clear vegetation and conduct earthworks for car park. Construct car park. Reinstate disturbed areas and monitor for mangrove regeneration.
Golf Course	Years 7-8	Prepare detailed design, including identification of vegetation clearing requirements and wildlife corridors. Identify appropriate grass species compatible with climate and irrigation of treated wastewater. Apply for permit to clear assessable vegetation (Vegetation Management Act). Prepare Erosion and Sediment Control Plan and install devices as per schedule. Conduct earthworks and install permanent drainage systems and lagoon systems. Place topsoil/top dressing and sow fairways and greens with selected grass species. Plant remaining areas with selected native species. Maintain temporary erosion and sediment control devices until 80% grass cover is achieved and permanent stormwater and drainage systems are in place.

Figure 2.13 Proposed Pacificus Tourism Project Development Schedule

ID	Task Name	Duration	Start	Finish
1	**Developmental Approvals**	**2223 days**	**Mon 1/07/13**	**Fri 31/12/21**
2	EPBC Approval	0 days	Fri 27/09/13	Fri 27/09/13
3	QLD CG Change Report	75 days	Mon 2/09/13	Fri 13/12/13
4	25 Year Development Lease issued by QLD Gov	0 days	Fri 6/12/13	Fri 6/12/13
5	EMP's	133 days	Mon 2/09/13	Wed 5/03/14
6	Complete the Statutory Plan of Development	133 days	Mon 2/09/13	Wed 5/03/14
7	Infrastrucutre Agreements with GRC	133 days	Wed 5/03/14	Fri 5/09/14
8	GRC MCU Approval	257 days	Wed 1/01/14	Thu 25/12/14
9	Environmental Monitoring Programs Commence	132 days	Tue 1/07/14	Wed 31/12/14
10	Offsets Purchased under QLD VMA	132 days	Tue 1/07/14	Wed 31/12/14
11	Infrastructure Detailed Design	915 days	Mon 1/07/13	Fri 31/12/21
12	Major Structures - Detailed Design	1440 days	Wed 1/07/15	Thu 31/12/20
13				
14	**Stage 1**	**519 days**	**Thu 1/01/15**	**Tue 27/12/16**
15	**Primary Infrastructure**	**519 days**	**Thu 1/01/15**	**Tue 27/12/16**
16	Minor Upgrading of Bruce H'way Intersection	85 days	Tue 1/09/15	Mon 28/12/15
17	Access Road to the Island	258 days	Thu 1/01/15	Mon 28/12/15
18	Bridge over Boyne Creek	380 days	Thu 1/01/15	Wed 15/06/16
19	Trans Island Boulevard and Services	257 days	Fri 1/01/16	Mon 26/12/16
20	Desalination Plant for Potable Water	257 days	Fri 1/01/16	Mon 26/12/16
21	Wastewater Treatment Plant - Phase 1	257 days	Fri 1/01/16	Mon 26/12/16
22	Recycled Water Treatment Plant	257 days	Fri 1/01/16	Mon 26/12/16
23	Power Supply	257 days	Fri 1/01/16	Mon 26/12/16
24	Solid Waste Collection Equipment	84 days	Thu 1/09/16	Tue 27/12/16
25				
26	**Stage 2**	**1818 days**	**Mon 2/01/17**	**Mon 18/12/23**
27	**Resort Village Precinct**	**1176 days**	**Mon 2/01/17**	**Fri 2/07/21**
28	Retail and Commercial Stage 1	500 days	Mon 1/01/18	Fri 29/11/19
29	Caravan Park/Camping Ground	220 days	Mon 2/01/17	Fri 3/11/17
30	Motel	108 days	Mon 2/01/17	Wed 31/05/17
31	Village Apartments	650 days	Mon 7/01/19	Fri 2/07/21
32	**Headland Resort Precinct**	**1818 days**	**Mon 2/01/17**	**Mon 18/12/23**
33	Resort Hotel (240 Rooms)	517 days	Mon 2/01/17	Mon 24/12/18
34	Headland Holiday Homes	516 days	Mon 1/01/18	Mon 23/12/19
35	Headland Holiday Apartments	1041 days	Mon 1/01/18	Mon 27/12/21
36	Headland Holiday Cottages	1301 days	Mon 1/01/18	Mon 26/12/22
37	Foreshore Homes	1035 days	Wed 1/01/20	Mon 18/12/23
38	**Colosseum Village**	**517 days**	**Mon 2/01/17**	**Mon 24/12/18**
39	Retail and Commercial	263 days	Mon 3/07/17	Tue 3/07/18
40	Apartments	517 days	Mon 2/01/17	Mon 24/12/18
41	**Community Infrastructure**	**642 days**	**Mon 3/07/17**	**Mon 16/12/19**
42	Town Maintenance Depot	145 days	Mon 3/07/17	Thu 18/01/18
43	Boyne Channel Boat Ramp	147 days	Mon 2/07/18	Tue 22/01/19
44	Beachside Picnic Parks Stage 1	147 days	Mon 2/07/18	Tue 22/01/19
45	Rural Fire Brigade	106 days	Tue 1/01/19	Tue 28/05/19
46	Surf Lifesaving Club	106 days	Tue 1/01/19	Tue 28/05/19
47	Airstrip and Support Services	250 days	Tue 1/01/19	Mon 16/12/19
48	Tourist Information Centre	106 days	Tue 1/01/19	Tue 28/05/19
49	Ecological Design Centre	106 days	Tue 1/01/19	Tue 28/05/19
50	Native Plant Nursery	250 days	Tue 1/01/19	Mon 16/12/19
51				
52	**Stage 3**	**2601 days**	**Fri 1/01/21**	**Wed 18/12/30**
53	**Infrastructure**	**366 days**	**Mon 3/01/22**	**Fri 26/05/23**
54	Major upgrading of the Bruce Highway-Turkey Beach Road Intersection	250 days	Mon 3/01/22	Fri 16/12/22
55	Upgrading Turkey beach and Foreshores Roads and Intersections	366 days	Mon 3/01/22	Fri 26/05/23
56	Recycled Water Treatment Plant - Stage 2	250 days	Mon 3/01/22	Fri 16/12/22
57	Wastewater Treatment Plant - Stage 2	250 days	Mon 3/01/22	Fri 16/12/22
58	Power Supply Augmentation	366 days	Mon 3/01/22	Fri 26/05/23
59	**Golf and Beach Resort Precinct**	**2600 days**	**Fri 1/01/21**	**Tue 17/12/30**
60	Tourist Hotel (150 rooms)	511 days	Fri 1/01/21	Fri 16/12/22
61	Beachfront Villas	1036 days	Mon 3/01/22	Fri 19/12/25
62	Beachfront Apartments	626 days	Mon 1/01/24	Mon 25/05/26
63	Golf Course Villas	1295 days	Thu 1/01/26	Tue 17/12/30
64	Golf Course Cottages	1030 days	Mon 1/01/24	Fri 10/12/27
65	Golf course Apartments	1036 days	Mon 3/01/22	Fri 19/12/25
66	**Ocean View Precinct**	**1035 days**	**Mon 1/01/24**	**Fri 17/12/27**
67	Spa Retreat	250 days	Wed 1/01/25	Tue 16/12/25
68	Ocean View Villas	1035 days	Mon 1/01/24	Fri 17/12/27
69	**Colosseum Precinct**	**1557 days**	**Wed 1/01/25**	**Wed 18/12/30**
70	Bushland Holiday Villas	1295 days	Wed 1/01/25	Mon 17/12/29
71	Colosseum Villas	1035 days	Fri 1/01/27	Wed 18/12/30
72	**Community Infrastructure**	**2083 days**	**Fri 1/01/21**	**Fri 22/12/28**
73	Golf Course	261 days	Fri 1/01/21	Fri 31/12/21
74	Beachside Picnic Parks Stage 2	108 days	Mon 2/01/23	Wed 31/05/23
75	Community centre	255 days	Mon 2/01/23	Fri 22/12/23
76	Terestrial and Marine Research Centre	255 days	Sat 1/01/28	Thu 21/12/28
77	Indigenous Cultural Centre	255 days	Mon 3/01/28	Fri 22/12/28



Project: Pacificus Tourism Project

Task	Rolled Up Task	Split	Group By Summary	Inactive Summary	Manual Summary Rollup	Finish-only
Milestone	Rolled Up Milestone	External Tasks	Inactive Task	Manual Task	Manual Summary	Progress
Summary	Rolled Up Progress	Project Summary	Inactive Milestone	Duration-only	Start-only	Deadline

2.8.3 Construction Activities – Site Preparation and Building Development

Tourist, residential, commercial and retail premises will be constructed over about 16 years, commencing once the bridge and main access roads are in place. For each component of the proposed development, construction will consist of:

- Confirm design requirements, survey and geotechnical investigations
- Prepare detailed design for earthworks, buildings and other structures
- Identify extent of vegetation clearing required
- Identify erosion and sediment control requirements and any other site-specific environmental management requirements and prepare site specific environmental control plans
- Obtain permits as required, including clearing of assessable vegetation and building certification
- Install erosion and sediment control devices and/or permanent stormwater and drainage systems
- Clear vegetation and conduct earthworks (progressively where possible)
- Install services including water, wastewater, power, gas, roads, driveways and pathways
- Construct buildings
- Connect to power, water and wastewater systems
- Reinstate disturbed areas (progressively where possible).

Equipment used in site preparation and building construction will vary depending on the type of building being constructed, but may include earthmoving equipment, lifting equipment and power tools.

2.8.4 Golf Course Construction

The 18-hole golf course will be designed and constructed in accordance with the general principles of the Society of Australian Golf Course Architects (SAGCA). In regards to the environment a well-designed Wild Golf Course will:

- Utilise natural features to the maximum extent whilst minimising the need for bulk earthworks
- Minimise any clearing required for construction
- Maintain native vegetation to provide wild life sanctuaries
- Preserve open space and remnant vegetation within urban environments
- Protect topsoil from degradation
- Protect water resources
- Rehabilitate degraded landscapes
- Promote indigenous flora and fauna and the Australian Landscape Experience

- Improve air quality and moderate temperature
- Utilise and treat water resources such as; sewage, stormwater and urban runoff thereby reducing pollutant loads on ephemeral watercourses.

A course maintenance facility will be located adjacent to the driving range, well away from the residential areas. The maintenance building will contain the machinery store and workshop, materials stores, offices and staff facilities. The building will be approximately 30 x 20 metres x 5.0 metres high, steel framed on concrete slab and Colourbond roof and wall cladding. Chemicals will be stored in a bunded area within the building. A hard stand area will be provided around the building for vehicle parking and wash down. Double skin, above ground fuel storage tanks will also be located on the hard stand area. The hard stand area will be bunded and drained to interceptor traps (to DEHP requirements) before being pumped to sewer. The maintenance area will be screened from the course and residential areas by the natural landform and by planted native vegetation.

The design of the course has not yet been completed and contract negotiations are currently underway with a number of Australia's leading golf course architects to design and supervise construction of the course. A certified golf course management company will be appointed to provide a high standard of operation and maintenance of the course with the view to elevating the stature and image of the Project and reinforcing the recognition of the project in the Australian market.

The programming and scheduling of construction works will take into account local weather patterns, including the 'wet' season. The course is to be staked in the field prior to any preparatory works or any clearing taking place. The site will be cleared of any noxious weeds, prior to commencement of construction and will be kept tidy at all times during construction operations. Some clearing of vegetation will be required, but will be kept to the minimum required to construct the course. All existing trees, shrubs and grasses on the site of the golf course, except that indicated as being removed as part of the development plans, are to be protected during the period of construction.

The general terrain is gently undulating and the course layout is designed to fit with the natural slopes of the land. The design aims to minimise the amount of earthworks. Where earthworks are required a localised cut and fill balance approach will be adopted to minimise the movement of earth around the site. Environmental protection measures including cut-off drains, berms, silt terraces, sediment retention ponds and bunding will be implemented to minimise sediments from entering existing watercourses. To minimise erosion a detailed construction plan will limit the areas of land to be cleared at any time. Earthworks, drainage, irrigation, sand capping and turfing will follow a logical progression so that construction site will be stabilised before moving to open up new areas.

Where possible materials will be sourced on site, however, it is likely that some materials such as sand will need to be imported from the mainland for sand capping of fairways and for tee and green seedbed medium, and for bunkers, along with suitable gravel for course drainage layers.

Construction will utilise a small fleet of scrapers, bull dozers and rippers, loaders and excavators, with skilled operators experienced at working in sensitive environments. Where construction is near particularly sensitive vegetation areas, the smallest machinery practical will be used. Machinery noise will be limited to that allowed by Environmental Guidelines.

The site will be progressively cleaned up and care taken to ensure weeds are not spread to sensitive vegetation areas.

2.8.4.1 Golf course drainage

Well planned and designed drainage will ensure all weather playing conditions. Drainage will include a combination of surface and sub-surface drains. Fairways, greens and tees will require formal herringbone sub-surface drainage. Fairways and green surrounds will be contoured to minimise runoff into sensitive vegetation areas. See also Section 2.7.3 for discussion of stormwater management principles.

2.8.4.2 Grasses

While it is intended to use native species for landscaping of the golf course, there are limited options available for native turf species for fairways and greens, and hence, non-native grasses may be required.

The selection of grasses will take into account the location, topography and climate In playing areas, grasses will be selected that are best adapted to the local environmental conditions to provide the necessary characteristics of playability, yet permit the use of environmentally sustainable maintenance techniques. Grass types requiring minimum irrigation will be selected.

It is most likely that the turf selected will be a hybrid green couch variety as this is well suited to coastal environments and sandy soils, and is hardy. Hybrid green couch is a sterile grass that does not flower or produce seeds. It can spread through sending out runners, although it is unlikely to thrive outside the managed, irrigated areas of the golf course.

Grassing of the course will be completed progressively in order to avoid erosion. Turf sod will be used on steeper slopes such as bunker faces, edges of tees and greens as required, with the more gently sloping greens and fairways either seeded or vegetatively propagated by use of stolons.

Land around the perimeter of the golf course will be monitored for weed invasion including spread of couch grass and other edge effects, as will all interface areas. Areas within the golf course that are landscaped with native species will also be managed for weeds. If the hybrid green couch is identified invading the adjacent native vegetation areas, or native vegetation landscaped areas, weed control will be implemented. However, simply maintaining the edges of fairways is expected to be adequate to prevent invasion of adjacent areas.

The roughs that make up a significant area of the golf course will be maintained in the natural uncleared condition, without irrigation.

2.8.5 *Excavation and Filling*

An estimate of the volumes of excavation and filling required for major infrastructure works is provided in Table 2.41 following.

Table 2.41 – Major Excavation Volumes

Infrastructure	Description of Required Works	Estimated Volume of Earthworks
Road works	Roads will be designed to follow natural land contours to minimise and balance cut - to-fill volumes Total length of roads – approx. 40km	5,000 m^3 per km of road 100,000 m^3 total
Boyne Creek Bridge piers, abutments and approach embankments	Excavation for abutments and piers Compacted fill for approaches Rocky material removed from the causeway.	1000 m^3 15,000 m^3 500 m^3
Stormwater retention basins and lagoons	Excavation of basins and lagoons Compacted fill from basin excavation for berms of lagoons Compacted fill for levelling development sites from excavation of basins	120,000 m^3 3,000 m^3 110, 000 m^3
Golf Course Construction	Cut to fill balance for construction of tees, fairways and greens	20,0000 m^3
Service trenches for water, sewer, power, telecom	Excavation and backfill of trenches Total length – 180km	180,000 m^3
Evaporation Ponds at Desalination Plant	Excavation of basins and lagoons Compacted fill from basin excavation for berms of ponds Compacted fill for levelling development sites	10,000 m^3 1,500 m^3 8,500 m^3
Major building foundations; hotels, commercial centre, treatment plants, etc.	Excavation for foundations and car parks Backfill to foundations Compacted fill for levelling development sites	150,000 m^3 15,000 m^3 135,000 m^3

Earthworks will be undertaken by excavators and scrapers and transported to areas where filling is required for levelling of development sites.

2.8.6 Construction Resources and Materials

Construction materials are proposed to be derived from existing sources located within the local area, such as local aggregate quarries, existing manufacturers and business. Typical construction materials to be sourced for the project will include, but not be limited to:

- Concrete
- Bricks
- Timber
- Steel
- Aggregate
- Glass
- Plastic.

Sourcing of materials for various stages of the proposed project will be at the discretion of the principal contractor awarded each stage of the project. Raw materials for the project will be obtained from local sources and businesses wherever possible.

2.8.7 Construction Workforce

It is estimated that construction will generate an average of 260 direct and indirect jobs per year, and a peak employment of 460 persons. At a State level, the project is estimated to directly and indirectly generate almost 4,700 person years of employment in construction, with an average of 300 jobs per year, and a peak employment of 550 persons.

Construction would create employment opportunities that include skilled and unskilled positions in engineering design, construction supervision and trades, earthmoving, equipment operation, building and landscaping. At a regional level the PTP would provide new opportunities in the building trades for those seeking to leave agricultural activities, particularly in the younger age groups.

The phased nature of the Project would provide the local labour market considerable time to adjust to the opportunities created and to build required skills through established systems (e.g. the apprentice and vocational education systems). Whether the jobs are secured by local residents or by labour from other regions would in part depend on how capable the region is in building the needed skills. Section 17.2.4 provides details on the economic benefits of construction employment opportunities for both the region and the State.

2.8.8 Construction Environmental Management

Construction activities will be undertaken by a range of contractors under the overall supervision of the Proponent. The proponent will set objectives, targets and performance measures for construction activities which will be imposed on all contractors through contract documents such as the Construction Environmental Management Plan (CEMP).

Preliminary objectives of the targets will be reviewed again prior to commencement of works, and throughout works, to ensure that they remain appropriate and reflective of best practice environmental management.

Contractors will then be required to submit environmental management plans specific to activities being undertaken, prior to commencement of works for approval. As a minimum, contractor's environmental management plans will be required to contain the identification of all environmental aspects and impacts of the proposed activities and an assessment of environmental risk associated with the activities. Specific Environmental Control Plans will be required to address all significant risks, and to achieve the objectives and targets established by the Proponent. Environmental Control Plans will include:

- A statement of relevant legislative requirements, including approval and permit requirements;
- A statement of policies, codes and standards applicable to the activity
- Management actions designed to ensure that objectives and targets are achieved
- Responsibility and time frames for all management actions
- Monitoring actions designed to detect non-compliance with objectives and targets, and responsibility and frequency of monitoring
- Corrective actions in the event that monitoring indicates that performance is not meeting targets
- Procedures for dealing with incidents and complaints
- A procedure for identifying and implementing required corrective actions
- Compliance checking/auditing and review of environmental management measures and performance
- Roles and responsibilities in relation to environmental management requirement
- Training and awareness activities to ensure that those with roles and responsibilities in relation to environmental management are appropriately trained and qualified to discharge those responsibilities.

The Proponent will compliance check/audit environmental performance of contractors. Failure to perform to the required standards may result in penalties or termination of contract.

Relevant legislation, policies, standards and codes are also identified; these will need to be reviewed and updated prior to and during construction. Refer to Section 2 for a list of pertinent legislation, policies, standards and codes.

Contractors with ISO14001 certified environmental management systems or demonstrated equivalent systems will be preferred tenderers for all packages of work associated with the proposed development.

2.8.9 Erosion and Sediment Control

A detailed erosion and sediment control plan will need to be developed for each phase of the proposed development. This will be part of the Operational Works development approval and will follow best practice standards as current at the time of the works. Currently, the International Erosion Control Association Australasia's *Best Practice Erosion and Sediment Control Guidelines* (2008) (International Erosion Control Association Australasia) and the *Queensland Urban Drainage Manual* (DERM 2008) are considered best practice for Queensland.

It is expected that, over 16 years or so of development of PTP, there will be ongoing developments in erosion and sediment control practices and in the range of devices and materials available. Hence, it is inappropriate to prepare a detailed erosion and sediment control plan for the proposed Project at this stage, but rather to make this a requirement for each phase of the works. In this way, lessons learned from earlier phases, as well as advances in techniques and technology can be incorporated into each successive stage.

The basic principles of erosion and sediment control are not likely to change and hence, any erosion and sediment control plan developed for PTP will comply with the following general principles:

- Exposure of soils to erosive forces (wind and rain) will be minimised through staged clearing of vegetation and progressive stabilisation and/or rehabilitation of disturbed surfaces
- The time which soils are exposed to erosive forces will be minimised through careful planning of construction activities
- Clearing of vegetation on individual land parcels will not be allowed until immediately before development of that parcel. This will avoid issues arising from the current common Australian practice of clearing vegetation from entire subdivisions at once, regardless of the time frames for house construction
- Erosion control techniques will focus first on avoiding raindrop and wind impact on exposed soils such that the mobilisation of soils is minimised
- Clean stormwater will be diverted around areas of exposed soil. Outlets from stormwater diversion drains/bunds will be stabilised to prevent scouring at the outlet
- If flows are concentrated along a drainage line or pathway, this will be stabilised to prevent scouring

- Runoff water from disturbed areas will be detained to maximise settlement of sediment before release off-site. The type of detention will be selected based on current best practice guidelines
- Permanent stormwater control systems will only be installed prior to earthworks where these are not susceptible to damage from sediment laden runoff during construction. Otherwise, temporary drainage control will be incorporated into the erosion and sediment control plan.

Further discussion on erosion and sediment control during construction is provided in Section 8.5.3.

2.8.10 Construction Waste

Construction waste management will be based on the accepted waste minimisation hierarchy which is based on waste avoidance as the highest priority, and then reuse, recycling, and energy recovery, followed by waste disposal as the least preferred. Construction waste management will also incorporate concepts of construction site waste management from other jurisdictions within Australia and overseas to make use of further construction waste management strategies such as the UK Building Research Establishment (BRE) SMARTWaste program for construction and demolition waste.

Anticipated construction wastes will include:

- Fill and soil (not contaminated)
- Fill and soil (contaminated soil removed from the cattle dip (see also Section 6.3.8 and 8.5.17)
- Timber and vegetation
- Scrap metal
- Cable and wire
- Concrete, bricks, tile and rubble
- Plasterboard offcuts
- Packaging wastes, plastic, glass and timber
- Domestic and general waste
- Organic and food waste
- Wastewater
- Materials contaminated with hydrocarbons
- Leftover paints and other chemicals
- Asbestos cement from existing buildings on HHI.

Any construction waste that cannot be recycled or reused and requires disposal, will be transported to Benaraby Landfill or a similar facility that is authorised.

Construction waste management will be the responsibility of the Principal Contractor at the time of the particular construction activity. The Principal Contractor will be required to prepare a waste management sub-plan as set out in Section 8.2 of Appendix G. In order to meet Queensland government requirements in relation to waste management and avoidance of environmental harm from waste, the construction waste management sub-plan will need to include:

- Strategies to avoid, minimise, reuse and recycle wastes where possible
- A waste monitoring regime that highlights opportunities for waste avoidance, minimisation, reuse and recycling
- Dedicated locations for storing different waste types and the segregation and containment requirements for each type of waste while it is stored at these locations
- Regulatory requirements including regulated waste tracking.

While standards and guidelines may change over the course of the construction program, the following have been identified as relevant:

- Queensland *Waste Reduction and Recycling Act 2011*
- Queensland Waste Reduction and Recycling Strategy 2010-2020 (currently under review)
- Queensland Department of Environment and Heritage Waste Tracking Guideline – Completing waste transport certificates http://www.ehp.qld.gov.au/waste/pdf/completing-wtc.pdf
- Australian Standard AS4123.7 – 2006 Mobile waste containers Part 7: Colours, markings and designation requirements specifies the appropriate bin and/or label colour for the associated waste streams.

Construction personnel will be provided with instructions of waste management during site induction as a requirement of the Construction Waste Management Plan.

Management of stormwater from areas disturbed by construction will be through implementation of erosion and sediment control plans. Erosion and sediment control methods will be based on the most recent applicable guidelines at the time. Currently, the International Erosion Control Association Australasia's *Best Practice Erosion and Sediment Control Guidelines* (2008) and the *Queensland Urban Drainage Manual* (DERM 2008) are considered best practice for Queensland. This is discussed further in Section 8.5.4.

Construction of permanent stormwater control lagoons in the western section of the PTP are likely to require de-watering of groundwater during construction. Collected groundwater will be transferred to sediment control ponds to reduce suspended sediments prior to being discharged back into infiltration trenches or used for site dust suppression/fill moisture control. This is discussed further in Section 8.5.5.

The first stage of the proposed wastewater treatment plant will be installed in the early stages of construction. Once this is in place, wastewater from temporary toilets and amenities will be held in storage tanks and discharged to this treatment plant, or will be removed from the site by authorised contractors responsible for supplying temporary toilets and amenities.

2.8.11 Air Quality

The main air quality impacts during construction activities will arise from dust generation during earthworks and vehicle movement over unsealed surfaces. Further dust generation will occur during phased construction activities when tourists and residents will be on the Island. Dust management strategies will be developed as part of the construction EMP.

Air emissions from heavy plant will be greatest during initial construction of infrastructure. No permanent inhabitants will be in place on the Island during major earthworks activities. Air emissions from heavy plant are not expected to have a significant impact on local or regional air quality, given the relatively low usage expected (and therefore low quantity of emissions) and the generally good daytime dispersion conditions experienced at this coastal location due to consistent south easterly prevailing winds. All construction vehicles will be required to comply with relevant Australian standards and State regulations for vehicle emissions.

2.9 Decommissioning

The proposed PTP does not have a finite life span, and is intended to be an effectively permanent facility. However it is recognised that various aspects of the proposed development will be modified or re-developed as buildings or facilities age. Any modifications or re-developments will be required to comply with:

- Conditions in the Queensland Coordinator-General's Report
- Conditions of approval under the EPBC Act
- The requirements of the Plan of Development
- The GRC MCU and subsequent development approvals
- Other legislative and policy requirements in place at the time.

Infrastructure for the proposed PTP is being designed with a nominal design life of 50 years. In practice, infrastructure will be replaced or upgraded when:

- The design life has been reached and the infrastructure cannot be maintained in a condition to meet the design standards and/or
- Improved technology is available, for example for treatment of stormwater and wastewater.

All construction plant and equipment will be decommissioned on the site and transported from the site via the same route.

2.10 Development Costs

Anticipated development costs for the PTP are anticipated to be $956 Million (at 2013 prices) over the 16 year construction period. A breakdown of anticipated development costs are outlined in Table 2.42.

Table 2.42 - Estimated Development Costs for the PTP.

Cost Item		Cost ($)
Primary Infrastructure	Access Road	
	Boyne Creek Bridge	
	Cross Island Boulevard	
	SUB TOTAL	38,000,000
Internal Civil Works Infrastructure	Internal Roads	
	Drainage	
	Water and Wastewater Reticulation	
	Electricity	
	Gas	
	Telecommunications	
	Land Clearing	
	Landscaping	
	SUB TOTAL	77,000,000
Community Infrastructure		30,000,000
Statutory and Associated Costs		15,000,000
Infrastructure Maintenance Costs		16,000,000
Management costs and Professional Fees		40,000,000
Tourism Infrastructure		560,000,000
Residential Buildings		180,000,000
	TOTAL (Excluding interest)	**956,000,000**

2.11 Operation and Maintenance

2.11.1 Waste Generation and Management

Domestic and general waste will be the largest waste stream generated during operation of the development. Remaining wastes streams generated include recyclable wastes such as paper, cardboard, plastics, glass, metals and organic waste.

Anticipated operational wastes will include:

- Domestic and general waste
- Organic and food waste
- Green waste
- Treated wastewater
- Metals
- Plastics

- Glass
- Paper and cardboard
- Hazardous and other chemicals
- Electrical and electronic equipment (e-waste)
- Sludge from water and wastewater treatment systems.

Management of operational waste will be based on the waste management hierarchy of:

- Waste avoidance/reduction
- Reuse of materials on and off site
- Recycling of materials on and off site
- Waste disposal as the last resort.

Domestic waste management and collection responsibilities will be transferred to GRC following completion of initial stages as part of the gradual hand-over of project responsibilities and waste services will be funded by rate payments. Both the proponent and GRC will utilise waste management contractors for collection of domestic waste. As PTP is located near the major population centre of Gladstone, there are already waste management contractors and associated waste management infrastructure including authorised landfill disposal sites in the region.

Commercial waste management and disposal will be the responsibility of the waste generator, who will engage a licensed recycling/waste contractor to dispose of waste material off-Island. This includes wastes from the golf course as well as hotels and other tourist accommodation, restaurants and retail areas. As PTP is located near Gladstone which is a major population centre and industrial hub, there are a number of waste contractors already operating in the region, and all types of commercial waste that may be generated at PTP will be able to be accommodated by existing waste management services.

Waste management contractors must hold appropriate authorisations under the Queensland EP Act for waste transport, storage, treatment and disposal which provides legislative control over illegal disposal of waste or disposal of waste to unsuitable facilities. The region is currently serviced by the Benaraby landfill.

Solid waste generated during operation of the PTP will be stored in colour coded bins as specified in Australian Standard AS4123.7 – 2006 Mobile waste containers Part 7: Colours, markings and designation requirements. Liquid waste generated during operation of the project will be contained in a suitably designed receptacle constructed to the relevant Australian Standard or building code.

In addition to domestic and commercial waste, a small amount of sludge will be generated from water and wastewater treatment. The quantity is estimated to be about 4 m^3/day, or 1,460m^3/year at full development. The sludge is organic in nature and includes particulate matter that is present in desalination plant feedwater as well as nutrients removed from wastewater during treatment. The sludge is not expected to contain any toxic components such as heavy metals as there will not be any industrial activities at PTP. Wastewater treatment processes will also assist in destroying pathogens that may be in the sludge. As the sludge is organic and nutrient rich, it may have benefit as a soil conditioner for use at the golf course and/or in landscaped areas, subject to laboratory testing of composition and trials. If sludge cannot be reused, it will be removed from the island for reuse or disposal on the mainland. A waste management contractor will be appointed to remove the sludge and, if it cannot be reused, it is expected that it would be disposed of either at an existing wastewater treatment plant or landfill (currently the Gladstone area is serviced by the Benaraby Landfill).

Sludge drying beds or a centrifuge may be used to reduce the water content of the sludge. If a centrifuge is used, this will be a fully enclosed system with no risk of release to the environment. If sludge drying beds are used, these will be designed so that, even in a severe rain event, sludge is not released to the environment.

Around 850 cubic meters a day (850 KL/day) of brine concentrate will be produced when the plant is operating at full capacity. As chemicals are not added, removed or chemically altered in the MVC process, the constituents of the concentrate are identical to that of the feedwater (i.e. seawater from Boyne Channel) but at about twice the concentration. Concentrated brine will be discharged to a series of evaporation ponds on a batch cycle. As each pond is filled, concentrated brine is pumped to the next pond in the sequence for evaporation. These ponds will occasionally require salt to be removed; this may be able to be utilised in commercial salt manufacturing processes active in the region, or can be disposed of at a landfill. Currently, the Gladstone region is serviced by the Benaraby landfill. Concentrated brine will not be discharged to estuarine or marine waters around the Island. The evaporation beds will be designed not to overflow in rain events up to the 1 in 100 year average return interval event. Potential environmental impacts are discussed further in Section 8.5.10.

2.11.2 Airstrip

Operation of the proposed airstrip will be as a private operation for small/light single turbo-prop aircraft only. Night time use will not be provided for. Use of the airstrip will be for private planes, scenic joy flights, or small charter flights (less than 10 persons) bringing visitors to the Island.

Airport Operations Procedures will include an overfly restriction over important roosting sites for migratory birds as shown on Figure 2.1.4. To protect the roosting sites, operating procedures will also require the following:

- aircraft approaching the airstrip for landing from the south must enter the glide path 5 km from the airstrip
- aircraft taking off from the airstrip towards the south must maintain course for a distance of 5km before turning to a new heading.

The proponent will make the operations procedures available to operators of charter flights and joy flights that might use the airstrip and will also discuss with Civil Aviation Safety Authority regarding dissemination of the information.

Operators of commercial tours into the GBRMP/GBRCMP will also require a permit from the Australian and/or Queensland Government.

Further discussion of operation of the airstrip to avoid impacts on migratory shorebirds and other MNES values is provided in Section 8.8.3 and 10.2.4.

Aviation fuel will be stored at the airstrip. Underground tanks will probably be used to reduce risk of collision. The airstrip operator will be required to hold a Development Approval to store fuels under the *Integrated Planning Act 1997/Environmental Protection Act 1994.* Details of design and management of fuel storage will be addressed in the application for this permit.

The fuel storage will comply with:

- Australian Standard 1940 (Storage and Handling of Flammable and Combustible Liquids)
- CP 4 Design installation and Operation of Underground Petroleum Storage Systems.

LEGEND

- Towns
- High Tide Roosting Locations
- Main Roads
- Roads
- Air Strip
- Flight Path
- Flight Restriction Area
- Development Footprint

Wetland Areas

- Palustrine
- Intertidal Estuarine
- Estuarine

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

0 0.5 1 1.5 2 km

1:90,000 on A4

Figure 2.14 - Flight Restriction Area

PACIFICUS TOURISM PROJECT

Path: I:\QENV2\Projects\QE99099\Spatial\ArcGIS\Figures\01_Final_Figures\Chapter_02\Figure2.14_Flight_RestrictionArea_v3.mxd Date: 11/09/2013

2.11.3 Golf Course

Operation of the proposed golf course will be based on current and future best management practices including the AGCSA (2001) Guidelines and e-par®, which is an ISO 14001-based EMS specifically designed for golf courses. To mitigate potential impacts associated with the golf course, the proponent will develop and implement a Golf Course management Plan in accordance with AGCSA Guidelines that will include:

- Integrated Turf Management Plans (ITMPs) as recommended by the Improving the Eco-efficiency of Golf Courses in Queensland (AGCSA & Qld DEHP, 2001)
- Use of recycled water for irrigation of turf using in ground sensors to control application
- Integrated Pest Management Plan in accordance with AGCSA requirements for the wild golf course will required prior to commission
- The aim of the golf course management plans is to ensure zero runoff, and such careful application would also ensure nothing is lost to the substrata.

No runoff will be created from irrigation practices, and so no fertilisers should reach a watercourse at the time of their application. Given the possibility exists that runoff from natural rainfall would re-entrain applied chemicals, the golf course will be designed in order to limit this Any overland flow that does result from rainfall events would be directed towards WSUD devices and then into the large storm water retention basins that will run through the golf course.

Information on key aspects of golf course management is provided here and further discussion on controls to avoid and minimise environmental impacts is provided in Section 8.5.7 (nutrients) and Section 8.5.12 (pesticides).

2.11.3.1 Fertiliser and Chemical Application

Best management practice will be used, with all fertiliser applications determined by regular soil analysis as required by the AGSCA Guidelines. Care will be taken to minimise the application of fertilisers and nutrients to areas of indigenous planting.

The development of a Golf Course/Turf Management Plan in line with the AGCSA (2001) will incorporate management principles such as:

- The use of in ground sensors and regular soils analysis to assess soil moisture and nutrients to manage recycled water application rates
- Management of fertiliser use, limiting fertiliser applications, use of slow release natural organic fertilisers, application of fertiliser during forecast dry weather only
- Management of the course as a “wild” course retaining and utilising native vegetation to the maximum extent, minimising the area of managed turf and limiting recycled water application to that available
- Design of the course to include bioretention basins to “process” stormwater residual nutrient loads prior to release to existing drainage lines and ephemeral watercourses.

Incorporation of the above management principles together with developing practices on similar courses within the GBRWHA will control potential nutrient inputs at the source and provide in stream treatment/mitigation measures to ensure that receiving water WQO are achieved and potential impacts to identified EVs minimised.

2.11.3.2 Chemical Application Management

Best management practices will be adopted and care taken with pesticides and chemicals including their appropriate storage, safe use and disposal, all to be carried out in accordance with the manufacturers recommendations and statutory regulations including conformance with applicable Australian Standards. Pesticide operators will be required to be familiar with the toxicity and hazard rating of pesticides with Material Safety Data Sheets (MSDS) kept in the maintenance shed for all the chemicals used.

Management of pesticide application within the PTP and particularly associated with golf course maintenance will be through the development of an Integrated Pest Management Plans (IPMP) as recommended by the Improving the Eco-efficiency of Golf Courses in Queensland (AGCSA, 2001). Components of the IPMP can include:

- Understanding course conditions and characteristics
- Surveying pest species on the course
- Defining pest management intervention thresholds
- Development of a monitoring and record keeping program
- Development and implementation of pest control strategies.

The pest management hierarchy under the IPMP includes non-chemical cultural methods as a preference followed by non-cultural methods utilising pesticides or biological control agents as a second tier management strategy. Cultural management strategies that control weeds without chemical use include:

- Selection of disease resistant turf specie
- Selection of low water requirement turf species
- Turf management through:
    - Soil aeration
    - Thatch control
    - Irrigation management
    - Increased mowing height
    - Minimal and appropriate use of organic fertiliser supplements
- Development of a pest monitoring plan
- Removal of low density pests/weeds by hand.

Non-cultural methods will be triggered at a certain pest threshold and will use pesticides or biological controls. Pesticides will be used based on the following principles:

- Review of the location where the chemical will be used and proximity of any drainage, bioretention/stormwater structures and ephemeral watercourses
- Selection of the lowest toxicity chemical that will be effective for the intended purpose (preferably compounds that biodegrade rapidly to non-toxic products)
- Consideration of soil and thatch conditions within the area to be used
- Review of weather conditions (no application if rain is forecast for 48 hrs).
- An application hierarchy of:
  - Direct (to leaf) application
  - Spot spraying
  - Treatment of the diseased area only
  - Strictly controlled broader spraying if necessary.

As discussed in Section 8.5.7 and 8.5.12, a monitoring program will be implemented to test soils and surface water and groundwater for pesticides and nutrients. Corrective actions have been identified where trigger levels are reached.

Use of such hierarchy and management options will minimise the use of chemicals within the PTP and minimise potential impacts to ephemeral watercourse and groundwater EVs, downstream waters such as dams, estuaries and the coast.

2.11.3.3 Irrigation System

The design and management of the irrigation system for fairways and greens will protect the soil profile and water table and control the spread of non-indigenous turf grasses. Directional sprinklers and dual irrigation lines on all fairways will be used to ensure uniform distribution and avoid over watered areas. Valve-in-head sprinklers will provide optimum control. All sprinklers and control valves will be shall be pressure regulated to prevent sprinkler operating pressure variations.

The system will be operated by a central computer in conjunction with field and in-ground decoders. Irrigation schedules will be controlled by on-site weather stations. Provision will be made for soil moisture and nutrient monitoring sensors around the course that will monitor root zone moisture and nutrient movement through the soil profile. The sensors will be connected to central computer to assist the system operator to make decisions regarding watering frequency and fertiliser application periods. Wind sensors may be installed to control watering during periods of undesirable wind speed and direction. Data from the weather station will be used to automatically adjust the pre-set daily watering times to match the daily evapotranspiration rates for the site. Off peak night time irrigation will lower pumping costs and apply water at optimum times to combat wind and evaporation effects.

Irrigation pumping stations will be equipped with variable speed pumps designed to meet peak season demands. The pumping stations will require 415 volt 3-phase supply.

Irrigation water for the golf course will be from both stormwater and recycled treated greywater from the STP. Greywater will be treated to A+ standard with phosphorous levels averaging 0.5 mg/L and not exceeding 1.0mg/L. The treated effluent will be piped to storage dams around the course. The course will require an average irrigation requirement in the order of 100 to 125 ML per year with peak demands in summer of approximately 1.25 to 1.5 ML per day. Storage dams will be lined and collectively have a storable capacity of 20 ML, equivalent to two weeks peak demand storage.

Warning signs will be provided around the course to inform that recycled waste water is being used for irrigation.

2.11.4 Management of Infrastructure and Services

A build, transfer, operate system is proposed for infrastructure and services required for the proposed PTP. Infrastructure and services required for the PTP will be installed by the developer at the developer's cost. This will include both internal and external infrastructure. The Proponent will transfer the completed public infrastructure to the GRC. Public infrastructure will include:

- All internal roads, paths, cycleways
- Access Bridge across Boyne Creek
- Boat ramps, car/trailer parking and access roads
- All water and wastewater reticulation systems
- All water and wastewater treatment systems
- All stormwater management systems
- Waste transfer stations and residential collection systems
- All parkland and public open space.

The proponent proposes to enter into an operation and maintenance agreement with the GRC to maintain and operate the infrastructure for a period of years to be agreed and until such operation and maintenance costs can be covered by income from rates applied to the developed land. The agreement will allow the proponent to recover a proportion of the operation and maintenance costs from rates collected by GRC during the period of this agreement. The proponent will provide a training program for GRC staff before transfer of operation and maintenance responsibilities to the GRC.

Installation of electrical power and gas will be by relevant authorities at the developer's cost. Operation will then be undertaken by the relevant authority. Costs of operation and maintenance will be through supply tariffs. This same arrangement is used for all developments of this type in Queensland.

2.11.5 Controls for Private Sector Activities

The Plan of Development provides a key control for private sector activities. The role of the Plan of Development in regulating development of PTP and ensuring that the various standards and requirements set out in this EIS are achieve with regard to buildings and services is described in Section 2.5. The Plan of Development will be reviewed if and when an approval under the EPBC Act is obtained to ensure that all relevant requirements are incorporated into the Plan of Development. It will then be incorporated into the Gladstone Planning Scheme through a Material Change of Use process.

The Gladstone Planning Scheme which is a statutory instrument under the Queensland *Sustainable Planning Act 2009*. Once incorporated, changes to the Plan of Development can also only occur through statutory processes established under this Act.

Individual components of PTP will also require various approvals under Queensland government legislation. These approvals are explained in Section 3. Such approvals are issued with conditions and there are penalties under all relevant legislation for non-compliance.

Restrictions on clearing and protection of vegetation on individual lots within the development boundary will be through:

- Development Conditions attached to the Material Change of Use Conditions from Gladstone Regional Council
- Approval conditions for clearing of assessable vegetation under the Queensland Sustainable Planning Act 2009
- the Statutory Plan of Development for the Project that will become an integral part of the Gladstone Regional Council's Regional Plan
- a registered covenant that sits on the title of each developed lot that can only be removed with approval of Gladstone Regional Council.

2.11.6 Management of Conservation Features

The continental islands in the Mackay-Capricorn Region of the GBRWHA are largely unprotected in the conservation estate. The current tenure on Hummock Hill Island does not provide any level of protection for terrestrial ecological values. The Proponent has negotiated with the Queensland government and the Gladstone Regional Council the following agreements:

- The undeveloped areas of Hummock Hill Island will be converted into a conservation area with suitable tenure under the *Queensland Nature Conservation Act 1992*
- the protected area will be maintained, protected and enhanced through a management contract, for the duration of the development period , between the Proponent and an appropriate environmental management company that will also manage the offsets required under QLD vegetation management legislation . The cost of this management is estimated at $250,000 per annum

- the Gladstone Regional Council will have responsibility for continuing management of the protected area after expiration of the development period and will introduce a Special Area Levy on the land owners and businesses on the island to meet the costs of ongoing management
- visitor and community awareness programs will be developed for presentation and preservation of the GBRWHA values (terrestrial and marine)
- a study of terrestrial world heritage values in the Mackay-Capricorn Region will be undertaken to identify processes threatening terrestrial WHA values and develop management priorities
- vegetation offsets outside the WHA will be acquired to directly offset the regional ecosystems impacted by the development. The proposed offsets have significant benefits to protecting the values of the WHA
- a local / based landcare group funded by the proponent will be established
- Weed, fire and pest management will be incorporated into the Conservation Area management plan
- The protected areas will be fenced and subject to access restrictions, including bollards to prevent access by vehicles. Walking trails and signage will be provided through the protected areas to control impacts
- Perimeters of the development areas will be fenced with 3 strand wire sheep fences to minimise vehicle access to the undisturbed areas of the island.

Further information on the management of the conservation area is provided in Section 8.3.8.

2.11.7 Annual Operating Costs

Annual operating costs for management of infrastructure will be covered by normal GRC rates. Costs for maintaining the undisturbed natural areas of the Island remaining outside the PTP are proposed to be covered by a Special Area Levy charged to all businesses and residences and included in Council charges and rates. Costs for drinking water are expected to be higher than typically experienced in urban areas but offset by the ability to supplement with rainwater and recycled water, such that, with good water management at the household level, households may pay significantly less for water supply than comparable properties in urban centres. Costs for electricity and gas will be comparable with those experienced in urban centres in Central Queensland.

SECTION 3
Approval Requirements

Contents

3. Approval Requirements

3.1 Approvals Process

The development has previously undergone extensive environmental assessment. On 17 November 2006, the Project was declared a 'significant project[1] for which an environmental impact statement (EIS) is required' pursuant to section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act). On 13th January 2006, the project was also declared a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Eaton Place prepared an EIS under the bi-lateral agreement between the Queensland and Australian Governments. The Proponent conducted a public information and consultation program throughout the EIS process including face-to-face meetings with 'affected' and 'interested' parties, newsletter / fact sheets, online information and feedback tools, free call 1800 number and reply paid mail service, as well as public displays and meetings. Following these extensive consultations with the public and all levels of government the proposed development was approved by the Queensland Coordinator-General under the SDPWOA with conditions acceptable to all Queensland Government departments and the Gladstone Regional Council.

The Coordinator-General's Report was sent to the Commonwealth Government Minister for Sustainability, Environment, Water, Population and Communities in February 2011. This report is available at http://www.dsdip.qld.gov.au/assessments-and-approvals/hummock-hill-island-development.html.

On 7 June 2011 the Minister informed Eaton Place that he intended to not approve the proposal as, based on advice received from his Department, the proposal would have "unacceptable impacts" on the Great Barrier Reef world heritage property, listed threatened species and communities and listed migratory species. Eaton Place consequently withdrew the referral to reconsider the development proposal.

At subsequent meetings the Australian Government Minister advised Eaton Place to work with staff from the then SEWPaC to formulate a development proposal that would minimise impacts on MNES such that they could be mitigated and offset to an acceptable level. Between August 2011 and November 2011 Eaton Place consulted with the then SEWPaC to resolve these matters and prepare a new development plan that specifically addressed each one of SEWPaC and the Minister's concerns and to ensure a proper and considered account of the values of the GBRWHA.

This EIS addresses the new development proposal and approvals required from Commonwealth, State and Local Governments.

[1] In December 2012, amendments to the SDPWO Act included a change in terminology from significant project to coordinated project

3.2 Approvals under Commonwealth Legislation

3.2.1 Environmental Protection and Biodiversity Conservation Act 1999

The EPBC Act seeks to protect MNES, being those matters that the Australian Government is obligated to protect under international treaties, and other matters which the Australian Government may regulate under the Australian Constitution. MNES which are covered by the EPBC Act are:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- RAMSAR wetlands of international importance
- The Commonwealth marine environment
- The Great Barrier Reef Marine Park
- World Heritage properties
- National Heritage places
- Water resources, in relation to coal seam gas development and large coal mining development
- Nuclear actions, including uranium mines.

The PTP project was referred under the EPBC Act (2012/6643) and was designated a “Controlled Action” on 14th December 2012 with the controlling provisions being:

- Sections 12 and 15A - World Heritage properties
- Sections 5B and 15C National Heritage places
- Sections 18 and 18A - Listed threatened species and communities
- Sections 20 and 20A - Listed migratory species
- Sections 24B and 24C – Great Barrier Reef Marine Park.

The referral decision required that the Project be assessed by an EIS. On completion of the assessment the Australian Government Minister for Environment will decide if the Project can proceed and, if it proceeds, any development conditions that should apply.

3.2.2 Great Barrier Reef Marine Park Act 1975

The *Great Barrier Reef Marine Park Act 1975* establishes the Commonwealth GBRMP and the management framework for the marine park. The Great Barrier Reef Marine Park Authority (GBRMPA) is the managing agency for the GBRMP.

The GBRMP lies offshore from the ocean side of HHI, with the boundary at low water mark along the northern coastline.

PTP does not impact directly on the GBRMP and there are no planned discharges to the GBRMP. Hence formal approvals are not required under this Act. Due to the proximity of the development to the GBRMP, GBRMPA will provide advice to Department of the Environment (DotE) during its assessment of the proposed development under the EPBC Act.

3.2.3 Aboriginal and Torres Strait Islander Heritage Protection Act 1984

This Act is intended to cover cultural heritage protection in situations not covered under the State legislation. However a Cultural Heritage Management Plan has been agreed with the island's Traditional Owners and is registered with the Queensland Department of Aboriginal and Torres Strait Islander and Multicultural Affairs (DATSIMA).

3.2.4 Native Title Act 1993

The *Native Title Act 1993* recognises the rights and interests over land and water by Australia's Indigenous people under their laws and customs

Native title has been extinguished on all land on the island impacted by the development. Where public infrastructure crosses land subject to native title (access road, bridge, boat ramp), native title will be suppressed under the *Native Title Act 1993*.

3.3 Approvals under Queensland Legislation

3.3.1 State Development and Public Works Organisation Act 1971

Among other things, the SDPWO Act includes a process for declaration of coordinated projects (formerly significant projects) and subsequent assessment of potential environmental impacts through preparation of an Environmental Impact Statement (EIS). The process requires the EIS to be released for public comment and supplementary information to be provided in response to any comments received from the public or government agencies. The Queensland Coordinator-General then considers the project, its potential impacts, submissions on the EIS and the proponent's responses to determine whether the project should proceed. If it is determined that the project should proceed, the process culminates in the issue of a Coordinator-General's report which contains a range of conditions.

The Coordinator-General's report provides the overarching approval for the Project under Queensland legislation. The Coordinator-General's assessment and conditions also become a Concurrence Agency response under the *Sustainable Planning Act 2009* for the material change of use development application to Gladstone Regional Council.

The Queensland Government under the SDPWO Act approved, in February 2011, a similar Project to that currently proposed in this EIS. The changes included within this proposal reflect discussions held with DotE and have also been discussed with the Queensland Department of State Development, Infrastructure and Planning which administers the coordinated/significant project process. If the project, the subject of this EIS, is approved by the Australian Government Minister for the Environment, the Proponent will make an application to the Queensland Coordinator-General, under Part 4, Division 3 of the SDPWOA, to change the previously approved project, providing details of:

- The proposed change and its effects on the project
- The reasons for the proposed change.

If these changes are acceptable, the Coordinator-General will then prepare a Change Report re-evaluating the impacts of the changes to the Project and imposing additional or amended conditions and recommendations where necessary.

3.3.2 Integrated Planning Act 1997 and Sustainable Planning Act 2009

The *Integrated Planning Act 1997* was the primary statutory legislation defining the framework for planning and development assessment in Queensland. The Act established the Integrated Development Assessment System which links with other related environmental and natural resource management legislation and incorporates the assessment of development proposals against that legislation.

The *Sustainable Planning Act 2009* which replaced the *Integrated Planning Act 1997* in December 2009 now forms the foundation of Queensland's planning and development assessment legislation. The purpose of this Act is to seek to achieve ecological sustainability by:

- Coordinating and integrating planning at the local, regional and state levels
- Managing the process by which development occurs
- Managing the effects of development on the environment.

Development applications lodged prior to 18 December 2009 are still assessed under the *Integrated Planning Act 1997* and applications lodged on or after 18 December 2009 are assessed under the *Sustainable Planning Act 2009*.

The Coordinator-General's Report allows the Project to proceed but development cannot commence until development approvals are obtained. The Coordinator-General's Report is the concurrence agency response for subsequent development applications and any approvals must abide by the recommendations and conditions of the Coordinator-General's Report.

The SP Act (Section 242) enables an applicant to seek a preliminary approval overriding an existing Local Government planning scheme if the application involves a Material Change of Use of the current land and if the change is impact assessable development. The application process and the status of the current application are detailed further in Section 3.4.

The SP Act establishes an integrated development assessment system (IDAS) which provides assessment requirements approvals processes for approvals under the following legislation:

- *Environmental Protection Act 1994*

- *Vegetation Management Act 1999*
- *Water Act 2000 (certain approvals)*
- *Coastal Protection and Management Act 1995*
- *Fisheries Act 1994.*

Each of these is addressed in the following sections of this chapter.

3.3.3 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) provides for the protection of Queensland's environment and amenity, particularly with regard to air quality, the noise environment and acoustic amenity, water quality, contaminated land and waste management.

Among other things, the EP Act sets requirements for certain activities to hold environmental authorisation, these being Environmentally Relevant Activities (ERAs). Approval to operate an ERA is obtained through a development permit and environmental authority under the *Sustainable Planning Act 2009*.

Requirements for an environmental authority depend both on the activity to be conducted and the capacity or other threshold of the equipment to be used in conducting the activity. It is likely that the Project will require environmental authorities for the following ERAs:

- ERA 6 – Asphalt manufacturing. It is expected that construction contractors will already hold authorisation for this ERA for their asphalt manufacturing equipment
- ERA 8 – Chemical storage – may be required if fuel storage facilities have capacity in excess of 500 m^3. Note that it is likely that fuel storages will not exceed this threshold. If required, the development permit and environmental authority for this ERA would be held by the individual or organisation operating the fuel storage facility.
- ERA 63 – Sewage treatment and ERA 64 – water treatment – will be required in relation to the desalination plant and water recycling system proposed for PTP. The development permit and environmental authority for this ERA will initially be held by the proponent and then transferred to GRC once operation and maintenance of the system is handed over.

Operators of ERAs must also be registered as suitable operators under the EP Act.

In addition to development approval requirements, Sections 319 and 320 of the EP Act establish a duty of care to all individuals and organisations to protect the environment (the General Environmental Duty). Therefore, it is not permissible to cause environmental harm (as defined in the Act) whilst undertaking any activity unless all reasonable and practicable means are taken to avoid that harm.

3.3.4 *Vegetation Management Act 1999*

This *Vegetation Management Act 1999* (VM Act) regulates the clearing of vegetation in a way that:

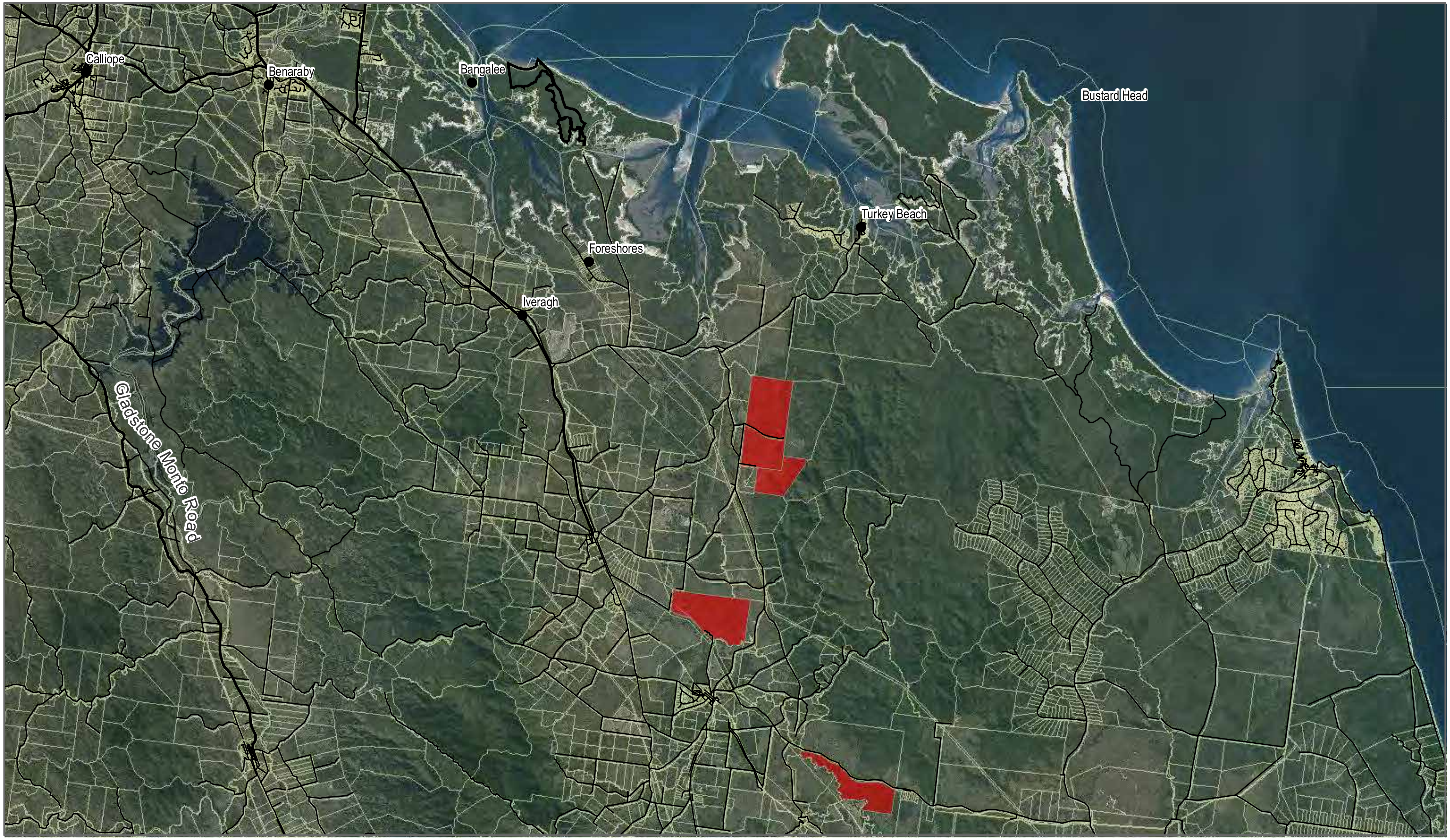
- Conserves vegetation in declared areas
- Ensures the clearing does not cause land degradation
- Prevents the loss of biodiversity
- Maintains ecological processes
- Manages the environmental effects of the clearing
- Achieves reduction in greenhouse gas emissions.

Clearing of native vegetation made assessable under the VM Act is assessable development under the SP Act. A Development Permit for Operational Works will therefore be required for PTP as the Project will impact on regional ecosystems prescribed under the VM Act. Remnant vegetation including “endangered”, “of concern” and “not of concern” regional ecosystems (REs) occurs within the project area, however the development has been planned to avoid clearing of “endangered” vegetation except where absolutely necessary for infrastructure provision. However clearing of “of concern” and “least concern” REs will be required.

The Proponent is committed to the provision of vegetation offsets and has already reached agreement with the Queensland Government on the extent and location of offsets for the previous development proposal. These will be re-negotiated with Department of Environment and Heritage Protection (DEHP) after receiving the Coordinator-General’s Change Report. The offsets will be located on the Island, within the Special Lease held by the Proponent and on a number of properties on the mainland. Offset locations are shown in Figure 3.1.

The proposed vegetation offsets will:

- Protect areas of habitat which are otherwise unprotected from clearing at some future point
- Maintain ecological processes at the sub-regional level
- Support areas of vegetation of equal or higher conservation status than the area to be cleared
- Be of ecological equivalence to the area cleared
- Be managed for conservation purposes in the long term and will be legally secured.



LEGEND

- Towns
- Main Roads
- Roads
- Cadastre
- Offset Lots

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

Figure 3.1 – Queensland Vegetation Management Act Offset Locations

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3.3.5 *Nature Conservation Act 1992*

The *Nature Conservation Act 1992* (NC Act) is intended to conserve biological diversity, ecologically sustainable use of wildlife and ecologically sustainable development. The Act promotes the criteria developed by the World Conservation Union (International Union for the Conservation of Nature and Natural Resources) for establishing and managing Protected Areas as well as declaring plants and animals to be vulnerable, or endangered.

Ecological surveys undertaken to date have identified a limited number of species listed under the Act, identifying several bird species listed under the *Nature Conservation Act 1992* as being present on the site (refer to Section 6.7). No flora species listed as endangered or vulnerable have been identified on the project site or on HHI generally.

The *Nature Conservation Act 1992* requires permits to be obtained for taking of protected plants, handling and relocation of protected animals and disturbance of an animal breeding place. Permits are not required for clearing of least concern native plants where a permit to clear vegetation assessable under the VM Act is in place. Surveys to date have not identified the need for clearing of listed threatened plants, relocation of native animals, or interference with an animal breeding place, however ongoing surveillance through pre-clearing surveys is proposed.

3.3.6 *Water Act 2000*

The *Water Act 2000* (Water Act) provides a legislative basis for the sustainable planning and management of the State's non-tidal water resources. The *Water Act 2000* identifies that most water related developments or developments affecting water supply and freshwater streams require assessment and approval under the *Sustainable Planning Act 2009*. Such works include:

- Works that take or interfere with water in a watercourse, lake or spring (e.g. pump, gravity diversion, stream redirection, weir or dam)
- Artesian bores
- Sub-artesian bores.

Schedule 3, part 1, table 4, item 3 of the *Sustainable Planning Regulation 2009* specifies that operational work for the purposes of taking or interfering with water under the *Water Act 2000* is assessable development. However, as there is no intention to extract water from aquifers or surface waters, these approvals will not be required. It is also not intended to divert or impound watercourses. Additionally, the proponent does not seek an allocation from the Awoonga Dam, but will be purchasing water supply from an existing entitlement.

The Water Act also requires a riverine protection permit to be issued for disturbance of the bed and banks of a watercourse. It has not been established whether ephemeral streams on HHI classify as watercourses under the Water Act, but if this is the case, crossings of these watercourses by roads or other infrastructure will require a riverine protection permit. In addition, approval may also be required for the mainland water supply pipeline alignments may include crossings of freshwater streams.

3.3.7 *Coastal Protection and Management Act 1995*

The objective of the *Coastal Protection and Management Act 1995* is to provide for the protection, conservation, rehabilitation and management of the coastal areas including resources and biological diversity.

Under the provisions of Schedule 3 of the *Sustainable Planning Regulation 2009*, the proposed bridge and boat ramp will require a development approval in respect of the undertaking of works in a tidal zone or coastal management district. A development permit will also be required if the middle section of the Boyne Creek causeway is to be removed.

3.3.8 *Fisheries Act 1994*

The *Fisheries Act 1994* regulates fisheries resources and fish habitats, and in relation to the project, controls removal of marine plants and works in or adjacent to a Fish Habitat Area. Schedule 3 of the SP Regulation makes removal of marine plants assessable development and hence an operational works approval will be required for removal of the small area of mangroves and saltmarsh associated with the bridge and boat ramp in Boyne Creek.

It should be noted that there is an existing exclusion area in the Colosseum Fish Habitat Area extending 100 m either side of the existing causeway. This will mean that a development approval for operational works in a Fish Habitat Area will not be required for the bridge and Boyne Channel boat ramp, or for removal of the existing causeway. However, applications for development permits in respect of tidal works within 100 m of a Fish Habitat Area must be referred to the Department of Agriculture, Fisheries and Forestry as an advice agency.

3.3.9 *Transport Infrastructure Act 1994*

The *Transport Infrastructure Act 1994* provides for the management of the national and state road network and rail network. A permit under this Act is required to work in, or interfere with, a state-controlled road or railway.

It is a requirement of the Special Lease that necessary road upgrades be provided by the proponent, including upgrades to the Bruce Highway intersection with Turkey Beach Road.

Referral of the Preliminary Approval development application lodged with Gladstone Regional Council to the Department of Transport and Main Roads is required under the *Transport Infrastructure Act 1994*.

3.3.10 *Aboriginal Cultural Heritage Act 2003*

This Act provides recognition, protection and conservation of Aboriginal cultural heritage. In accordance with this Act, the project's effects on Aboriginal cultural heritage are being managed through the development of a Cultural Heritage Management Plan (CHMP) (refer to section 6.10). The CHMP was formally notified to the Port Curtis Coral Coast (QC 01/29 [Q 6026/01]) native title claimant group through their applicants.

The *Aboriginal Cultural Heritage Act 2003* establishes duty of care guidelines to ensure all reasonable and practical measures are taken to ensure that (an) activity does not harm [remove or possess] Aboriginal Cultural Heritage. The Act establishes a framework for the assessment of potential impacts on cultural heritage and processes to be undertaken in preparing CHMPs.

The *Aboriginal Cultural Heritage Act 2003* establishes a risk management assessment based on many factors including nature of activity and likelihood of causing harm, extent of consultation, searches of database/register, extent of any survey, nature/extent of past use of area, nature of cultural heritage likely to be harmed and compliance with duty of care guidelines.

The *Aboriginal Cultural Heritage Act 2003* does not require any formal approvals to be obtained. Instead, it makes it an offence to harm any item of Aboriginal cultural heritage significance unless such harm takes place in accordance with an agreed CHMP. The content of a CHMP must be agreed between the Proponent and the Traditional Owners of the affected lands. The Act and the associated Duty of Care guidelines set out processes by which Traditional Owners can be involved in a process of negotiating a CHMP.

Demonstrated compliance with the Duty of Care guidelines is a defence against prosecution for harming items of Aboriginal Cultural Heritage material.

The actual investigation and management requirements as set out by the duty of care guidelines are basically a function of level of both existing and proposed disturbance of the subject site. Hummock Hill Island is largely undisturbed in an archaeological context, and the site is therefore a Category 5 in the Duty of Care Guidelines. Satisfaction of the Duty of Care requires a CHMP to be negotiated and adhered to for all development related activities on the site.

The Guidelines also require a CHMP for any Project where an EIS is required.

A registered CHMP is in place for the development.

Note that requirements of the *Aboriginal Cultural Heritage Act 2003* do not constitute approval in relation to SPA and the CHMP negotiation process can be undertaken independently of Development Approvals.

3.3.11 Land Act 1994

The *Land Act 1994* regulates the opening and closing of State and local roads and land dealings relating to changes in land tenure. The primary focus of the *Land Act 1994* is the development of the State.

The *Land Act 1994* provides that special conditions can be placed on an offer of freehold or a freeholding lease. The Current Special Lease contains conditions of freeholding and includes the following:

- Obtaining all necessary development approvals from the appropriate authorities for development proposals envisaged in respect of the lease land
- Progressively developing the leased land for subdivision for business, residential, tourist or recreation purposes.

In developing the leased land, the lessee is required to, amongst other things:

- Fill the land where necessary after making adequate protection against storm surge
- Provide adequate stormwater drainage
- Upgrade road access
- Pay headworks contributions for water supply and sewerage
- Provide other services (electricity, telephone service)
- Set aside and development land for community facilities (high school, public hospital, public building) and park and recreation spaces.

In certain circumstances, depending upon the outcome of the native title assessment, the applicant (as a condition of the letter of offer) may be required to satisfactorily address native title issues for the conversion of tenure. Native title on Lot 3 FD841442 (the Special Lease area) has been extinguished.

The Queensland Government, in granting the Special Lease (SL 19/52155) in 1991, decided the site was suitable and desirable for a range of *"Business, Industrial, Commercial, Residential, Tourism and Recreation"* purposes. This decision has been reflected in approval of a previous application for a residential and tourist development by Miriam Vale Shire Council in 1996.

The long-established land use intention for the leased area is for a tourism and residential development. Indeed, there is an obligation, under the conditions of the lease, for the lessee to develop the leased land promptly and make payments to the Queensland Government for the revenue generated from sales.

3.3.12 Marine Parks Act 2004

The object of the *Marin Parks Act 2004* (MP Act) is to provide for the conservation of the marine environment. The Act establishes marine parks, including the Great Barrier Reef Coastal Marine Park (GBRCMP), The GBRCMP includes the enclosed waters of Colosseum Inlet, Boyne Creek and Seven Mile Creek to the high water mark of HHI, as well as the section between high water mark and low water mark along the northern edge of HHI (see also Figure 1.4).

A bridge and boat ramp is proposed to be constructed in Boyne Creek and Colosseum Inlet which would require placement of structures in the GBRCMP and hence these structures would require a permit under the MP Act.

An emergency sewage outlet is proposed for disposal of treated effluent when flows are greater than three times average dry weather flow typically when severe weather conditions preclude land irrigation. This outflow will discharge to an ephemeral creek that flows to the main channel of Colosseum Inlet. This would require a Marine Parks Permit

For works in a State Marine Park, the permit approval process is administered by the Department of National Parks, Recreation, Sport and Racing (NPRSR) and is usually done in parallel with the application for tidal works.

3.3.13 State Planning Policies

Provisions of the *Sustainable Planning Act 2009* enable the State Government to prepare and adopt State Planning Policies (SPP). The policies have effect throughout the State, except where specified, and set out the State Government's position on planning and development matters of State significance. The policies have effect throughout the State, except where specified, and set out the State Government's position on planning and development matters of state significance.

SPPs apply to assessable development and must be considered during the assessment of any relevant development applications lodged under Integrated Development Assessment System. In addition, the provisions of the *Sustainable Planning Act 2009* require that SPPs are incorporated into local government planning schemes.

State Planning Policies relevant to the project are:

- State Planning Policy 1/92 – Development and the Conservation of Agricultural Land
- State Planning Policy 2/02 – Planning and Managing Development Involving Acid Sulfate Soils
- State Planning Policy 1/03 – Mitigating the Adverse Impacts of Flood, Bushfire and Landslide
- State Planning Policy 4/10 – Healthy Waters
- State Planning Policy 4/11 - Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments
- Temporary State Planning Policy 2/12 – Planning for Prosperity
- Draft Coastal Protection State Planning Regulatory Provision.

On 15 April 2013 the State Government release the Draft State Planning Policy for public comment. The Draft SPP will, when adopted, replace all current SPPs.

3.3.13.1 State Planning Policy 1/92 Development and the Conservation of Agricultural Land

State Planning Policy 1/92 sets out the broad principles for the protection of good quality agricultural land from inappropriate development. The project has been assessed in accordance with the guideline relating to this policy. The site has been classified broadly as non-agricultural land (steep slopes of Hummock Hill, sand dunes and mudflat and mangrove areas) and pasture land of very low to low fertility (gently sloping plains and foot slopes of HHI) and as such, it is not good quality agricultural land. On that basis, the proposal would not result in the loss of good quality agricultural land and would not compromise the State's interests under this policy. The policy is expected to be replaced in 2013.

3.3.13.2 State Planning Policy 2/02 Planning and Managing Development Involving Acid Sulfate Soils

State Planning Policy 2/02 sets out the State's interests in managing acid sulfate soils in low-lying coastal areas. The policy applies to development involving filling or excavation above defined thresholds and areas at or below 5 m AHD where the natural ground level is less than 20 metres AHD. It is supported by 'Guidelines for SPP2/02: Planning and Managing Development involving Acid Sulfate Soils' which provides information and advice on interpreting and implementing SPP2/02 in development assessment. Potential acid sulfate soil has been identified in the vicinity of the proposed boat ramp in Boyne Creek. Potential acid sulfate soils and acid sulfate soils would be managed in accordance with an Acid Sulfate Soil Management Plan in order to achieve the development outcomes of the SPP and not compromise the State's interest.

3.3.13.3 State Planning Policy 1/03 Mitigating the Adverse Effects of Flood, Bushfire and Landslide

State Planning Policy 1/03 aims to minimise the potential adverse impacts of flood, bushfire and landslide on people, property, economic activity and the environment. It is supported by 'Guideline for SPP 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide' which provides information and advice on interpreting and implementing SPP 1/03 in development assessment and when making and amending planning schemes. This SPP sets out development outcomes that must be considered when assessing development. The outcomes relevant to the project are:

Outcome 1: Within the natural hazard management areas, development to which this SPP applies is compatible with the nature of the natural hazard, except where:

- The development proposal is a development commitment; or
- There is an overriding need for the development in the public interest and no other site is suitable and reasonably available for the proposal.

Outcome 2: Development that is not compatible with the nature of the natural hazard but is otherwise consistent with Outcome 1 is minimised as far as practicable from adverse impacts from natural hazards, and does not result in an unacceptable risk to people or property.

The development has been located and designed to minimise adverse impacts from natural hazards in accordance with the objectives of this SPP.

3.3.13.4 State Planning Policy 4/10 Healthy Waters

The State Planning Policy 4/10 Healthy Waters took effect on 2 May 2011 with the purpose being to ensure that development is planned, designed, constructed and operated to manage stormwater and waste water in ways that help protect the water environmental values specified in the *Environmental Protection (Water) Policy 2009*. The SPP is supported by a guideline.

The SPP is applicable to the project as it applies to:

- Stormwater management and management or new or expanded non-tidal artificial waterways associated with urban purposes
- Waste water management associated with industrial or commercial development.

The provisions of the development assessment code (Appendix 1 of the SPP) and the Project response are addressed in Table 3.1.

Table 3.1 - SPP 4/10 Performance Outcomes

Performance Outcome	Response
Part A – Urban Stormwater Management	
Performance outcome PO1 The development is compatible with the land use constraints of the site for achieving storm water design objectives.	The project is planned to proceed in an environmentally sensitive manner, considering the principles of sustainable development. As such, a number of water cycle design objectives including maximising site based water management including roof catchment collection and reuse of greywater. A Feasibility Strategy has been prepared for the PTP by Cardno (2013) (Appendix D1) and incorporates elements of water conservation, recycling and water sensitive urban design.
Performance outcome PO2 The entry of contaminants into, and transport of contaminants, in stormwater is avoided or minimised	During construction of the bridge, a small amount of excavation will be required for bridge pylons. Excavation is not expected to be required for the boat ramp or for the desalination plant intake, which will be attached to the bridge. The preparation of an acid sulfate soil management plan is required as a condition of the Coordinator-General's recommendations and in addition following management measures are included in the EMP for the project. The acid sulfate soil management plan will address: • Minimising the disturbance of potential acid sulfate soil • Immediately removing potential acid sulphate soils to a dedicated bunded area that provides for capture of stormwater flowing from stockpiles • Treatment with lime at a rate of about 50 kg/tonne. Field pH peroxide test (pH_{FOX}) or similar will be used to test whether

Performance Outcome	Response
	neutralisation has been successful. • Reuse of neutralised soils as fill if geotechnical properties are suitable, otherwise disposal at an authorised disposal facility.
Performance outcome PO3 Construction activities for the development avoid or minimise adverse impacts on stormwater quality.	Erosion and Sediment Control plans will be prepared as required for site development activities. These will be prepared and implemented in accordance with relevant guidelines.
Performance outcome PO4 Construction and operation activities for the development avoid or minimise changes to waterway hydrology from adverse impacts of altered stormwater quality and flow.	Water sensitive urban design measures (refer to Section 2.7.3) are proposed for stormwater management with the overarching criteria for the development being no significant change in quality or quantity of overland flow.
Part B – Point Source Waste Water Management	
Performance outcome PO1 Development does not discharge waste water to a waterway or external to the site unless demonstrated to be best practice environmental management for that site.	Routine discharge of wastewater or treated wastewater is not proposed as part of the project. In addition detailed measures are proposed to ensure that it will be highly unlikely that an emergency release of untreated sewage would occur. Refer to the Cardno (2013) Feasibility Strategy (Appendix D1).
Performance outcome PO2 Any treatment and disposal of waste water to a waterway accounts for: a. The applicable water quality objectives for the receiving waters; and b. adverse impact on ecosystem health or receiving waters; and c. in waters mapped as being of high ecological value, the adverse impacts of such releases and their offset.	
Performance outcome PO3 Waste water discharge to a waterway from nutrient hazardous areas or acid sulfate soil areas is managed in a way that maintains ecological processes, riparian vegetation, waterway integrity, and downstream ecosystem health.	Acid Sulfate Soils – refer to Performance Outcome P02 Refer to Section 8.5 for further discussion on potential impacts on water quality.
Part C – Non-Tidal Artificial Waterways	
Performance outcome PO1 The waterway is not designed only for stormwater flow management or stormwater quality management.	Water sensitive urban design principles will be used throughout the development, to maximise stormwater quality management. Refer to Section 2.7.3 and Cardno (2013) Feasibility Strategy (Appendix D2) for information on proposed stormwater management.
Performance outcome PO2 The waterway is located in a way that is compatible with the land use constraints of the site for protecting water environmental values in existing natural waterways.	Refer to Section 2.7.3 and Cardno (2013) Feasibility Strategy (Appendix D2) for information on stormwater management.
Performance outcome PO3 The waterway is located in a way that is compatible with existing tidal waterways.	Not applicable

Performance Outcome	Response
Performance outcome PO4 A The construction phase for the waterway is compatible with protecting water environmental values in existing natural waterways.	Erosion and Sediment Control plans will be prepared as required for site development activities. These will be prepared and implemented in accordance with relevant guidelines.
Performance outcome PO5 Stormwater overflows from the waterway provide for the achievement of water quality objectives in existing natural waterways.	Refer to Section 8.5 for further discussion on potential impacts on water quality.
Performance outcome PO6 The waterway is designed, managed and operated by suitably qualified persons.	The design and construction of water quality management devices will be undertaken by suitably qualified professionals.
Performance outcome PO7 The waterway is managed and operated in ways that demonstrate achievement of water quality objectives in natural waterways.	Appropriate management measure will be undertaken and will be detailed in subsequent applications and approvals for the project.

3.3.13.5 State Planning Policy 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments

State Planning Policy 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments took effect on 25 November 2011 as part of a package of legislation applicable to development within the Great Barrier Reef catchments. The intent of the legislation is to maintain the ecological processes of these wetlands which reduce nutrient, pesticide and sediment loads in the reef catchments and protect them from the effects of high impact earthworks.

The wetland protection areas include wetlands of high ecological significance and a 100 m trigger ban areas and a 500 m trigger area within rural areas. DEHP is an assessment manager or referral agency for material change of use, reconfiguring a lot or operational works involving high impact earthworks in wetland protection areas.

Wetlands of HES high ecological significance and associated wetland protection areas occur on HHI wetlands occur on HHI (see Figure 6.37) and therefore referral of the relevant applications will be required to DEHP for assessment against the SPP.

3.3.13.6 Temporary State Planning Policy 2/12 Planning for Prosperity

The Temporary SPP 2/12 Planning for prosperity came into effect on 24 August 2012, details the State's position on economic growth with this to be reflected through the implementation of the SPP in relevant State and local government decisions.

A key aspect of the State's position on economic growth, as detailed in this SPP, is the promotion of tourism by:

- Protecting Queensland's tourism attractions and significant natural assets, for the benefit and sustainability of the tourism industry
- Facilitating tourism projects that complement local conditions
- Removing hurdles and locational limitations for appropriate tourism development.

At the decision making stage the purpose of the Temporary SPP will be achieved by a balancing of competing or conflicting outcomes that gives additional weight to:

> *c. tourist development which can be shown to be complementary to an area's environmental, scenic and cultural values*

The Temporary SPP includes policies about matters of state interest, with the policies relating to the project being:

- Remove regulatory barriers which impede the development of the following in appropriately zoned or suitable locations
  - Agriculture
  - Tourism projects
  - Mining and extractive resource industries
  - Residential, commercial and industrial activities
- Tourism
  - Protect existing and appropriate tourism development
  - Identify opportunities for the expansion of existing tourism development
  - Identify localities or areas appropriate for tourism development, and protect these areas from incompatible development
  - Provide for the infrastructure and services necessary to support both existing tourism and identified tourism opportunities.

The Queensland Government approval of the HHI project (similar to that currently proposed) in February 2011, demonstrates its support for the development of a tourism focused development on HHI. This approval reflects the intent of this policy.

3.3.13.7 Draft State Planning Policy

The Draft State Planning Policy was released for public comment on 15 April 2013. The Draft SPP will, when adopted, replace all current SPPs. The Draft State Planning Policy incorporates five state interest areas that identify policies relevant to making or amending planning schemes, development assessment decision making and community infrastructure designations.

In relation to the approval/development assessment process the Draft SPP is applicable

(2) *the assessment of a development application mentioned in Part C by a local government, to the extent the SPP is not identified in the planning scheme or a regional plan as being appropriately reflected in the planning scheme or a regional plan, and*

(5) *the assessment of development applications by the chief executive responsible for administering the SPA* (Department of State Development Infrastructure and Planning 2013).

Where development applications are required to be submitted to an entity other than the local authority as either a referral agency or assessment manager it is intended that they be referred or made the chief executive responsible for administering *Sustainable Planning Act 2009* as the single State Assessment and Referral Agency. These applications would then be assessed against the State Development Assessment Provisions. These provisions have yet to be released.

The state interest areas and their relevance to the project are detailed in the following table.

Table 3.2 – Applicability of the Draft State Planning Policy to the PTP

Theme	State Interest	Applicability to the Project
Housing and livable communities	Amenity and community wellbeing	No policies identified for the development assessment process
	Land development and housing supply	
Economic growth	Agriculture	
	Development and construction	
	Mining and extractive resources	Not applicable as there are no key resource areas on HHI
	Tourism industry	No policies identified for the development assessment process
Environment and heritage	Biodiversity	Applicable – relates to land identified by a matter of state environmental significance. All applicable legislation has been addressed through the previous and current EIS process.
	Coastal environment	Applicable – referenced legislation includes • *Coastal Protection and Management Act 1995* • *Transport Operations (Marine Pollution) Act 1995* • *Great Barrier Reef Marine Park Act 1975* (Cwlth) • *Marine Parks Act 2004.*
	Cultural heritage	Applicable – referenced legislation includes • *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) • *Queensland Heritage Act 1992.*
	Healthy waters	Applicable - referenced legislation includes • *Environmental Protection Act 1994* • *Environmental Protection (Water) Policy 2009* • *Water Act 2000.*

Theme	State Interest	Applicability to the Project
Hazards and safety	Air, noise and other emissions	Applicable - referenced legislation includes • *Environmental Protection Act 1994* • *Environmental Protection (Noise) Policy 2008* • *Environmental Protection (Air) Policy 2008.*
	Hazardous materials and developments	No policies identified for the development assessment process
	Natural hazards	Applicable – relates to flooding, bushfires, landslide and coastal hazard.
Transport and infrastructure	State infrastructure and services	No policies identified for the development assessment process
	State transport infrastructure and networks	Applicable through the provisions of the *Transport Infrastructure Act 1994* and the *Transport Planning and Coordination Act 1994.*
	Strategic airports and aviation facilities	Not applicable
	Strategic ports	Not applicable
	Water supply catchments and infrastructure	Not applicable

3.3.13.8 Coastal Planning Provisions

State Planning Policy 3/11: Coastal Protection has been suspended and replaced by the Draft Coastal Protection State Planning Regulatory Provision on 8 October 2012 and will operate for 12 months unless repealed sooner. In addition the State Coastal Management Plan—Queensland's Coastal Policy has been replaced with the Queensland Coastal Plan.

Draft Coastal Protection State Planning Regulatory Provision

The Draft Coastal Protection State Planning Regulatory Provision applies to:

- Development applications
- The making of local planning schemes and amendments
- The making of regional plans
- The designation of land for community infrastructure.

Part 2 of the provision identifies that it applies to assessment of a development application:

- For impact assessable development in a coastal management district by an assessment manager
- Considered by the chief executive administering the Coastal Act as assessment manager in accordance with the *Sustainable Planning Regulation 2009*
- For development in a coastal management district by an agency with jurisdiction under the *Coastal Protection and Management Act 1995*
- For a master plan application.

Part 2 of the Draft Coastal Protection State Planning Regulatory Provision applies to the assessment of development application, and will be applicable to the current development application lodged with Gladstone Regional Council. The relevant provisions about coastal protection from the Draft CPSPRP are detailed in Table 3.3.

Table 3.3 - Draft Coastal Protection State Planning Regulatory Provision

Provision	Response
Coastal hazards	
Development in areas on the coastal zone identified as having a high risk of being affected by coastal hazards needs to be carefully considered and wherever possible, be retained undeveloped. Where an area vulnerable to storm tide inundation is developed, or has a development commitment, further development in these areas needs to address: (a) its vulnerability to sea level rise and storm tide inundation (b) the proposed access to and protection of evacuation routes. In such areas, local government may have in place counter-disaster plans to address these coastal hazards.	The areas to be developed are outside the erosion prone area and areas most vulnerable to coastal hazards.
Development in an erosion prone area	
To the extent practicable, erosion prone areas are to remain undeveloped apart from acceptable temporary or relocatable structures for safety and recreational purposes.	The erosion prone areas have been identified and mapped and the area is generally retained free of development. In particular, the most sensitive erosion prone areas on the east and north sides of the Island would be retained free from development.
Where building works and activities have been undertaken within an erosion prone area, future use should not be at a greater intensity than the existing level. Redevelopment of these areas or an increase in intensity may only occur in circumstances where it can be clearly demonstrated that it would not compromise coastal management outcomes and principles.	Public access to the coastal zone would be retained where human access is compatible with the management of these areas (SKM 2005). Pedestrian access would be improved at certain locations, through the creation of well-defined public access points from the development to the coastal zone. A new boat ramp is proposed adjacent to the new bridge The ramp would provide a new access point to the coastal environment and would serve to discourage access elsewhere. All new access infrastructure would be located and designed to avoid impact on the coastal resources.
In areas under constant threat of erosion, a strategy of retreat from erosion prone areas is the preferred option. However, where an area has been developed to a scale and intensity that the retreat option is not achievable, property protection works may be needed to defend land uses and infrastructure from coastal processes. In such circumstances, any further building or infrastructure including extensions to existing buildings or the location of services (including water, power and sewerage), should not extend any further seaward than the existing building alignment for the neighbouring properties.	Not applicable to the project

Provision	Response
For developed areas, structural engineering and stabilisation works will be initiated only as a last resort where erosion presents an immediate threat to public safety or property and infrastructure that is not expendable. The siting, design and materials used for works will not cause any significant adverse impacts on the coastal resources of the location nor significantly impact on the natural cycles of erosion and accretion of beaches.	Not applicable to the project
Construction of structures for the purpose of beach protection (including artificial reefs, banks, wrecks, breakwaters and groynes) in coastal waters will only be approved where: (a) there is a demonstrated need in the public interest (b) comprehensive investigation has been carried out and it can be demonstrated that: (i) there would not be any significant adverse impacts on the longshore transport of sediments (ii) there would be no increase in coastal hazards for the neighbouring foreshore.	Not applicable to the project
Nature conservation	
Biodiversity on the coast is to be safeguarded through conserving and appropriately managing the diverse range of habitats including coral reefs, seagrass, soft bottom (benthic) communities, dune systems, salt flats, coastal wetlands and riparian vegetation.	The proposal seeks to avoid impacting on the coastal wetland areas by maintaining appropriate buffers to the wetland areas and maintaining existing discharge levels from ephemeral watercourses into the wetland areas.
The following matters are to be addressed to achieve the conservation and management of Queensland's coastal biodiversity: (a) the maintenance and re-establishment of the connectivity of ecosystems; particularly to ensure viable populations of protected native species continue to exist throughout their range, by maintaining opportunities for long-term survival, genetic diversity and the potential for continuing evolutionary adaptation. This includes the protection of significant wildlife habitats, such as: (iii) protecting beaches providing significant wildlife habitats (including roosting, nesting and breeding habitat for turtles, birds or crocodiles) through suitable management measures including buffers for those habitats (iv) protecting the values and integrity of intertidal communities such as tidal flats, salt flats and rocky reefs, including natural fluctuations of location (v) retaining the current extent and quality of migratory and resident shorebird roosting and feeding habitat. If habitat is to be lost it should be replaced, where practicable, before loss, by an equivalent artificial habitat in a location that minimises any alteration of distribution and abundance of shorebirds	The proposal seeks to maintain the biodiversity of the coastal ecosystem on and around HHI by avoiding biodiversity and habitat loss. Vegetation and fauna habitats on the Island have been mapped and the Master Plan for the project avoids development in areas of endangered ecosystems and important habitats. The south-east coastline of HHI has been identified as providing roost sites for migratory shorebirds. This area is about 4 km from the project boundary and there is not potential for direct or indirect disturbance. The project boundary is more than 300 m from identified turtle nesting beaches. Access to this area will be controlled during laying and hatching and there is also lighting controls proposed on the headland and behind the beaches to minimise disturbance.

Provision	Response
(vi) maintaining the values and integrity of fish habitats and fish migratory pathways through suitable management measures including buffers for those habitats (vii) protecting the values and integrity of soft bottom (benthic) communities (viii) retaining and protecting the existing extent, quality and functionality of seagrass beds, particularly in dugong protection areas or known areas of turtle habitat	
The retention of native vegetation wherever practicable	Vegetation and fauna habitats on the Island have been mapped and the Master Plan for the project avoids development in areas of endangered ecosystems and important habitats. The project seeks to minimise development in these areas in order to preserve them as natural areas.
The retention of and appropriate management of riparian vegetation along waterways of sufficient width to provide for a self-sustainable linked network. The width of the corridor will be determined from the size, values and functions of the vegetation and the nature of potential threats to its functions and integrity from the specific activity or land use. However, the buffer should be of sufficient width to maintain bank stability, existing water quality, maintain aquatic and wildlife habitats and movement corridors for native animals, and long-term viability of existing isolated stands of vegetation.	The development footprint minimises the impact on waterways, and where impact cannot be avoided wide buffers to ephemeral watercourses are proposed to assist in maintaining existing nature stormwater flow regimes, vegetation and habitat. In addition the PTP will incorporate extensive water management techniques, including no discharges of any waste streams or contaminated stormwater streams to the coastal environment, and the use of water sensitive urban design principles.
Areas of high ecological significance	
Development and development infrastructure is to be located outside of, and not have a significant impact on, an area of high ecological significance in any coastal management district, unless the development or development infrastructure is for a purpose specified below: (a) urban or rural residential purposes within an urban area (b) development for tourism purposes (c) any purpose within a maritime development area or aquaculture development area (d) development associated with a port or airport (e) low impact tidal water intake or discharge infrastructure for aquaculture development on land (f) minor public marine development and associated pedestrian and vehicle access facilities, or (g) extraction purposes within a key resource area.	The proposal seeks to maintain the biodiversity of the coastal ecosystem on and around HHI by avoiding biodiversity and habitat loss and protecting areas of HES. Areas of state significance are identified Section 3. Particularly relevant to the development are the endangered regional ecosystems and significant coast dune systems on the Island. The proposal seeks to minimise development in these areas in order to preserve them as natural areas. This would contribute to the recreational and tourism setting and opportunities of the project. Vegetation and fauna habitats on the Island have been mapped and the Master Plan for the project avoids development in areas of endangered ecosystems and important habitats. This is discussed further in Section 14.

Provision	Response
Public Access	
There is no net loss of public access to the foreshore. Public access is to be maintained, protected and enhanced where the provision and operation of infrastructure of state economic significance and protection of coastal resources is not compromised. In planning for new urban land uses on the coast, the following additional matters are to be considered with respect to public access and use of the foreshore: (a) the need for new or upgraded public access facilities (such as boat ramps, jetties, boat moorings, pedestrian boardwalks, carparks and vehicle access) (b) appropriate location and design with respect to sensitive coastal resources and their values (c) the safety of the public, if access is provided.	Public access to the coastal zone would be retained where human access is compatible with the management of these areas (SKM 2005). Pedestrian access would be improved at certain locations, through the creation of well-defined public access points from the development to the coastal zone. All new access infrastructure would be located and designed to avoid impact on the coastal resources.
Any new private structures proposed over state land on the coast or public waters that are not major private infrastructure of state economic importance, should maintain or enhance public access, useability or enjoyment of the land or water, subject to ensuring safety of the public.	A new public boat ramp is proposed adjacent to the new bridge which would provide a new access point to the coastal environment and would serve to discourage access elsewhere. All new access infrastructure would be located and designed to avoid impact on the coastal resources.

Queensland Coastal Plan

The Queensland Coastal Plan took effect on 3 February 2012 replacing the 2001 State Coastal Management Plan. It was introduced to establish the state's policies in relation to matters of state interest relating to coastal protection. The coastal zone includes coastal waters and all areas to the landward side of coastal water in which there are physical features, ecological or natural processes or human activities that affect, or potentially affect, the coast or coastal resources.

The Queensland Coastal Plan includes the State Policy for Coastal Management and the State Planning Policy for Coastal Protection, however as detailed above the State Planning Policy has subsequently been replaced by the Draft Coastal Protection State Planning Regulatory Provision.

The policy areas of relevance to the project are addressed in Table 3.4.

Table 3.4 – Queensland Coast Plan Specific Policy Outcomes

Policy Area	Principle	Response
Protecting coastal process in erosion prone areas	Natural coastal processes including erosion and accretion are able to occur without interruption	The erosion prone areas have been identified and mapped and these are generally retained free of development. In particular, the most sensitive erosion prone areas on the east and north sides of the Island are retained free from development. The main intrusion into erosion prone areas is to allow for pedestrian access through the creation of well-defined public access points. These works would be designed to prevent increased vulnerability of the coastline to erosion and would be developed in accordance with relevant State guidelines.
Buildings and structures in erosion prone areas	Structures (including all infrastructure) in erosion prone areas are designed, located and managed to ensure that impacts on coastal processes are avoided or minimised.	This development provides a diversity of housing choice and location not able to be accommodated within nearby existing urban areas. Due to its location on an Island, expansion of the development beyond the lease area is not possible. Design of the development creates a new integrated tourist and residential community that coexists with the natural environment in a sustainable manner. To achieve this, valuable coastal resources have been identified for protection and appropriate buffers have been identified to further protect them from incompatible development to the extent practicable. This EIS addresses possible impacts on coastal resources and demonstrates how these impacts would be avoided or minimised.
Dune Management	Dunes are to be protected and dune vegetation is maintained and enhanced.	Particularly relevant to the development are the endangered regional ecosystems and significant coast dune systems on the Island. The proposal seeks to minimise development in these areas in order to preserve them as natural areas.
Management of areas of ecological significance	Protect areas of high ecological significance and conserve other ecological values.	The proposal seeks to maintain the biodiversity of the coastal ecosystem on and around HHI by avoiding biodiversity and habitat loss and protecting areas of HES. Areas of state significance are identified Section 6.7. Particularly relevant to the development are the endangered regional ecosystems and significant coast dune systems on the Island. The proposal seeks to minimise development in these areas in order to preserve them as natural areas. This would contribute to the recreational and tourism setting and opportunities of the project. Vegetation and fauna habitats on the Island have been mapped and the Master Plan for the project avoids development in areas of endangered ecosystems and important habitats. This is discussed further in Section 6.7.
Indigenous cultural heritage	The living culture of Indigenous Traditional Owners and their connection with cultural resources on the coast and in marine areas is maintained and enhanced.	As areas of state significance have not been identified through a regional coastal management plan, this policy only requires consultation with Traditional Owners – which has been undertaken. A CHMP for the project has been developed in consultation with Traditional Owners and has been approved by the Queensland DATSIMA.

Policy Area	Principle	Response
Public access and use of the coast	Public access and use of the coast is maintained and enhanced for current and future generations.	Public access to the coastal zone would be retained where human access is compatible with the management of these areas (SKM 2005). Pedestrian access would be improved at certain locations, through the creation of well-defined public access points from the development to the coastal zone. A new ramp is proposed adjacent to the new bridge which would provide a new access point to the coastal environment and would serve to discourage access elsewhere. All new access infrastructure would be located and designed to avoid impact on the coastal resources.
Buildings and structures on State coastal land	Buildings and structures (including all infrastructure) are established on State coastal land only where they are essential, provide a public service, and cannot be feasibly located elsewhere.	Development on State coastal land is limited to that required to provide for community access. As detailed above the project incorporates: • Creation of well-defined public access points from the development to the coastal zone; and • Construction of a new boat ramp.
Driving on beaches	Driving on beaches is not supported unless required for access and is actively managed to prevent significant impacts on ecological values and ensure a safe environment for other beach users.	No beach access for vehicles or driving on beaches is included as part of this development
Management Planning	Management and use of coastal land is guided by plans of management.	The Queensland Coordinator-General's report included a substantial number of conditions that relate management planning and these along with EIS commitments provide an extensive management framework.

3.4 Gladstone Regional Council

Development within the Gladstone Regional Council (GRC) area is currently managed by three existing Planning Schemes. That is, the planning schemes for the former Gladstone City Council, Calliope Shire Council and Miriam Vale Shire Council remain in effect until such time as the new GRC planning scheme is adopted. The new GRC planning scheme is in preparation and expected for release for public comment in mid-2014 and finalisation in mid-2015.

PTP is located within the Miriam Vale Council Planning Scheme and is included within the Parkland and Open Space Zone with the Rural locality of the planning scheme. However it should be included in the Rural Zone. In 2006, the Director General of the then Department of Local Government Planning Sport and Recreation, advised the Coordinator-General in writing that:

- In October 2005 the draft new scheme zoned the land as Parkland and Open Space
- The State Land section of the then DNRM advised Council at the first state interest review that the land should be zoned Rural

- In August 2005 the Council response was that it would be mapped at Rural in the second State interest check. The site zoning was not changed to Rural prior to going on public display and prior to finalisation, because of human error, not because of a policy position; and he advised that the rural zone would be more appropriate.

To date this error has not been corrected.

PTP is generally inconsistent with the rural objectives of the Planning Scheme, given that the proposed land uses are tourism, commercial, light industrial and residential and the land is to be reconfigured into a range of lot sizes. The location of PTP is also inconsistent with the regional settlement pattern however the special lease, issued in 1999 allows tourism, residential and recreational development over the SL area, and acknowledges that for the development to proceed, a material change of use would be required over the land. These issues were covered at length in the HHID EIS and supplementary material (SKM 2007, SKM 2011) and after extensive consultation with GRC and other regulatory agencies, it was agreed with GRC that the development could go ahead subject to an application for material change of use of the land. The Coordinator-General's report documents this agreement, and contains preliminary conditions of approval which GRC would subsequently impose on the Proponent.

Given the complex nature of the development, the mechanism that the Proponent has put forward is to seek a preliminary approval to vary the existing Planning Scheme to incorporate a Plan of Development with associated development codes relating to the development. Relevant conditions imposed on the project through the Australian Government Minister's approval and the Coordinator-General's Change Report will then be incorporated into the preliminary approval. The Material Change of Use application will:

- Establish the level of assessment for any further development on the site
- Identify the codes against which subsequent development will be assessed.

The Plan of Development is a site specific planning document that uses the Planning Scheme for Miriam Vale Shire development codes as the basis against which subsequent development is assessed.

The Plan of Development provides Council with certainty as to the form of the development to be undertaken on site. In addition, the Plan of Development also provides the mechanism through which the level of assessment and the assessment codes are approved and established for subsequent development approvals.

The preliminary approval does not authorise development works to take place, but rather establishes a regulatory framework for all future works. Thus each stage and component of the project will be assessed against the Plan of Development. Generally, development proposals that are consistent with the Plan of Development are subject to either self-assessment or code assessment. Development proposals that are inconsistent with the Plan of Development would need to undergo impact assessment, and would be assessed against the relevant provisions of the Planning Scheme for Miriam Vale Shire.

Following gazettal of the Coordinator-General's Change Report (if approved), the Proponent will amend the Material Change of Use application lodged with Gladstone Regional Council in December 2009 under IP Act, to reflect the changes to the project.

SECTION 4
Consideration of
Constraints and Alternatives

Contents

4. Project Alternatives

4.1 Location

The PTP is very well located in relation to the Central Queensland Region, being the only readily accessible coastal area for a new tourism project between Yeppoon to the north and Agnes Waters/1770 to the south. As such, it is ideally located to contribute to the Central Queensland Tourism Opportunities Plan.

HHI has unique attributes that are not otherwise available in Central Queensland. The location is integral to the proposed development, and indeed the proposed development has been conceived specifically for this location. PTP takes place within a Special Lease designated for *business, industrial, commercial, residential, tourism and recreation*, there are no alternative locations readily available to the Proponent. While it would be possible to provide an equivalent number of residential and tourism accommodation units elsewhere in the Central Queensland region, and potentially within 40 minutes drive of Gladstone, the particular attributes of Hummock Hill Island make it favourable over any other location in easy reach of Gladstone. In particular:

- The coastal location provides a micro climate that is more comfortable for tourists and residents, and reduces the need for artificial cooling minimising energy consumption and associated greenhouse gas production
- The beach and surrounds are attractive and provide outdoor recreational opportunities that cannot be recreated anywhere else on the Central Queensland coast
- The landform provides a variety of development opportunities in beachfront, hillside and bushland locations
- The land for the proposed development is available and has long been identified by the Queensland Government for this type of development under a special lease.

4.2 Alternative Master Plans and Land Use Proposals

The Island has a long history of use with a Pastoral Lease first issued on the Island in 1878 and running till 1991 when the Pastoral Lease was converted to a Special Lease for Lot 3 on FD841442. Conditions of the Special Lease included, construction of a bridge across Boyne Creek linking the Island to the mainland (Condition C374), progressive development of the leased land (Condition C380) and conduct all works in accordance with the approved plans (condition C378).

A number of development configurations have been developed since the establishment of the Special Lease over Lot 3 on FD841442. These are discussed in the following sections.

4.2.1 Proposed Development 1993

An original proposal for the "*provision of a major residential and recreational facility*" was proposed in 1993 by Hummock Hill Island Pty Ltd (a wholly owned subsidiary of Raymag Securities Ltd) and included:

- A 100 room hotel
- 300 Park residential houses
- 3,290 Residential allotments
- 820 Condominiums
- A marina adjacent to the northern headland
- A caravan, relocatable home, holiday cabin and camping site with a 250 caravan capacity
- Community facilities such as schools and emergency services
- 2 Golf courses, bowling greens and tennis complexes
- Water supply reservoirs
- Sewerage treatment plants
- Water management processes including drainage to replenish aquifers.

The proposed development was given approval by Miriam Vale Shire Council however the development did not commence and the approval lapsed. Figure 4.1 presents a plan of the proposed development 1993.

4.2.2 Proposed Development 1999

A proposed development for "*a combination of tourist and residential facilities with supporting community infrastructure and commercial services*" was proposed by East Wing Corporation Pty Ltd in 1999 and was granted Significant Project status under the SDPWO Act. The development comprised:

- A three phased residential tourist development housing about 9,000 people
- A Centre for higher learning based on space related technology and incorporating a technology park complex
- A commercial space launch vehicle facility for launching low earth satellites.

Figure 4.2 presents the master plan for the proposed 1999 development.

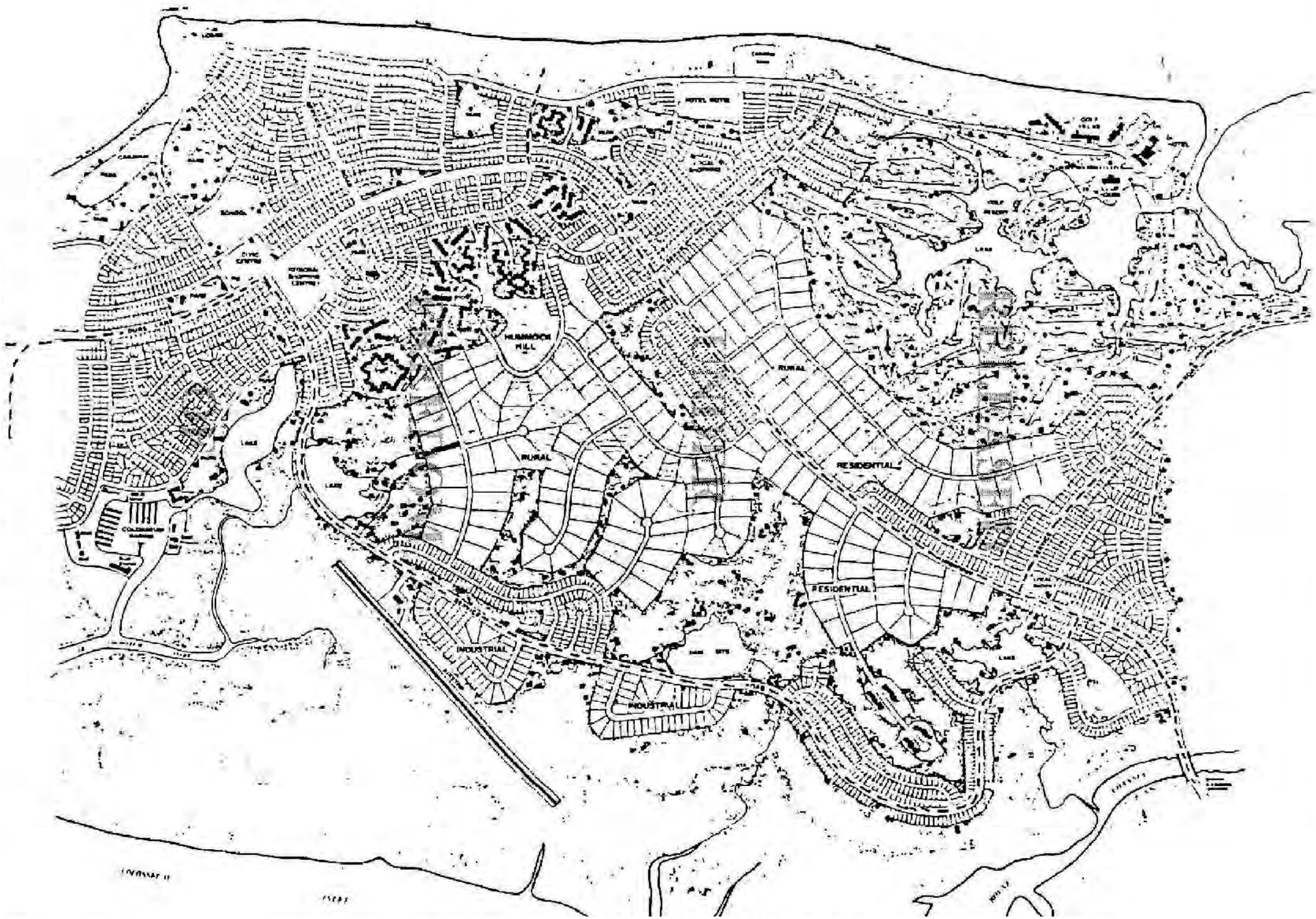

Figure 4.1 - Proposed Development Circa 1993

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability are given. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations. SKM accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon the figure and the associated data

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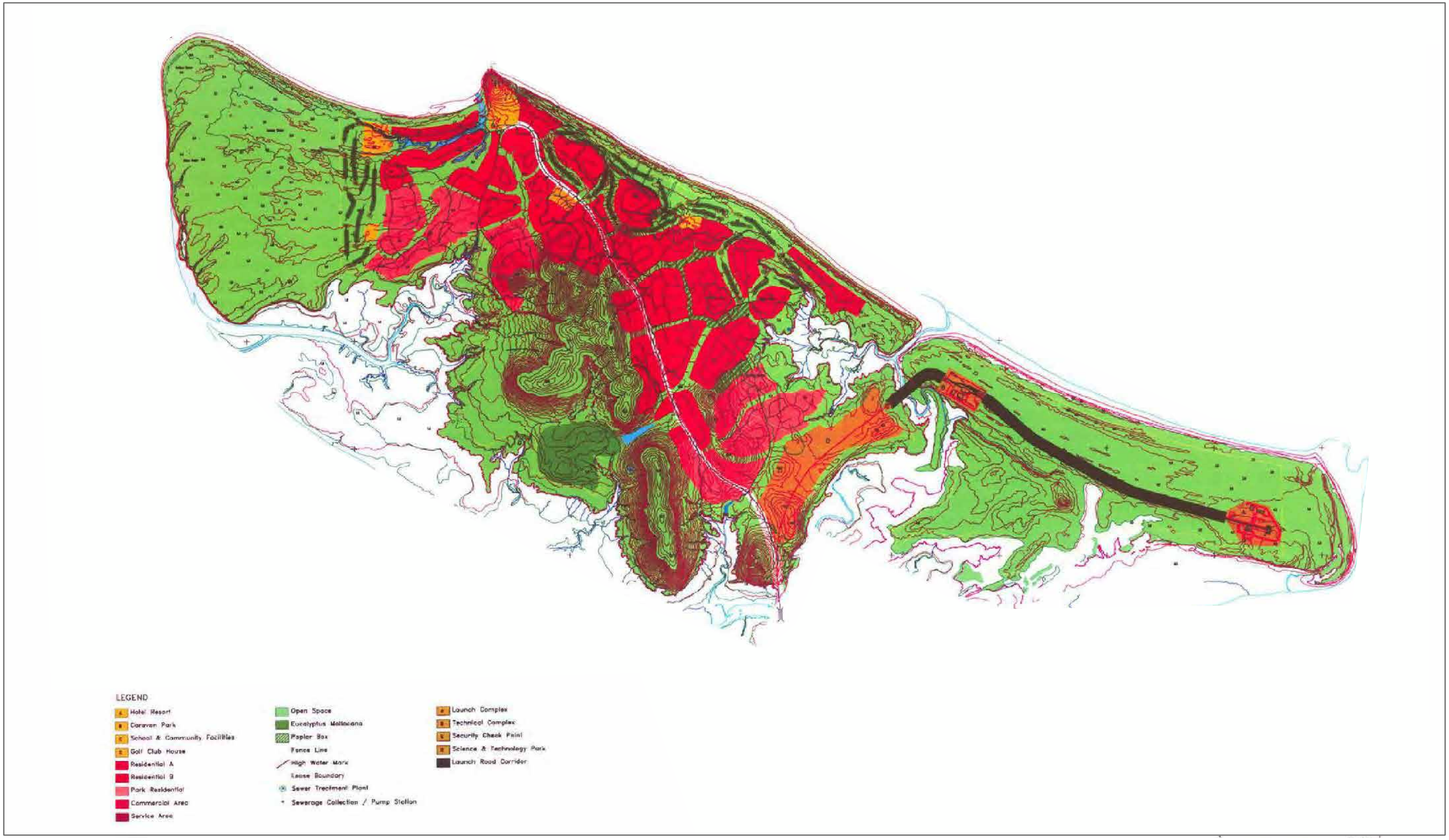

Figure 4.2 Proposed Development Circa 1999

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability are given. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations. SKM accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon the figure and the associated data

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4.2.3 Proposed Development 2005 - 2011

A number of master plan developments were proposed by East Wing Corporation Pty Ltd between 2005 and 2010. During this period an EIS was under preparation in accordance with the conditions of the Special Lease.

The overall footprint of the master plan and the nature and location of individual components was iteratively adjusted to conform to the constraints imposed by the environment as they were revealed through the EIS site investigations.

The final development proposal for the HHID (Figure 4.3) was approved with conditions by the Queensland Coordinator-General in February 2011. The CG's report is available on the following website www.dlg.qld.gov.au/assessments-and-approvals/hummock-hill-island-development.html.

The master plan responded to the terrain and natural environmental values of the Island and was in accordance with Queensland Government policy requirements governing development in or adjacent to areas of higher environmental sensitivity.

Consideration of alternative footprints was undertaken iteratively as the site constraints were identified during the investigation process and the master plan adjusted accordingly to minimise disturbance to the natural environment within these constraints. Key constraints considered in development of the master plan included:

- Developing only a relatively small proportion of the Island
- Avoiding coastal zone areas where coastal processes and coastal erosion may be more sensitive to disturbance, and also where acid sulphate soils might be located and low density turtle nesting has been observed in some years
- Avoiding threatened ecological communities, endangered regional ecosystems and habitat known to or highly likely to be occupied by listed threatened species as well as avoiding vegetation communities that are not well represented elsewhere in the GBRWHA and
- Ensuring that representative areas of all vegetation communities and habitats are preserved
- Avoiding intertidal and supratidal areas used by migratory shorebirds
- Maintaining fauna passage across HHI through permeability of the proposal to fauna movements
- Avoiding development in visually prominent areas.

Land uses for the proposed development were selected based on the need to meet demand for residential development, tourism opportunities and recreational opportunities in the region. The proposed land was developed to meet regional needs, and hence a wide range of alternatives was not considered.

The project approved by the Queensland Coordinator-General was the redevelopment of 341 hectares of the lease area into a master planned community over a 15 to 20 year period.

The GC's conditions and the Special Lease conditions both require the construction of a bridge to HHI from the closest point on the mainland, at the end of Clarke's Road, in a designated corridor that has been excluded from the Colosseum Inlet Fish Habitat Area. The beaches and foredunes of the island, in the designated erosion prone areas and/or Coastal Management Districts, were not to be developed.

In summary, the approved development incorporated the following components:

- 240 room resort hotel
- 150 room beachfront tourist eco-hotel
- 70 room motel
- Tourist park
- Holiday and residential properties in 1, 2, 3 and 4 bedroom configurations
- Golf course and other sporting facilities
- Community centre
- Education and research centre
- Public boat ramps
- Commercial facilities
- Health facilities
- Associated public infrastructure (including access bridge).

The proposal accommodated approximately 2,800 tourists and 1,200 residents when the development would be operating at full capacity during peak tourist seasons.

The proponent was required to provide and/or fund all necessary infrastructure for the project to ensure there was no burden on local and state infrastructure providers.

The proposed project had a development area of 518 hectares consisting of 341 hectares for the development footprint and 177 hectares (1.77 square kilometres) for open space, golf course and parkland.

4.3 The PTP Alternative

Since 2011, The Proponent has worked with a team of specialist environmental scientists and advisers to prepare a development proposal revise the HHID to further address identified environmental values, particularly in relation to impacts on MNES and including impacts on those features of HHI and surrounding waters that contribute to the OUV of the GBRWHA.

The most crucial aspects of the proposed PTP have been the incorporation of additional protection of the values of HHI and its surrounding coastal and marine environment into the Master Plan and determination of an approach to the project that avoids and minimises impacts such that environmental values are protected. The protection of these environmental values may be considered constraints on development.

Key strategies adopted to protect the values include:

- Avoiding direct impacts on values that contribute to OUV of the GBRWHA and maintaining overall biodiversity values of HHI
- Setting standards for design, construction and operation of all aspects of the proposed PTP to minimise adverse effects
- Imposing mitigation measures and contingency measures for transient impacts such as construction related impacts
- Providing protection for vegetation and habitat outside the project footprint
- Providing offsets for unavoidable vegetation clearing.

The PTP Master Plan has been developed to:

- Protect and preserve MNES including those features that contribute to the OUV of the GBRWHA
- Restrict the master plan footprint to less than 10% of HHI
- Avoid disturbance to the coastal area including all coastal wetlands and mangrove vegetation, supratidal salt pans and beaches, except for the proposed bridge and boat ramp which affect less than 0.5 ha. This will protect the vulnerable Water Mouse if it is present on HHI
- Avoid disturbance to the critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and provide for a buffer adjacent to this area. This also protects habitat for the vulnerable black-breasted button quail which is considered highly likely to be present
- Avoid disturbance to the 10 ha patch of *Eucalyptus melanophloia* woodland (classified as 12.12.8 under the Queensland Regional Ecosystem Description Database) that does not occur on other islands within the GBRWHA
- Retain 229 ha of *Eucalyptus tereticornis* and *E. crebra* dominated forest (classified as 12.12.12 under the Queensland Regional Ecosystem Description Database) which also does not occur on other islands within the WHA

- Retain at least 50% of trees throughout the master plan footprint. This will provide nesting and foraging habitat for native animals including the vulnerable Grey-Headed Flying Fox
- Provide vegetation buffers to sensitive ecosystems
- Provide buffers along ephemeral watercourses within PTP and preserve of existing drainage paths on HHI
- Retain east-west habitat connectivity and permeability for wildlife movement across HHI. This is particularly achieved by the location of the golf course, the design of the trans island connector road and the lower density bushland precinct that will provide footprints that are highly permeable to ground dwelling fauna
- Include a water supply and wastewater system that maximised water reuse and limit discharges into the coastal environments
- A water cycle approach that includes treating wastewater to a high quality (TN = 4 mg/L, TP = 0.5 mg/L) and reuse through third pipe systems and for irrigation of the proposed golf course and landscape and open space areas
- Provide stormwater systems that ensure that the quantity and quality of stormwater flowing through the existing ephemeral streams to the surrounding marine areas is not significantly changed in rain events up to the 100 year ARI event
- Ensure that stormwater from the project area will not impact on the coastal vine thicket
- Achieve a high level of visual amenity, consistent with the HHI landscape to minimise adverse impacts on views from the GBRWHA through architectural design and selection of building materials
- Locate elements of the PTP to minimise visibility when viewed from the GBRWHA and restrict building heights so that elements are not visible above the ridgelines or treelines
- Consolidation of tourism elements to the northern coastline of HHI and amalgamation of the major tourist accommodation and attractions to provide for ease of management of these areas and enhanced social and amenity aspects
- Provision of designated walkways through the protected areas of HHI to showcase these areas while minimising human contact with areas that may provide habitat to protected and migratory species

The Master Plan includes a Terrestrial and Marine Research Centre that will provide community awareness programs to promote an appreciation and understanding of native wildlife and to promote the GBRWHA to visitors and residents of PTP.

4.4 Infrastructure Alternatives

4.4.1 Project Access Options

Access is available to the development via gazetted roads. Alternative road access was not considered as this would have required new road easements to be identified and gazetted. Shorter road access routes would require traversing a large width of the upper estuary of Colosseum inlet.

Access via ferry from Gladstone was discounted due to:

- Access being restricted in times of bad weather
- The north side of the Island is too exposed for a safe landing port (without significant engineered protective structures)
- navigational difficulties traversing sand bars at the mouth of Colosseum Inlet
- Travel times would generally be longer than by road.

4.4.2 Water Supply Options

4.4.2.1 Relevant Targets and Principles

A range of performance targets and principles have been established for the proposed development (Table 4.1). These targets and principles form the basis upon which options for water supply were identified and investigated for the supply of water to the proposed development.

Table 4.1 - Water Supply Targets and Principles

Performance Targets	Development Principles
A reliable water supply is provided Quality of water is appropriate for designated uses Natural hydrological cycles are not undermined Environmental quality is not degraded Water management infrastructure meets best practice urban design standards.	Groundwater is not used for water supply to protect the shallow aquifer Water harvesting and consumption is strictly controlled Wastewater is treated and reused. Limited reliance on water resources from the mainland Provision of a safe potable water supply that meets Australian Drinking Water Quality Guidelines Site based water management is maximised including collection from roof catchments and reuse of wastewater A reliable water supply is available for fire fighting

4.4.2.2 Options Considered – Water Supply Strategy

Water demands for a development of this type are quite variable in terms of quality and opportunities exist to maximise efficiency of water cycle management by matching available supplies to different types of uses. A range of options for water supply were identified:

- Mains water supply, involving installation of a water supply main connecting existing municipal water supplies to PTP
- Desalination, involving installation and operation of a reverse osmosis desalination plant (thermal desalination was not considered because of high energy costs compared to reverse osmosis)
- Salt water, use of untreated water from the sea
- Recycled water, being water treated to Class A or Class A+ in a wastewater treatment plant
- Recycled water treated to better than Class A+ suitable for 100% potable reuse
- Grey water, being water generated at a household level from showers, baths, hand basins and washing machines
- Stormwater, being stormwater collected from overland flows (for example in a dam)
- Rainwater, being water collected from rooftop catchments and stored in tanks at the household level.

Suitable uses for each of these sources are shown in Table 4.2.

Table 4.2 - Water Uses and Source Options

Water Type	Suitable Uses	Source Options							
		Mains Water	Desalination	Recycled (Water (potable)	Recycled Water (A or A+)	Greywater	Stormwater	Rainwater tank	Sea Water (untreated)
Potable	Drinking, cooking	✓	✓	✓				✓(1)	
	Washing hands, cleaning teeth, shower, dishwashing	✓	✓	✓				✓	
High Contact	Toilet flushing	✓	✓	✓	✓		✓	✓	✓
	Clothes washing	✓	✓	✓	✓			✓	
	Car washing	✓	✓	✓	✓			✓	
	Marine and vehicle servicing	✓	✓	✓	✓			✓	
Irrigation	Garden irrigation	✓	✓	✓	✓	✓	✓	✓	
	Irrigation of public areas, golf courses, etc	✓	✓	✓	✓	✓	✓	✓	
Supply Considerations									
	Quality	☺	☺	☺	☺	😐	😐	😐	☹
	Reliability	☺	☺	☺	☺	😐	☹	😐	☺
	Site suitability	😐	☺	😐	☺	😐	😐	😐	NA
	Community Acceptance	☺	😐	☹	😐	😐	😐	😐	☹
	Implementation	Centralised	Centralised	Centralised	Centralised or Local	Household or Local	Centralised or Local	Household	Centralised (toilets only)
	Treatment Requirements	Possible re-chlorination	High energy requirement for treatment.	Very high level of treatment required.	High level of treatment required to meet guidelines	Treatment required to maintain acceptable standard	High level of treatment required	Disinfection and filtration required for potable uses	Toilets only, special fittings required to handle corrosion issues

(1) With treatment (sterilisation)
☺ = high, 😐 = Moderate, ☹ = Low

The suitability of each source for water supply was analysed in detail. At least one of mains water, desalinated water, recycled potable water or tank water (treated) is required to meet quality requirements for potable and high quality uses. Of these:

- Mains water is available from Gladstone Area Water Board and can be piped to PTP from Tannum Sands. Adequate supplies are available to meet 100% of demand for PTP
- Desalinated water can be produced from a small scale desalination plant sited on the Island. Plants can be sized to ensure that 100% of water demands can be met through desalination
- Potable recycled water can be produced from wastewater using specialised wastewater treatment units. However even with 100% recycling of wastewater, not enough water can be produced to meet demands, due to losses from the system due to outside use, evaporation and so on. Also, drinking of potable recycled water is not acceptable to all members of the community
- Rainwater tank, with a suitable disinfection unit fitted to the tank, can meet quality requirements for all required uses. However, analysis of rainfall patterns indicates that the required tank size for reliable household yield, even allowing for some recycling of wastewater, is in excess of 145 KL per household. This size is prohibitively large for this type of development.

On this basis, it is clear that the only water supply options that can, alone, meet 100% of the demand for PTP are desalination or mainland water supply. It is also clear that any water supply solution for the island must include either of these two options, or rainwater tanks (as supplementary supply mechanisms).

While both mainland supply and desalination are capable of providing 100% of PTP's water needs, project targets and development principles call for reuse and recycling of wastewater to be maximised, and also call for minimisation of reliance on mainland supplies. Further investigations were therefore carried out by Cardno (2013) on various integrated water supply options to identify suitable options to meet both quality and quantity requirements while also maximising reuse and minimising dependence on mainland water supplies.

Six configurations for water supply were investigated:

- Option 1 – Recycled Water Reticulation with Reticulated Potable Supply - providing reticulated recycled water to every property throughout the development. Recycled water derived from sewage treatment would be utilised for external uses and toilet flushing. It would also be used for irrigation of the golf course, sports field and airstrip. The remaining water would be provided through a potable supply (desalination or a pipeline from the mainland)
- Option 2 – Recycled Water Reticulation and Rainwater Tanks - recycled water supplemented by rainwater tanks. Rainwater tanks would be fitted with disinfection units to allow safe potable supply

- Option 3 – Recycled Water Reticulation with Rainwater Tanks and Potable Backup – as for option 2 but with a separate potable water supply available for drinking and for top-up of the rainwater tank, if necessary. Potable back up could come from desalination or mainland supply
- Option 4 – Greywater, Recycled Water & Reticulated Supply - Greywater is used for garden irrigation, recycled water for toilet flushing and potable supply (mainland or desalination) for all other uses
- Option 5 – Greywater. Stormwater & Reticulated Supply – similar to option 4 but with use of stormwater rather than rainwater tank. This option would not involve recycling of blackwater, and hence a separate blackwater treatment system would be required. Treated wastewater from this would need to be disposed of to land (irrigation) as discharge to the marine environment is unacceptable in this location, and generally not preferred by Queensland Government for new installations
- Option 6 – Stormwater Harvesting & Reticulated Supply. As for Option 5 but with greywater and blackwater being treated by a separate treatment system and not available for recycling. As for option 5, treated wastewater would have to be disposed of through irrigation.

Each of the 6 options can meet the quality requirements for the proposed development, i.e. potable quality water is available for highly sensitive uses. A water balance was undertaken for each of the 6 options to determine whether each could meet the quantity requirements. Of the 6 options:

- Options 1, 3 and 4 can all meet the demand in all years as the amount of potable water (desalination or mainland supply) can be balanced to take into account dryer years
- Option 2 does not achieve reliable supply of water in all years, i.e. would fail to meet adequate supply requirements in dry years
- Options 5 and 6 can meet reliability requirements in terms of quantity but result in generation of several hundred megalitres of treated wastewater per year requiring disposal via irrigation (over and above irrigation requirements of the proposed development).

Cost estimates were prepared for each of options 1, 3 and 4 and are presented in Table 4.3. Table 4.3 also shows the extent to which each of these options reduces overall dependence on potable water supply, compared to conventional urban developments. Option 3 shows a reduction in potable water supply requirements of almost two thirds.

Table 4.3 - Estimated Cost of Alternative Water Supply Options

Option	Description	Potable substitution	Est Capital Cost ($000s)
Option 1	3rd pipe reticulation plus potable	57%	$33,013
Option 3	3rd pipe reticulation, rainwater tanks, plus potable	65%	$35,680
Option 4	Greywater, 3rd pipe reticulation plus potable	57%	$43,213

Option 3 was selected as the preferred option on the basis that:

- Capital costs are comparable to Option 1 and lower than Option 4

- It achieves the highest degree of potable substitution
- It complies with Miriam Vale Shire Council requirements that all new households and accommodation units have rainwater tanks installed.

4.4.2.3 Potable Water Supply- Options Considered

The final matter to be resolved in selection of the preferred water supply strategy is the source of potable water. Having determined that rainwater tanks alone cannot supply reliable enough yield for potable water, two other sources have been identified:

- Desalination
- Mainland supply from Calliope Shire Council.

For the mainland supply option a new pipeline between the Tannum Sands reservoir and PTP would be required. Two alternative pipeline routes were identified; one following existing roads and the other taking the shortest route which would include crossing Colosseum Inlet. Capital and operating cost estimates for all three were prepared and are shown in Table 4.4. Operating costs are presented as Net Present Value annual costs over 25 years. While energy consumption is a consideration for all three options, it has not been considered separately as it is implicit in the operating costs.

Table 4.4 - Estimated Cost of Potable Water Supply Options

Option	Description	Estimated Capital Cost ($000s)	NPV ($000s)
Option A	Tannum Sands Reservoir via southern route	$9,750	$ 9,891
Option B	Tannum Sands Reservoir via Colosseum Inlet	$5,150	$ 7,693
Option C	Desalination	$8,500	$11,485

Option B, a supply from Tannum Sands reservoir via Colosseum inletwas demonstrated to be the most cost effective option for potable water. However, the proposed pipeline route traverses estuarine wetlands and would also be required to cross Colosseum Inlet which is a deep, relatively fast flowing body of water. Environmental and construction considerations mean that this option was discounted in favour of Option C, desalination.

Mechanical Vapour Compression (MVC) technology has been suggested for desalination water supply. MVC technology is suitable for small scale applications such as PTP and is cost effective and energy efficient at this scale. It is also straightforward to operate, with low maintenance requirements.

A more detailed investigation into preferred desalination technology will be undertaken in the detailed design stage to ensure that the most appropriate type of desalination plant is selected. In particular, energy efficiency of a range of plants will be investigated and the most energy efficient plant selected. Regardless of the technology selected, a brine concentrate stream will be produced, hence all technologies will have a similar environmental footprint in this regard.

4.4.3 Wastewater Treatment Options

Selection of an integrated water supply system means that wastewater treatment options must be able to reliably produce high quality recycled water suitable for most household uses. This is consistent with project performance targets and development principles set out in Section 2. Relevant targets and principles for wastewater treatment are reproduced in Table 4.5.

Table 4.5 - Wastewater Treatment Targets and Principles

Performance Targets	Development Principles
Quality of water is appropriate for designated uses Environmental quality is not degraded	Discharge of treated wastewater occurs only in high rainfall events (>3 x ADWF) Wastewater is treated and reused. A reliable water supply is available for fire fighting

The wastewater treatment plant will be located in the Island Services Centre along with the water treatment plant, emergency generators, electricity substation, maintenance depot and LPG gas tanks. This location was chosen to provide these industrial uses with significant buffers to the tourism and residential precincts. The location will also provide the plant with an emergency discharge into an ephemeral steam feeding into Boyne Creek.

The treatment plant is based on a high velocity sonic disintegrator technology that meets the requirements of the project and is already in use in similar applications nearby, at Agnes Water. This technology does not produce any difficult-to-dispose wastes or consume excessive energy or chemical resources. However a further review of the latest technologies will be undertaken in the detailed design phase to ensure that any recent developments in wastewater recycling have not been overlooked.

4.4.4 Power Supply Options

Consulting Engineers Lincolne Scott P/L and MPI P/L were commissioned to undertake studies into the supply of electrical power to the development. Alternative power sources investigated included combinations of:

- Mains grid connection from Ergon Energy's 22KV network on the mainland
- On-Island generation using a gas fired cogeneration plant or diesel engine generators
- Large scale wind turbines
- Solar/photovoltaic cell arrays.

All investigated alternatives concluded that:

- A baseload supply of electricity will be required from the mainland grid to ensure security of supply to the development
- Extension of the grid to service PTP cost effective compared to other sources of electrical power identified

- The baseload supply could be supplemented by the other sources including those listed above.

A gas fired, cogeneration plant could be developed on the Island to provide reticulated chilled water, hot water and electricity to the high density housing and commercial buildings, as well as chilled water and electricity to adjacent residential lots. The chilled and hot water could be reticulated in pre-insulated direct buried pipe work and the electricity fed back into the Island electricity grid. The overall annual electrical energy consumption, as well as the electrical maximum demand, for the Island, could be significantly reduced if a cogeneration plant were installed. Greenhouse gas emissions (from coal fired power generation) would be significantly reduced if cogeneration replaced supply from the mainland grid. This option will be further investigated during detailed design of the town centre buildings and facilities.

Wind power is becoming increasingly popular worldwide, in both giant utility-scale installations and small-scale turbines intended to power a single home. Recent analyses show that wind power is considerably more environmentally friendly than, for example, electricity produced by coal-fired power stations. It uses fewer non-renewable resources, causes less local or regional air pollution and makes virtually no contribution to the enhanced greenhouse effect. Advances in wind power science and technology are reducing the cost of wind power to a point at which it is becoming competitive with many other energy sources, but still far greater that the cost of supply from the grid. To provide an effective electrical supply and make significant reduction in the islands greenhouse gas emissions a number of large scale wind turbines, standing up to 100 m high with 30 m blades would need to be installed. The proponent considers that large scale wind generators would be visible from sensitive receptors around the Island and would have significant and unacceptable aesthetic and visual impacts.

Solar power generation through photovoltaic cells is currently not an effective, efficient or economic solution for supply of electricity on the Island. However from 1 March 2006 all new homes built in Queensland are required to install energy efficient hot water systems (solar, gas or electric heat pump) and use energy efficient lighting for at least 40 per cent of internal floor space. All residences in the proposed development will be required to install solar hot water systems reducing electrical power demands.

4.4.5 Boat Ramp Options

The proposed boat ramp would be adjacent to the bridge to HHI over Boyne Creek. This site was chosen for the following reasons:

- The ramp is in an area that has already been disturbed by construction of the existing causeway
- The ramp is within a corridor that has been excluded from the Fish Habitat area
- The ramp is at the entrance to PTP and will provide easy access for visitors to PTP
- The ramp is in a calm estuary protected from high winds and wave action

4.5 Reason for Choice

The proposal is to develop a sustainable tourist development on Hummock Hill Island. The island is undoubtedly the best development location for coastal tourism in the Gladstone region, where the majority of the coastline is dominated by National Parks or port and industrial development. The Island has a desirable location, fine beaches and peaceful estuaries.

Industry in Gladstone has a history of having difficulty in attracting staff to live in the area because of a lack of facilities and a perception of pollution of the urban areas from adjacent industrial and port development. The PTP will provide people living in the Gladstone Region with a much needed, high quality recreational destination with excellent beaches, sporting and leisure facilities that are not currently available in the region. The development will enhance the social and recreational infrastructure in the Gladstone Region, making the region more attractive to investors, particularly in industry and tourism. Central Queensland will benefit both economically and socially from a sustainable and integrated tourism industry on the island.

Special Lease No. 19/52155 was issued for the purpose of undertaking feasibility studies and environmental investigations to prove up a major development project on the Island for business, industrial, commercial, residential, tourist and recreation purposes. Upon receiving necessary development approvals the proponent must provide basic infrastructure, including access roads, a bridge across Boyne Creek, water supply, wastewater treatment and electrical power to the Island. The proponent then has the opportunity to purchase and develop the land from the State for the uses listed above. The major up-front investment required to provide the basic infrastructure will be approximately $30 million which can only be recovered though development of project of a scale similar to that proposed. Development of this environmentally sustainable infrastructure would not be justified by a small scale development or alternatively would make the proposed tourism and property residential markets on the island too exclusive for a predominantly intrastate tourism market.

4.6 No Project Option

The no project option would result in Hummock Hill Island remaining in an unused state. Economic benefit of the project would be foregone, including:

- Domestic, interstate and international expenditure predicted to be $55pa million by 2022 and $95pa million by 2030
- International tourism expenditure (excluding domestic and interstate tourists) to the region of $151.2 million (NPV) over a 30 year period from the date of development inception

An estimated average of 190 jobs per year from 2015 to 2030 would be directly generated during construction, and a peak employment of 350 persons. When indirect employment is included, construction is estimated to generate an average of 260 jobs per year, and a peak employment of 460 persons. At a state level, the project is estimated to directly and indirectly generate an average of 300 jobs per year, and a peak employment of 550 persons. Employment opportunities expected to be generated during construction include both skilled and unskilled positions, including in engineering design, construction supervision and trades, earthmoving, equipment operation, transport and building and landscaping.

Following construction, employment opportunities would also arise from tourism activity generated by the project. It is estimated that the number of jobs created directly and indirectly by the Project is expected to rise steadily to the peak level in 2025, in the order of 700 persons. At a state level, the tourism expenditure is estimated to directly and indirectly generate up to 850 jobs per annum by 2025. Employment opportunities generated during the Project's operation are expected to include administration and management (i.e. resort and facilities management), service-

Access to high quality tourism, residential, and recreational opportunities for existing and future residents of the region, including residents attracted to the region by further development in the State Government's Gladstone State Development Area

PTP has the opportunity to accommodate 5% of the Gladstone Regional Council area growth in a sustainable low impact/footprint development.

The Island does provide limited habitat for species of conservation significance, such as the Black Breasted Button Quail in the coastal vine thickets and migratory birds on the intertidal area to the south of the island. However the essential habitat for these species is outside the development footprint and a vegetation buffer is located between the development and habitat for these species. Areas of the Island with higher conservation significance, particularly the coastal zone and endangered regional ecosystems are not directly impacted by the development, hence, whether or not the project proceeds does not affect the ongoing conservation value of these areas.

SECTION 5
Project Need and Justification

Contents

5. Project Need and Justification

5.1 Introduction

Hummock Hill Island has suitable natural attributes and topography for a major resort and recreational development and is also extremely well located in this regard. The natural attributes of HHI, with its sandy beaches and warm seas, elevated hillsides with sea views, bushland and calm waterways in a protected estuary will attract international, interstate and local visitors and holiday makers. The island offers access to world class fishing, calm waters for swimming and bushwalks. The project will have a variety of quality restaurants, cafes, clothes boutiques tourist shops local handcrafted wares and artworks. Visitors will also be able to experience local Aboriginal culture and historical sites, through the Indigenous Interpretive centre.

PTP offers the only real opportunity for a major seaside tourism, holiday and recreational development in the Gladstone region. The coast from 1770 to Gladstone is mostly National Park and the coast north of Gladstone is quarantined for industrial development and oil shale exploitation. The Development will provide public access to a coastline that is presently only accessible by boat. Located at the southern end of the Great Barrier Reef, the location is also less vulnerable to cyclones and severe tropical storms.

PTP will provide public access to arguably the best beaches between 1770 and the Capricorn Coast. PTP will also offer high quality leisure and accommodation opportunities for the regional population.

The $956million private sector project is of both state and regional significance with the potential to be the focal point for tourism, and act as a catalyst to a range of other tourism investment in the Gladstone region. The Proponent will provide all necessary infrastructure for PTP as well as contributions for external infrastructure so that local and State infrastructure providers are not affected. The project will not require government or public sector investment.

The new design of PTP has been planned to not adversely impact on the MNES and particularly those elements that contribute to the OUV of the GBRWHA and takes all environmental opportunities and constraints into consideration to ensure that PTP takes place within the sustainable limits of its environment. PTP takes place on only 10% of the island area.

The undeveloped areas of the island outside the development boundary will be given protected status under Queensland State Government legislation. The Proponent will be responsible for land management of the protected areas of the island during the period of the project. The long-term management of the undeveloped areas will be guided by an Environmental Management Plan to be implemented by a professional environmental management contractor. The costs of long term management will covered by a special area environmental charge to be paid by the land owners on the island through Gladstone Regional Council's rates system.

5.2 Project Justification

5.2.1 Regional Tourism Development

The Queensland Tourism Strategy (2006) set a number of ambitious targets for tourism growth. The strategy clearly recognised the need to invest in new tourism products for the state to maintain its competitive advantage. The Strategy provided the funding and impetus for the preparation for the Central Queensland Tourism Opportunity Plan (2009-2019) (TOP). The Plan proposes a direction for the sustainable development of tourism in the Central Queensland Region to 2019.

The Plan's vision statement is to:

> ***"Encourage profitable and sustainable development that immerses the ideal visitor in experiences that are sensitive to the unique natural, cultural and lifestyle features of Central Queensland"***

The development of PTP fully supports this vision. The TOP identified the target growth tourism markets in the region as shown in Table 5.1. The PTP offers tourist facilities and infrastructure that appeal to all of the identified target markets.

Table 5.1 - Gladstone Regional Tourism Target Markets

Target Tourism Markets	PTP Response
"Escape" Escape to Reality – Real Adventure, Real Experiences, Real Holidays. From snorkelling the reef, fishing and surfing to gem fossicking, outback cattle stations, scenic gorge country, or touring industrial giants – the experience is real in Central Queensland, not manufactured. You can touch and feel everything about it.	PTP will provide public access to the best beaches on the Capricorn Coast. The project will offer excellent "escape " activities including: • trips to the GBR and offshore islands • bushwalking, • horse riding, • tours of Colosseum Inlet and Rodds Bay, • industrial tours, • beach swimming and fossicking, • guided turtle hatching tours
"Discovery" Discovering nature, discovering industry, heritage, culture and discovering self. Experiences of exploring, learning, reconnecting, understanding, reflecting, regenerating, rejuvenating.	PTP will appeal to visitors seeking "discovery" experiences including: • Guided bushwalks through the protected areas of the island (avoiding the highly sensitive areas such as migratory shorebird habitat) • Aboriginal interpretive centre providing a history of the islands traditional owners • Learning about the European heritage history of the island
"Learning/Education" Learning about the lifestyle of the Central Queensland Region, learning about the industry and job opportunities, learning about nature, culture and heritage of the region, and imagining what it would be like to 'live the life'.	PTP will have an Education and Research Centre that focuses on sustainable coastal development. Activities for visitors will include visits and educational programs in: • Sustainable environmental development Environmental management of the island • Aboriginal heritage • European heritage • Terrestrial and marine research including

Target Tourism Markets	PTP Response
	ecological and environmental monitoring programs • Land care and conservation programs. • Awareness Programs on GBR World Heritage Values • Marine mammal and turtle monitoring programs in the Rodds Bay Dugong Protection Area.
"Adventure" Many adventurous things to do, fishing, surfing, snorkelling, visit National Parks, gem fossicking, visit coastal townships.	PTP will provide an avenue for adventurous activities including: • Fishing charters • Estuary fishing • Canoeing • Dinghy sailing • Bushwalking • Trail riding

As shown above, the PTP will appeal to a broad range of visitors including:

- The short break market
- Visitors seeking beach and adventure holidays
- Domestic and international 'touring' visitors seeking a new off the beaten track destination or avoid those parts of the GBR that are more vulnerable to cyclones
- Sports people seeking active holidays
- Visitors seeking an educational experience
- International backpackers
- Conference visitors.

The TOP identified the need for new tourism products with specific development goals that meet the demands for growth target markets. Table 5.2 shows how the PTP would achieve these goals.

Table 5.2 - Development Goals

TOC Development Goals	PTP Response
Contribute to a positive image of the area as a destination in its own right (not just a stopover) for local and international visitors and business people	PTP will be of international standard and clearly contribute to a positive image of the region as a destination in its own right for both domestic and international tourists PTP will be a model for sustainable development in coastal areas
Recognise and highlight the internationally and nationally significant natural and heritage assets	PTP is within the GBRWHA and borders the GBRMP The design of the project recognises the importance of its location and minimises impacts on the island and its surrounding environment Tourism and educational programs and tours will provide ongoing detail of the islands environment and present the OUV of GBRWHA
Successfully blend nature based and industrial tourism to create a spectrum of experiences that encourage an increased length of stay	As described in Table 5.1 the PTP is designed around adventure, discovery and education focussed tourism. The wide range of tourist activities available on (and

TOC Development Goals	PTP Response
	from) the island will encourage visitors to increase their length of stay in the region
Protect and enhance the lifestyle of residents in Central Queensland	PTP will provide residents of the region with a high quality resort destination for short term stay visitors and day trippers that is not currently available in the region
Target a specific market that appreciates the regions unique character and successfully provide infrastructure suitable to their needs	PTP will appeal to a broad market spectrum providing a wide range of types and cost of accommodation and a wide range of sporting and leisure activities
Products that match the natural assets of the region and provide immersive experiences where you can get-away from the crowds	As described in Table 5.1 above the PTP will use the natural assets and beauty of the island and its surrounding waters to provide interesting and exciting holiday experiences
Support a profitable and sustainable tourism industry	PTP will be the central focus for tourism in the Gladstone Region, along with Heron Island. PTP will be a master planned community providing economic and social stability and prosperity for the island's population. The proposed mix of tourist and permanent accommodation will provide a sustainable community The social environment will be based on a vibrant, dynamic and diverse community that has a strong environmental awareness and is committed to sustainable living and self-development.

The TOP undertook project assessments, using the criteria listed in Table 5.3.

Table 5.3 - Tourism Project Criteria

TOP Criteria	PTP Response
Is the product unique or provide a competitive advantage for the region?	The PTP will be unique in the Region. There are no other mainland tourism developments proposed or envisaged in the region that will provide the quality of tourism product or scope of leisure facilities provided by PTP PTP will provide a significant advantage to tourism in a region where tourist accommodation is generally of a low standard and the majority of short term accommodation is targeted at business travellers
Does the project meet the needs of growth target markets?	Qld Tourism estimated that both domestic and international tourism will grow significantly over the next 20 years without PTP PTP is a stand-alone international standard tourist destination that will support the growth target markets and create its own market. The project is 10 minutes from the Bruce Highway and will be a popular destination for the growth target markets- "Escape, Discovery, Learning/Education and Adventure" holiday makers
Is the product/project demand driven?	The Queensland Tourism demand forecasts for tourism growth clearly indicate the need for quality tourist accommodation and infrastructure. PTP meets both of these criteria, providing a wide range of

TOP Criteria	PTP Response
	accommodation types and a wide range of leisure and sporting activities.
Is the project aligned with Local, State or Federal Government's priorities and likely to gain support from the decision-makers?	The project has been approved by both state and local governments Negotiations are continuing with the Commonwealth Government over the environmental impacts of PTP
Is the project aligned with the vision for the region and community aspirations?	The project has been approved by both state and local governments and has the support of the GAPDL and the GEIDB. The project is obviously aligned with government, industry and community aspirations and GAPDL's vision for tourism in the Gladstone Region. The newly designed PTP proposes to meet government objectives of protecting the MNES and OUV's of the GBRWHA

5.2.2 Regional Economic Development Strategies

"The Gladstone Region will be recognised, nationally and internationally, as a sustainable "region of choice" for achieving the best integration of large industry and commerce, environment protection and community wellbeing. We will be renowned for balance: a friendly, clean and vibrant place in which to work, live and raise a family." (Extract from Gladstone Region Vision 2028 Statement, August 2008)

Regional economic growth is very positive. In the 2009/2010 financial year, estimated gross regional product (GRP) of the Gladstone Region was $2.5 billion. The Region's GRP was dominated the industrial sector with an output of $2.0 billion. The agricultural sector contributed $40 million to the region's economy while regional tourism expenditure totalled $270 million. Future economic growth is focussed on the development of major industrial projects. Plants currently under construction in the Gladstone region have a financial investment of approximately $55 billion with a further $30 billion of proposed projects in the pipeline. These projects will bring major population growth, economic development and employment. GEIDB estimated that investment in project construction, infrastructure and future operations will create over 20,000 local job opportunities over the next 20 years. Significant contributions from industry, totalling $162million, are already committed for specific social infrastructure projects. State, Commonwealth and Local Government commitments are also providing $1.5billion for specific infrastructure projects.

"Economic development" is typically measured in terms of jobs and income but it also includes improvements in human development, education, health, choice and environmental sustainability. It will be essential to diversify and balance the economy of the Gladstone Region in order to achieve those outcomes for the community.

> *"For the Gladstone Region to compete effectively at a national and global level, it is imperative to embrace and encourage a diversity of economic activity. Only with a diversity and balance of industry and employment across a range of sectors will the region be capable of providing for its future residents in a sustainable fashion."*
> Gladstone Regional Economic Development Strategy (March 2010)(GREDS)

Economically, the Gladstone Region has depended on the manufacturing and construction sectors, underpinned by major investments in minerals processing and export trade, as well as its traditional strength in agricultural production. This reliance has exposed the region to the vulnerabilities of what could be considered a narrow economic base, subject to the vagaries of boom and bust cycles and to national and international economic impacts. A major challenge facing the region is the need to diversify its economic base.

The tourism sector is second only to the industrial and services sector in the region and must be supported to diversify the regional economy. Tourism promotion and development can build on the region's existing coastal, city and rural assets to provide a fully integrated and appealing regional tourism product. Major investment in tourism infrastructure and projects will be essential to ensure growth of the sector. The PTP Tourism Project would be a major non industrial project that meets all of the economic objectives of GREDS, as demonstrated in Table 5.4.

Table 5.4 - GREDS Economic Development Strategies

GREDS	PTP Contribution
The Gladstone Region will ***continue to grow and diversify its economic base***, building on its industrial strength, its established manufacturing and world class port infrastructure to become Australia's premier 21st Century industrial region.	PTP is a $956 million private sector project that will diversify the regional economic base. The Project is expected to inject $55 million per annum in tourism expenditure by 2022 and over $95 million by 2030. $390 million direct and indirect regional and $460 million added to Queensland economies from building and construction $810 million direct regional value-added income from tourism expenditure Construction of the project will employ an average of 190 persons pa over a 20 year period The completed project will employ over 700 permanent full time positions.
The Gladstone Region's economic development will be characterised by the continual ***development of local business and industry*** from within the region, and across all communities, providing a diversity of ***sustainable employment and career opportunities*** for the region's residents.	The project will be primarily constructed by local contractors and builders using local expertise and labour. PTP will offer career and employment opportunities in a non-industrial sector. The region's residents, particularly young people will benefit from these opportunities. The project will help in retaining people and expertise in the region
The strength of the Gladstone Region's industry will be balanced by a depth and diversity of business and employment across the region's supply chain, including its ***retail and service industries*** and its ***strong and continually developing agricultural sector***.	PTP will be a stand-alone international standard tourist destination that will be a catalyst for tourism growth in the region. Significant retail, commercial and service facilities are incorporated into PTP to support tourism
The Gladstone Region will continue to develop its ***tourism*** sector through co-ordinated regional branding and product development. Tourism promotion and development will build on the region's existing coastal, city and rural assets to provide a fully integrated and appealing regional tourism offer.	The PTP will be unique in the Region. There are no other mainland tourism developments proposed or envisaged in the region that will provide the quality of tourism product or scope of leisure facilities provided by PTP The island has amazing natural attributes for tourism development- north facing white sand beaches,

GREDS	PTP Contribution
	elevated topography with outstanding outlooks over the Coral Sea and protected estuaries Central Queensland is losing market share in tourism against other Queensland destinations. Central Queensland is losing market share in tourism against other Queensland destinations and PTP will act as a catalyst to stimulate future tourism investment in the Region
The Gladstone Region's economic development efforts will continue to ***recognise and observe the values of the region***; strong leadership and governance, environmental sustainability, people safety, cultural diversity, community wellbeing, social inclusion and opportunity for all.	PTP will be a low impact master planned community based on complete eco-Sustainable development (ESD) principles. PTP will provide a social environment with strong environmental awareness, committed to sustainable living and self-development. The project will provide a range of affordable housing types for the islands employees The project will provide a large number of community and public facilities The project will include an Aboriginal interpretive centre promoting knowledge, understanding and respect for the traditions and culture of the Traditional Owners. PTP will provide a wide variety of housing, including affordable housing for people working in the tourism industry on the island
The Gladstone Region's appeal as an investment location and as a place in which to work, live and do business will be underlined by the region's lifestyle attributes including its diverse geography comprising small towns, rural areas, coastal enclaves and urban centres, its wide range of quality education, environmental values, recreational and community services and facilities and the diversity of its economy. These attributes will serve as key attractors for new business investment and skilled workers.	PTP will become the focus of tourism in Gladstone, improving the Regions image as a place to work and live. The project will significantly improve the Region's tourism and leisure infrastructure The project will act as a catalyst for further investment in tourism in the region. The project will be a model for sustainable coastal development in Australia The project will provide an extensive range of community and social infrastructure

5.2.3 Support for a Growing Regional Population

"One third of the population lives there not by choice but because circumstances demand it" (TQ Research)

Economic growth fuels population growth and over the next 10 years, Central Queensland's regional economy, population growth and investment will continue to be driven by the mining, mineral resources and energy industries. With current developments in the coal seam gas industry driving rapid population growth, substantial social infrastructure will be needed to meet this increase in population. There will also be increasing pressure on transport infrastructure and utilities to meet growing demand.

The medium series growth projections used for the 2010 Social Infrastructure Planning Study anticipated the Gladstone regional population to grow to around 98,000 by 2031. However OESR

2011 high series population projections indicate that the population will grow from the current level of some 64,000 people to 123,000 by 2031. 60,000 new dwelling units (apartments, townhouses and houses) will be required to accommodate this growth. There will also be great demand for social infrastructure such as hospitals, doctors; aged/community care, police, child care; schools; sporting, leisure and cultural facilities.

The Gladstone Region must present an exceptional social climate as well as a good business climate to successfully compete for business investment and attract people to work in the region. The social climate would include access to:

- Good social, cultural and recreational services
- A high quality urban lifestyle
- A good physical environment.

These elements are particularly important for an industrial city like Gladstone, where a high quality of life can attract a diversity of business people and skilled workers in spite of the significant industrial landscape.

The coastal areas adjacent to the major industrial centre will serve as an escape destination for regional residents. PTP in particular will offer wonderful leisure and accommodation opportunities for the people in the Region. The project will be the only major tourist destination in close proximity to the major regional population centres. The project will offer the best destination for day trippers and short break holiday makers from the Region and will be a major asset in attracting people to migrate to the region for investment and employment.

Community and public facilities proposed for PTP:

- Beachside public parks
- Public golf course and sports club
- Tennis courts
- Squash courts
- Lawn bowling club
- Surf Lifesaving Club
- Sports centre
- Swimming and diving
- Sailing club
- Nature education, bushwalks, HHI lookout
- Emergency services
- Tourism information centre
- Indigenous cultural centre
- Potential for helicopter transfers to the GBR Islands
- Boat ramp
- Airstrip
- Tourist park and camping
- Commercial and retail precinct
- Cafes / restaurants.

This major development of leisure and sporting infrastructure be a major regional asset and improve the quality of life of the local population

5.2.4 *Future Market Demands for Visitor Accommodation*

In June 2010 the Gladstone Region had only 36 accommodation establishments with capacity of 5 or more rooms. For the past 5 years the majority of these establishments have been catering to persons travelling on business. In 2009/10 the occupancy rate of these establishments averaged 49%, reflecting the high rates achieved during the week from business travellers and low occupancies at the weekends. This pattern of use discourages the tourist traveller, seeking extended stays and unable to find mid-week accommodation because of the high occupancy by business travellers. Further, most accommodation is location in the City of Gladstone, which may discourage tourists seeking to stay in a natural environment setting.

There has been acceleration in the development of short term accommodation in Gladstone City over the past 2 years. However PTP is not targeting accommodation for short term employees of the major industrial developments (such as the coal seam gas processing plants) that will be constructed over the next 10-20 years. The PTP will be designed with tourism as its focus and accommodation on the island will be designed to meet future tourism demands and to attract a broad spectrum of new tourists to the region as well as provide tourism and recreational opportunities for existing residents.

PTP, as a stand-alone international standard tourist destination, will support the growth target markets and create its own market. The Queensland Tourism demand forecasts for tourism growth clearly indicate the need for quality tourist accommodation and tourism infrastructure. The PTP will provide international standard accommodation and leisure facilities and experiences.

Published tourism data and statistics from QT have been used to assess future market demands to 2030 (when the PTP will be completed) to assess the impact the project will have on future tourism accommodation needs. Visitor projections for the year 2030 are shown in Table 5.5.

Table 5.5 – Gladstone Regional Visitor Projections

Visitor Category		% of Category	2011 Visitors	Growth projections	2030 Visitors	2030 Visitor Nights
Domestic						
Holiday (217000) and VFR (142,000)	Short break	34%	122,060	3.3% pa	226,190	452,380
	Beach Holiday	46%	165,140	1.0% pa	199,510	798,040
	Domestic touring	20%	71,800	1.0%pa	86,740	346,960
Business (118,000)	Business Travel	95%	112,000	3.3% pa	207,550	724,500
	Business Events	5%	6,000	3.3% pa	11,120	38,920
International						
Holiday (43,000) VFR (4,000)	Touring	100%	47,000	4.0%	99,020	396,080
Business (4,000)		100%	4,000	4.0%	8,430	33,720

Accommodation demands from this growth in visitors to the region are shown in Table 5.6.

Table 5.6 – Gladstone Region Tourist Accommodation Demands

Visitor Category		2030 Visitors	2030 Visitor Nights	Hotel/Motel		Caravan Park / Backpacker		Other	
				% of visitors	Visitor nights	% of visitors	Visitor nights	% of visitors	Visitor nights
Domestic									
Holiday VFR	Short break	226,190	452,380	40%	180,952	20%	90,476	40%	180,952
	Beach Holiday	199,510	798,040	45%	359,118	20%	159,608	35%	279,314
	Domestic touring	86,740	346,960	30%	104,088	45%	156,132	25%	86,740
Business	Business Travel	207,550	724,500	80%	579,600	10%	72,450	10%	72,450
	Business Events	11,120	38,920	90%	35,028			10%	3,892
International									
Holiday VFR	Touring	99,020	396,080	30%	118,824	45%	178,236	25%	99,020
Business		8,430	33,720	90%	30,348			10%	3,372
TOTALS		**838,560**	**2,790,600**		**1,407,958**		**656,902**		**725,740**

The PTP is expected to achieve a significant market penetration rate for visitor accommodation in the Region (as shown in Table 5.7) because of the quality and variety of product offered and the wide range of leisure activities available. The PTP is 35 minutes from central Gladstone City and with good transportation services will also attract a significant number of business visitors.

Table 5.7 - PTP Market Penetration

Visitor Category		Penetration Rate	2030 Visitors	2030 Visitor Nights	Occupancy factor	Room Nights		
						Hotel/ Motel	Caravan Park / Backpacker	Other
Domestic								
Holiday VFR	Short break	15%	33,929	67,857	1.5	18,095	9,048	18,095
	Beach Holiday	15%	29,927	119,706	1.5	35,912	15,961	27,931
	Domestic touring	15%	13,011	52,044	1.5	10,409	15,613	8,674
Business	Business Travel	5%	10,378	36,225	1	28,980	3,623	3,623
	Business Events	10%	1,112	3,892	1	3,503		389
International								
Holiday VFR	Touring	20%	19,804	79,216	2	11,882	17,824	9,902
Business		5%	422	1,686	1	1,517		169
TOTALS			**108,581**	**360,626**		**110,298**	**62,068**	**68,783**

The “Travel for a Purpose” market segment is a collection of niche market segments that are not included in the leisure holiday/VFR domestic and international data. These markets provide opportunities for overall market growth relying on targeted promotion and marketing to sell the product. The PTP will attract “Travel for a Purpose” visitors as shown in Table 5.8.

Table 5.8 - Travel for a Purpose to the Gladstone Region

Purpose	Number of Events pa	Event Visitors	Visitor Room Nights	Total Room Nights
Weddings	26	150	60% of 150 stay 1 night @ 1.5per room	1560
Regional Conferences	12	150	80% of 150 stay 2 nights @ 1.5 per room	1920
Fishing tours	30	10	Staying 2 nights	600
Golf Events	12	150	80% of 150 stay 1 night @1.5 per room	960
Miscellaneous sporting events: tennis, lawn bowls, squash, sailing	50	250	30% of 250 stay weeks, 2 night @ 1.5 per room	5000
Reef Trips	300	20	2000 visitors staying 2 nights @1.5 per room	8000
Educational		2000	2000 visitors staying 4 nights @1.5 per room	5330
Gladstone Industry Short Breaks	50	50	Staying2 nights@ 1.5 per room	3330
Total	**70% in hotel/motel, 20% in caravan park, 10% in other**			**26700**

In addition to the above visitor numbers PTP will create its own market and significantly increase tourist visits to the region above the currently projected demands. As a new International standard destination with exceptional recreational and leisure facilities PTP is expected to attract an additional:

- 30,000 visitors per annum staying in hotel/motel accommodation
- 12000 visitors per annum staying in the caravan park and backpacker accommodation
- 50,000 visitors (including unit owners) staying in rental units/chalets

5.3 Conclusion

PTP is on HHI, an island with in a unique location in that it provides ready access to coastline, beaches, waterways, ocean views and bushland areas. HHI is also close to Gladstone for health, transport, education and social services. HHI is also unique from the perspective that other areas of the coastline in the region are committed to development for port, mining, national parks and urban uses.

HHI is the only location in the central Queensland area that provides the diversity of settings in relative proximity by road to a major service centre and that is available for development.

PTP meets the criteria for, and is considered a “Catalyst Project” under the Central Queensland Tourism Opportunity Plan (2009-2019).

PTP meets all of the economic objectives of the Gladstone Regional Economic Development Strategy (March 2010) by diversifying the region’s economic base, diversifying the community profile, and adding to the region’s appeal as an investment location and as a place in which to work, live and do business. PTP provides major employment opportunities in the region during construction and longer term permanent jobs in tourism and supporting industries.

The PTP will make a major contribution to meeting regional tourist accommodation demands over the next 20 years offering a wide range of accommodation types, from 5 star hotels, serviced and self-catering units and villas through to cabins and caravan park and backpacker accommodation. PTP will appeal to a broad cross section of both domestic and international tourists and a major recreational hub for the regions residents.

SECTION 6
Environmental Characterisation

Contents

6. Environmental Characterisation

6.1 Topography and Land use

6.1.1 Introduction

Hummock Hill Island (HHI) is a continental island separated from the mainland by Boyne Creek a shallow, tidal channel connecting Colosseum Inlet to the west and Seven Mile Creek to the east (see Figure 1-4). The island is approximately 8 km long and 3.5 km wide. A range of hills runs north-south across the island, separating the western third from the eastern two thirds. Otherwise, the island is flat to gently undulating. The southern coastline of HHI is fringed with mangroves and supra-tidal salt flats while the western and northern coastline features sandy beaches. There is a prominent rocky headland on the north coast which divides the northern beaches into a distinct east and west component.

6.1.2 Topography

The topography of HHI is characterised by four distinct units:

- The Main Range unit – which consists of a line of low rocky hills, which run approximately north-south across the centre of the island. The highest point on the island is Hummock Hill with an elevation of 126.2 m AHD. The slopes of the foothills are steep and concave, and decrease rapidly in slope with distance from the main range, where they merge into the adjacent plains. Rock either outcrops or occurs at shallow depths or as scree with soil depth only increasing as the slope flattens off
- Undulating plains underlain by acid intrusives occur at the base of the Main Range unit and surrounding areas. They appear as plains merging with the dune areas to the west and east or to the tidal flats to the south
- Sand dune areas extend from the undulating granodiorite plains to the west, north and east coasts of the island, merging into coastal beaches. The frontal dune system is stabilised by coastal vegetation such as Sand Spinifex and Dune Couch
- Tidal areas comprising mangroves and salt flats.

Topographical features of the island are shown on Figure 6.1.

Figure 6.1 - Hummock Hill Island Topography

LEGEND

- Index Contour (5m)
- Intermediate Contour (1m)
- Development Footprint

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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6.1.3 Land Form

Six broad land form patterns are represented on HHI based on MacDonald *et.al.* (1990). Table 6.1 describes the main landforms identified on HHI.

Table 6.1 - Landform Patterns on Hummock Hill Island (after MacDonald *et al.* 1990)

Landform Pattern	Landform Descriptors
Beaches	Very gently inclined to gently inclined aggraded slopes at <5%, occasionally gently undulating plain with a wave built berm at the slope crest, intertidal
Sand Plains	Very gently inclined to gently inclined aggraded gently undulating plain with relict parallel beach ridges with slopes between 5-10%
Tidal Flats	Very gently inclined to gently inclined aggraded gently undulating plain, intertidal
Colluvial Plains	Gently inclined to moderately inclined aggraded slopes between 5-10% undulating rises typically forming the waning lower slope
Low Hills	Gently inclined to moderately inclined eroded rolling rises with slopes between 10-20% on granodiorite with occasional tors
Central Ridge	Moderately inclined to steep ridge with slopes greater the 20% with a crest leading to maximal upper slopes that lead into waning mid and low slopes, eroded, steep low hills to steep hills with drainage depressions and ephemeral creeks

6.1.4 Natural Systems and Features

Natural systems and features of HHI vary with soil type and topography and include:

- Low frontal dune & beach system with sparse *Casuarina spp.* and *Pandanus spp.* with a sparse ground cover of *Spinefex spp*
- Undulating low dunes and relict beach ridges with intervening depressional swales, with moderate dense littoral vine scrub, large emergent *Melaleuca spp.* and Moreton Bay ash
- Coastal wetlands, consisting of supratidal saltpans and mangrove forests adjacent to sheltered estuaries
- Open and closed woodland including endangered and of concern regional ecosystems.

While vegetation is reasonably diverse, the range of native animals on the Island is limited, with most diversity seen in bird populations.

Flora and fauna surveys have identified remnant vegetation and a small number of animals listed under Commonwealth and State legislation. Beaches along the northern side of HHI are considered suitable for marine turtle nesting, with intermittent, low density nesting recorded as discussed in Section 6.6.4 and Section 7.4.4.3. More information on flora and fauna is provided in Sections 6.6 and 6.7 and Sections 7.4 and 7.5.

LEGEND

Development Footprint

Slope Analysis (%)

- < 5
- 5 - 10
- 10 - 20
- > 20

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Figure 6.2 - Slope and Landform Analysis

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The island is wholly contained the GBRWHA, the boundary of which lies at the highest astronomical tide mark along the mainland coast. Although within the GBRWHA, HHI does not have any formal conservation status, nor has it come under any kind of management plan in relation to its World Heritage status. The adjacent Wild Cattle Island is a National Park but does not have any formal management plan.

The Island is bounded along the northern edge by the GBRMP and the waters between HHI and the mainland are within the GBRCMP (See Figure 1.4). Colosseum Fish Habitat Area includes Wild Cattle Creek, Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek. These features are also discussed in Sections 6.5 and 6.6. Estuarine and marine waters surrounding HHI are part of the larger Rodds Bay Dugong Protection Area.

6.1.5 Land Cover

Land cover on HHI is dominated by native woodland and forest, with four major ecosystems identified:

- Grey ironbark woodland in the centre of the island extends along the crest of the main range and down into the plains
- Open dry sclerophyll forests and woodlands in the north section of the island
- Fore dune communities along the coast, contain she-oaks, Spinifex and a stand of littoral vine forest
- Mangrove, salt marsh and seagrass communities located in the intertidal zone on the southern side of the island
- Detail regarding the ecological characteristics of HHI is detailed further in Section 6.7.

6.1.6 Land Use

The Island is not used currently used for any economic activity nor have any improvements been undertaken since the Special lease was issued in 1991. Cleared areas and natural ecosystems in various stages of regrowth comprise the majority of the project area. An unimproved vehicle track links the causeway and the northern headland and also a number of shacks adjacent to the beach midway between the northern headland and Sandfly Creek. Historical aerial photography indicates a number of additional tracks existed, however, these have partly or wholly overgrown with undergrowth due to lack of use following cessation of pastoral activities.

Vehicle access to the Island is restricted by Boyne Creek, however, at very low tide, access is possible via a constructed causeway (see Figure 6.3) extending from the end of Clarks Road, an unsealed road, some 15 km east of the Bruce Highway.

Figure 6.3 - Boyne Creek Causeway at Low Tide

Use of HHI is limited to the coastal fringe in areas of unallocated State Land. During the public consultation process, it was noted that some low scale recreation activities such as camping is carried out on the Colosseum Inlet shoreline, in Sandfly Creek and on the southern tip of the Island, all outside the current Development Lease. Water based recreational activities are conducted in coastal and estuarine waters adjacent to the Island. In particular the area is becoming an increasingly popular area for boating and fishing activities as population increases in the Tannum Sands and Turkey Beach area. Existing formal and informal boat launching ramps provide access.

A Pastoral Lease has existed on the Island since the 1870s, including the area that is now subject to the special lease. Land clearing has also been conducted over much of the special lease area since the 1870's for maintenance of the pastoral lease and as a source of wood for railway sleepers. Sheds, dams, fencing and a cattle dip associated with former pastoral activities is located near the headland are evidence of former pastoral activities.

Modification to the Island environment during pastoral activity has resulted in a patchwork of cleared land and regrowth vegetation (see Figure 6.4) with grazing activity occurring over much of the Island at one point or another. Lantana infestation occurred over much of the western portion of the Island in the early part of the 1900s with Government intervention during the 1930s to halt the infestation. Pastoral activity legacies include fences, a cattle dip, several sheds and other remnants of this activity. Several access tracks remain in reasonable condition and a grass airstrip is still discernible on aerial photographs and on the ground.

Little arable use has been made of the Island except for a few citrus trees near the shack on Hummock Hill. Anecdotal evidence points to historical use of this limited area of red earth soils for intermittent lucerne cultivation when the land was used for grazing. Based on surveys conducted by SKM (2007) in 2005 no good quality agricultural land is present on the Island that would be impacted by the proposed development activities.

Figure 6.4 - Vegetation in the Centre of the Lease Area

A dam, located in a saddle of the main ridge bisecting the Island, appears to hold water throughout the dry season. A number of other turkey nest dams have been created on the site but do not hold permanent water. There are no permanent water courses or natural freshwater wetlands on the Island although there are some low-lying areas that receive surface run off.

There is currently no power, telecommunication (with the exception of intermittent mobile phone coverage), water or wastewater infrastructure servicing the Island.

6.2 Climate and Natural Hazards

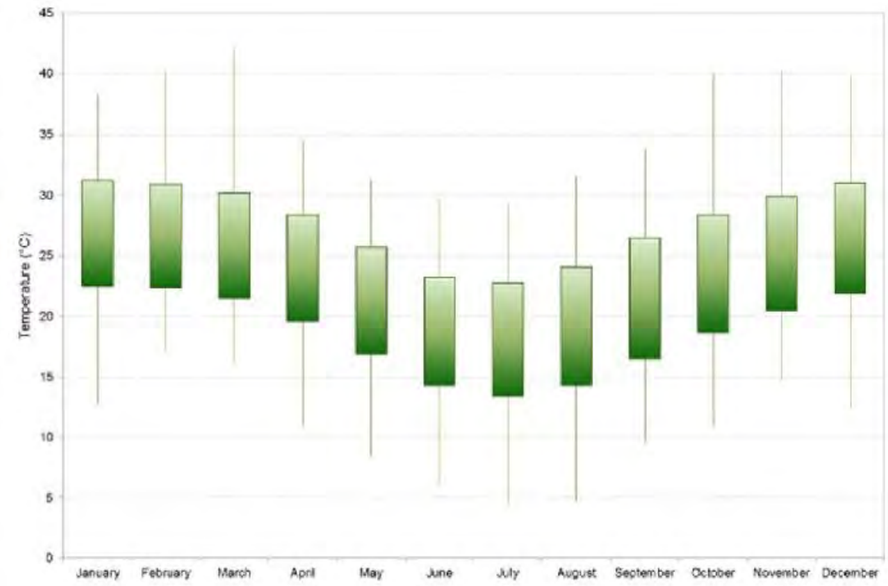
This section describes the climate of HHI and also identifies the potential risks to the project from climate change.

6.2.1 Climate

The Bureau of Meteorology classifies the climate of the HHI area as subtropical with hot wet humid summers and low winter rainfall. No weather station is located in the immediate vicinity of the Island with Gladstone Radar (Stn. # 039123) located 30 km to the north-west, and Bustard Head Lighthouse (Stn. # 039018) located 30 km directly east of the Island.

6.2.1.1 Air Temperature

Figure 6.5 presents typical average and extreme temperature ranges for the above two stations. Average and extreme temperatures of the more coastal Bustard Head tend to be slightly lower when compared to the more inland Gladstone Radar. Temperatures on the Island are likely to be somewhere between the ranges observed in the two stations.



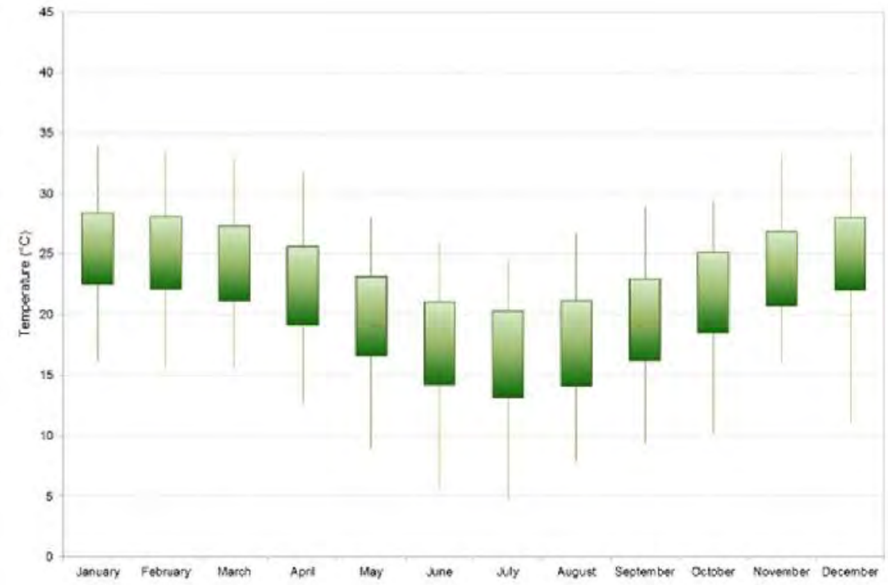


Figure 6.5 - Average and Extreme Temperature Range for Gladstone Radar (Stn. #39123) and Bustard Head Lighthouse (Stn. # 39018)

Notes: Solid bars = average maximum and minimum temperature range
Lines = maximum and minimum temperature recorded

6.2.1.2 Relative Humidity

The average monthly 9am 3pm relative humidity at Gladstone Radar (1957 to 2010) is presented in Figure 6.6.

Relative humidity varies with the seasons as well as time of day. Mean 9 am humidity is generally greatest in late summer, ranging from a maximum of 72% during February to 65% during August.

Mean 3 pm humidity is generally greatest during the summer months, ranging from a maximum of 65% in February to around 55% in the months from July through to September.

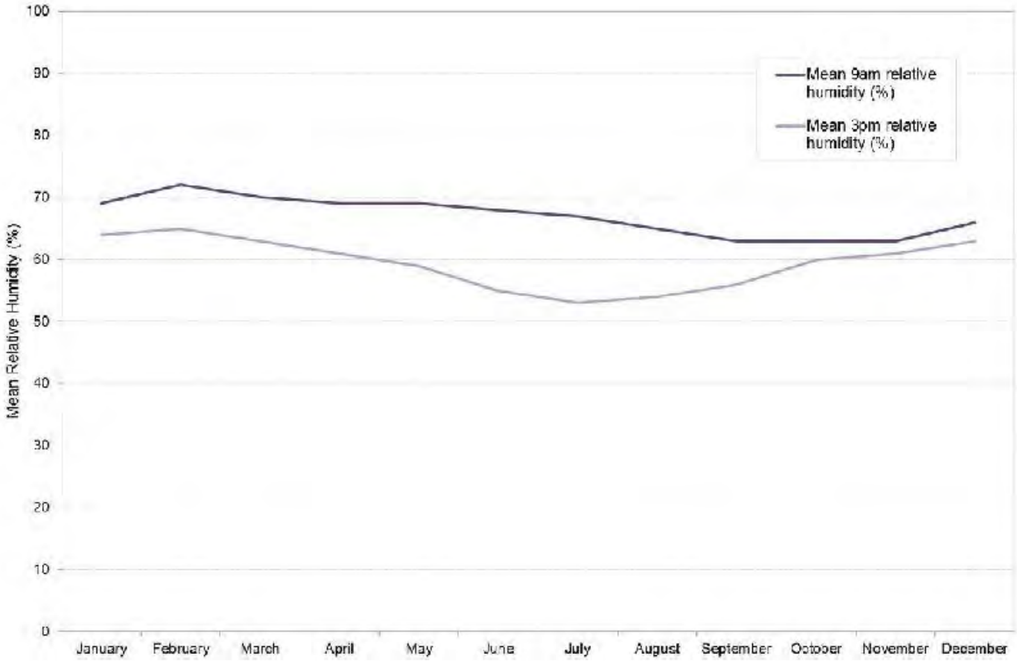


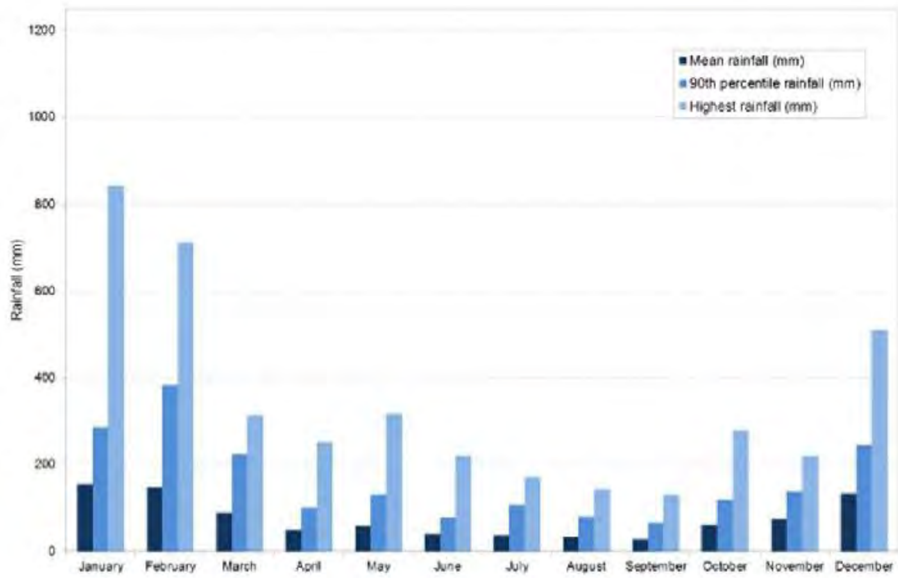
Figure 6.6 - Average 9am and 3pm Relative Humidity at Gladstone Radar (Stn. #39123) and Bustard Head Lighthouse (Stn. # 39018)

6.2.1.3 Rainfall

Rainfall patterns at HHI are based on rainfall records recorded at Gladstone Radar and Bustard Head Lighthouse. Mean monthly, 90th percentile and maximum monthly rainfall for Gladstone Radar and Bustard Head Lighthouse are presented in Figure 6.7. Mean annual rainfall is 894 mm per year for Gladstone Radar (1957 to 2013) and 1,146 mm per year for Bustard Head Lighthouse (1885 to 2013).

The trends in mean monthly rainfall indicate highest rainfall is generally recorded during summer months (predominantly associated with storm and cyclonic events). January and February typically receive the highest monthly rain averages with around 150 mm/month (Gladstone Radar) and 195 mm/month (Bustard Head Lighthouse). During the winter and early spring months mean monthly rainfall generally drops to less than one third of the average summer monthly rainfall totals with the lowest average monthly rainfall of 35 mm/month occurring in August.

The maximum monthly rainfall patterns in Figure 6.7 show monthly rainfall can be much greater than mean monthly rainfall. The highest monthly rainfall recorded at Gladstone Radar was 841 mm in January 2013. The highest monthly rainfall recorded at Bustard Head Lighthouse was 1,227 mm in January 1913.



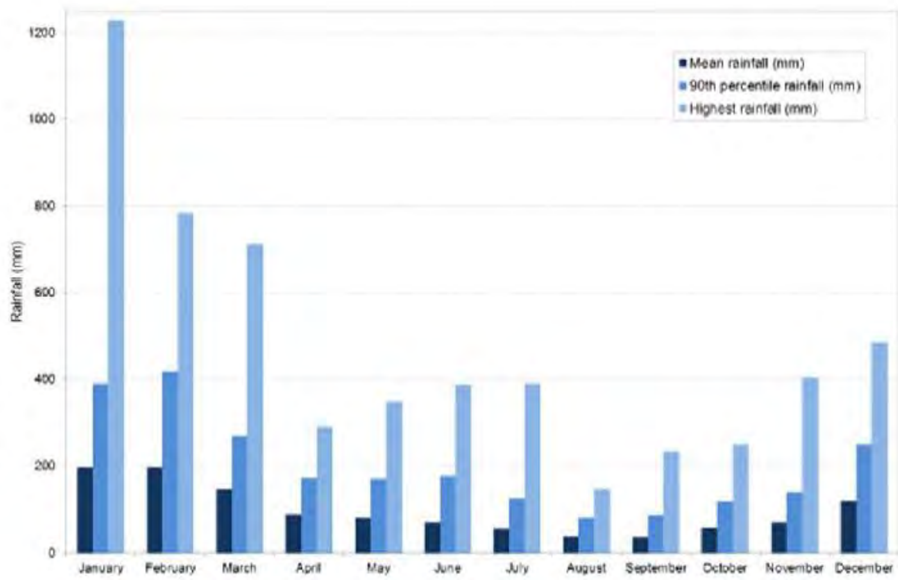


Figure 6.7 - Mean, 90th Percentile and Maximum Monthly Rainfall for Gladstone Radar (Stn. #39123) and Bustard Head Lighthouse (Stn. # 39018)

Annual rainfall figures at Gladstone Radar and Bustard Head Lighthouse from 1885 to present are shown in Figure 6.8.

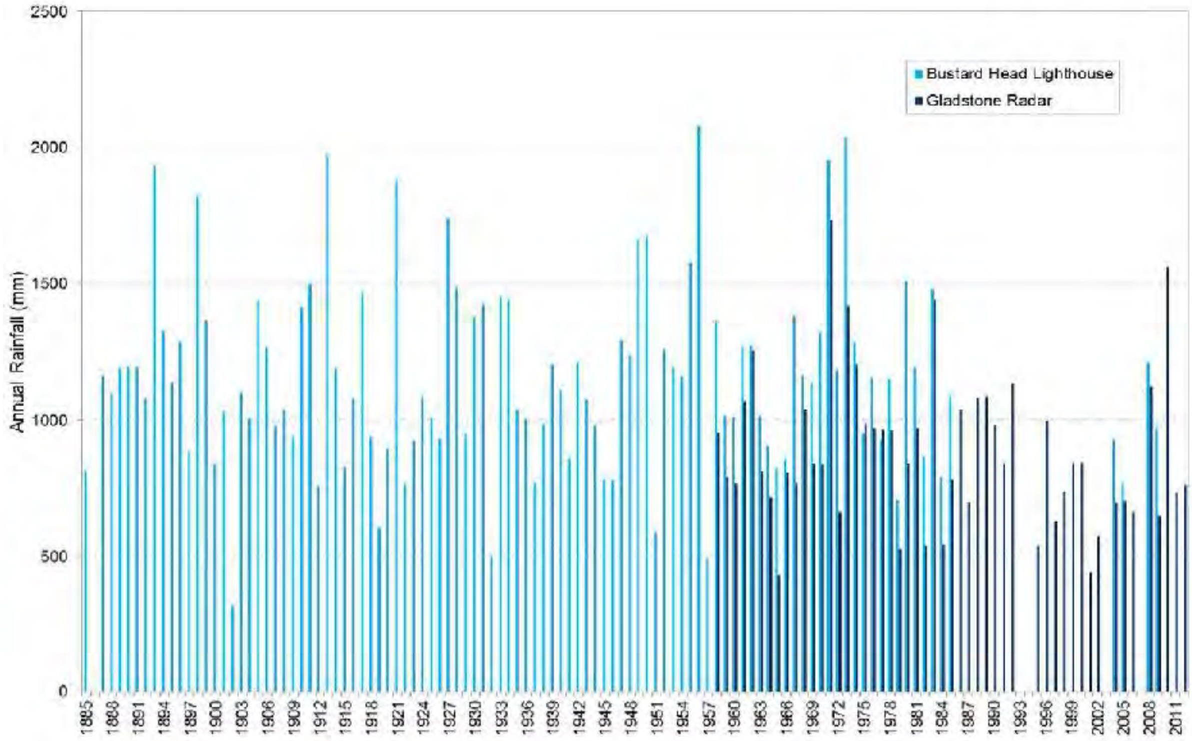


Figure 6.8 - Annual Rainfall at Gladstone Radar (Stn. #39123) and Bustard Head Lighthouse (Stn. # 39018)

6.2.1.4 Evaporation

Mean monthly evaporation rates (mm per month) at Gladstone Radar are presented in Figure 6.9, highlighting that the evaporation rate is highest in summer, and lowest in winter.

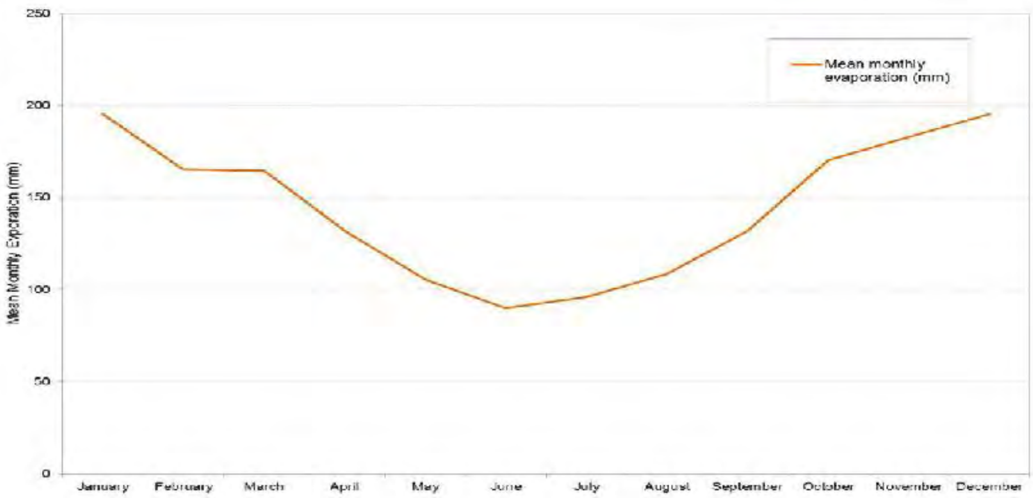


Figure 6.9 - Monthly Evaporation Rates at Gladstone Radar (Stn. #39123)

6.2.1.5 Wind Regime

A description of the wind regime near HHI is based on hourly wind speed and wind direction readings recorded by the Bureau of Meteorology at Gladstone Radar (Stn. #39123) from 2002 to 2012.

Annual and seasonal windroses for Gladstone Radar are presented in Figure 6.10. The key features of the wind regime are:

- Winds are predominantly easterlies
- Strongest winds are recorded during summer from the east
- Calm conditions were recorded 0.8% of the period.

6.2.2 Natural Hazards

6.2.2.1 Cyclones

Cyclonic activity in the region of the Island occurs predominantly between January and March, although the cyclone season encompasses all months between November to April. Reference was made to the Bureau of Meteorology records for cyclone activity between 1969 and 1999 to assess cyclone activity. Records show that the annual average number of tropical cyclones in the Gladstone region is 0.2, or 1 cyclone every 5 years. Variation due to El Nino/Southern Oscillation events does occur with an increase in cyclone occurrence during La Nina events, when annual average cyclone occurrence increases to 0.4, or 1 every 2.5 years (AGC Woodard-Clyde 1993). Extreme weather conditions associated with cyclones are:

- Severe wind velocities - the highest wind velocity recorded at Gladstone is 155 km/hr (GHD 2006)
- Extreme rainfall events - the highest daily rainfall recorded at Gladstone is 229 mm and at Bustard Head is 379 mm. Severe flooding is not likely to be a concern on HHI due to the limited size of catchments on the island (GHD 2006)
- Increased tidal effects (storm surge) - storm surge has been estimated to be 3.3 to 3.6 m AHD (100 year average recurrence) (CES 2005). Existing erosion prone areas are considered to be sufficient to protect against a 100 year storm surge event.

Major flood inundation from rivers and creeks is considered minimal on the Island due to the limited size of catchments on HHI. Master planning for the project has considered of potential severe weather risks such as storm surge and does not impinge on erosion prone areas.

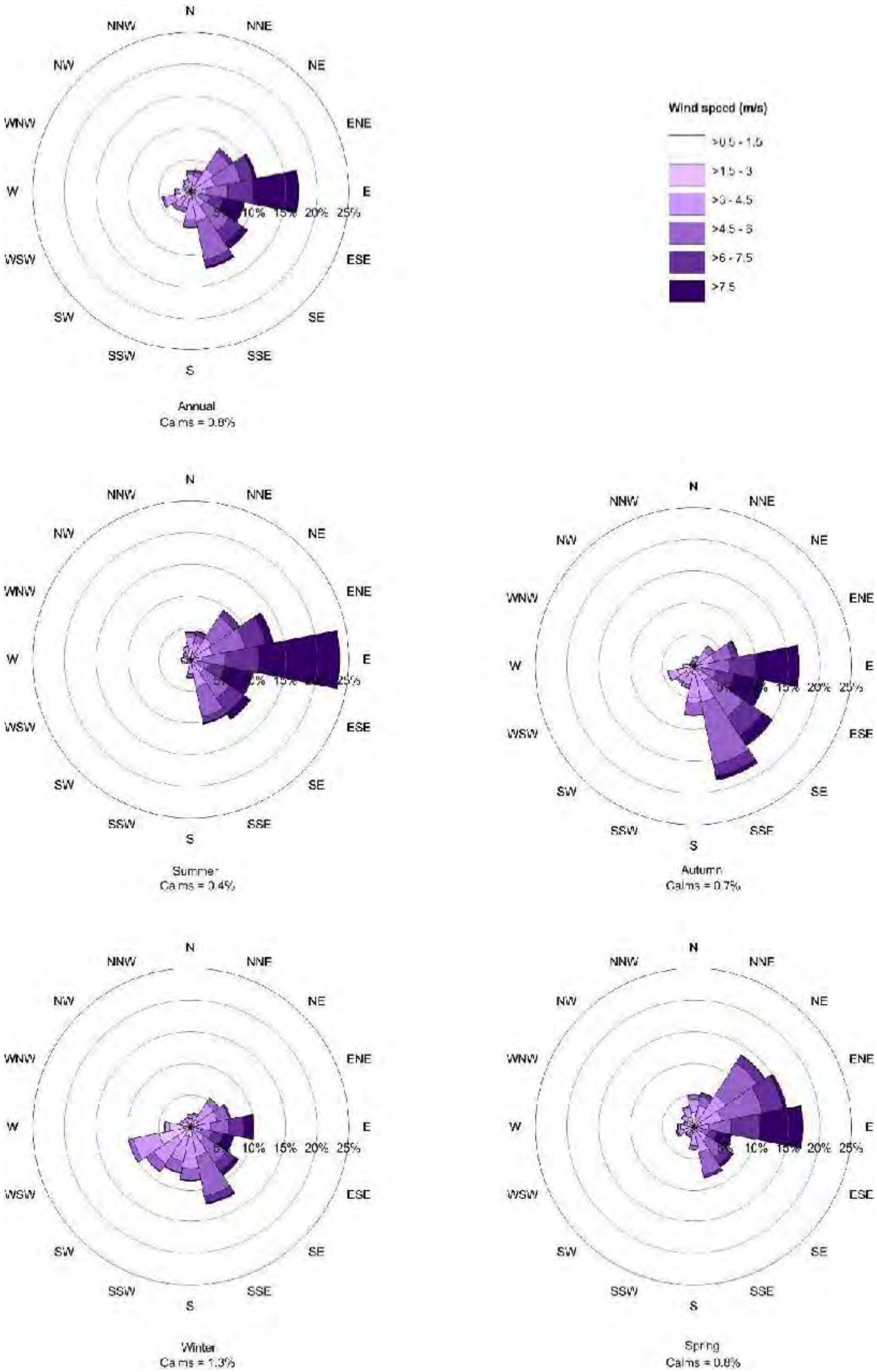


Figure 6.10 – Annual and Seasonal Windroses for Gladstone Radar (Stn. #39123)

6.2.2.2 Earthquake Potential

The following is extracted from notes attached to the Gladstone Earthquake Risk Map issued by Queensland University Advanced Centre for Earthquake Studies:

> *"The Queensland catalogue contains a total of 409 earthquakes in the Gladstone map region. Shown here are Richter magnitude ML > 0 events. Gladstone lies on the northern edge of what appears to be a high seismicity belt stretching from Brisbane to Gladstone."*

Figure 6.11 shows no earthquake recorded within 30 km of HHI. However, the project site possibly falls within the area of influence for medium sized earthquakes as evidenced by the range of structural damage of the 1918 Earthquake. Subsequent smaller earthquakes appear to have been "felt" within the region but with little apparent structural damage.

Reference to the AS 1170.4-2007 Structural design actions – Part4: Earthquake actions in Australia provides an earthquake Hazard Factor (Z) of 0.1 – 0.11 for HHI and adjacent areas. The soils of HHI, as discussed in Section 6.3.5, range from loose sands in the western section of the development to residual soils on the Miriam Vale granodiorite. Whilst the earthquake risk is relatively minor compliance with AS 1170.4-2007, or any subsequent revised versions and any related standard will be required in all designs to ensure that buildings and structures are designed to address meets the required level of earthquake risk.

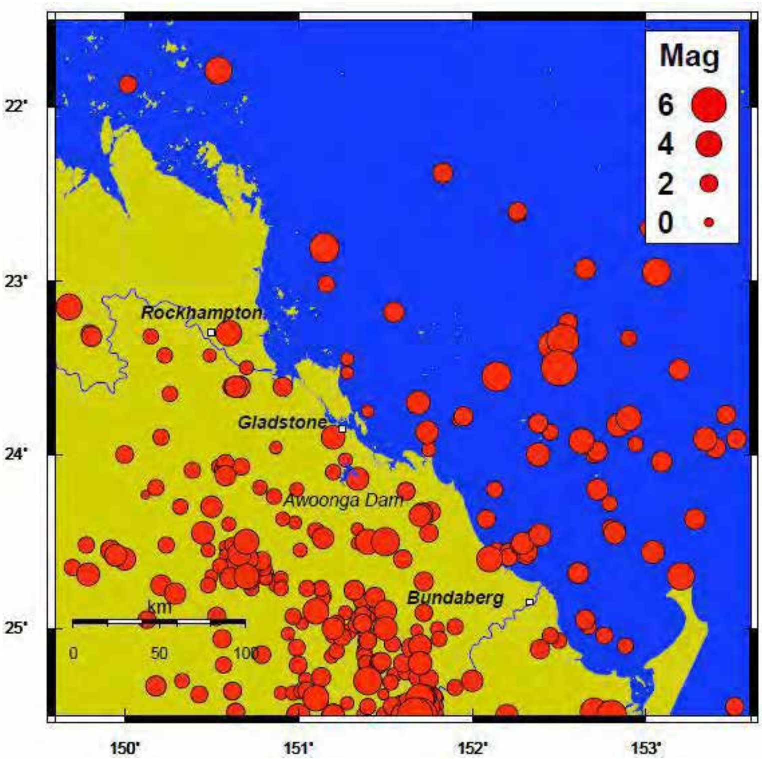


Figure 6.11 – Gladstone Earthquake Risk Map

(Source: http://www.quakes.uq.edu.au/html/quake_info/PDF/Gladstone_col.pdf, accessed on 9 May 2013)

6.2.3 Climate Change Risk Assessment

Changes in local weather patterns resulting from climate change have the potential to affect the operation of a project in the future. A climate change risk assessment has been undertaken for the design and operation of the project.

DERM (2009) have published climate change projections for the Central Queensland region including Gladstone. The climate change projections were produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (Bureau of Meteorology) based on the results of a variety of global climate models.

Climate change projections for Central Queensland region for 2030, 2050 and 2070 are presented in Table 6.2.

Table 6.2 - Projected Change in Climate for Central Queensland Relative to Current Historical Mean

Feature	2030	2050 Low Emissions	2050 High Emissions	2070 Low Emissions	2070 High Emissions
Annual average temperature	+1.0°C	+1.2°C	+2.0°C	+1.7°C	+3.2°C
Annual average rainfall	-3%	-4%	-7%	-6%	-10%
Seasonal average rainfall • Summer • Autumn • Winter • Spring	 • -2% • -4% • -5% • -6%	 • -2% • -5% • -5% • -7%	 • -3% • -8% • -9% • -12%	 • -3% • -7% • -7% • -10%	 • -5% • -13% • -14% • -19%
Annual average potential evaporation	+3%	+4%	+7%	+5%	+10%
Annual average number of hot days (>35 °C)	+10 days	+13 days	+24 days	+20 days	+48 days

6.3 Geology, Soils and Contaminated Land

6.3.1 Introduction

HHI is approximately 13 km long and 3.5 km wide, separated from the mainland by a shallow (approximately 4m deep at HAT) tidal channel called Boyne Creek.

The island is an extension of the mainland Miriam Vale Granite geological unit comprising of a bedrock core of granodiorite flanked by colluvial/alluvial plains which grade into relict beachridge or foredune strandplains on the ocean side of the island and intertidal salt flats and mangrove muds on the landward side of the Island.

The soils range from sands in the dunal areas, moderately deep sodic texture contrast soils on the undulating plains and shallow rocky soils on the steeper ridge country. Soils associated with the coastal marine muds on the southern side of the island are potential acid sulfate soils.

The island has a range of near-shore ecosystems in the form of mud flats, dunes and creek systems that demonstrate, in the broad sense an example of the processes of geological evolution within the GBRWHA. However HHI, as a continental island within the World Heritage Area, is not a unique or outstanding example of a stage of earth's history.

6.3.2 Geology and Geomorphology

A Geology and Soils Report was completed for the project by SKM in August 2007 with the information contained in this section based on the SKM assessment.

HHI comprises part of the north-easterly margin of the Miriam Vale Granodiorite, which is a large granitic batholith (acid intrusive) from the Permian-Triassic period. The igneous rocks on HHI are an extreme margin of the larger mass and hence these rock units have been subjected to a degree of variability in the rates of cooling (producing the range of grain sizes observed) and in mineralogy as a result of magmatic differentiation and/or assimilation of country rock.

Below about 6 m AHD the Miriam Vale Granodiorite is overlain by an extensive layer of decomposed granodiorite. Overlying this is a layer of aeolian sand, generally less than 3 m thick, except in the north-west of the island in the vicinity of Tiber Point where the depth of sand is greater than 10 m.

Reference to the 1:250,000 Geological Map Series for Monto Qld (Geological Survey of Queensland, 1981 – Sheet SG 56-1) shows that HHI comprises three main geological units (refer Figure 6.12):

- PRm – Permian to Triassic aged granodiorites, tonalite and diorite
- Qb – Quaternary aged coastal beach ridges
- Qm – Quaternary aged mangrove swamps and saltpans.

Reference to the 1:250,000 Geological Map Series for Rockhampton Qld (Geological Survey of Queensland, 1974 – Sheet SF 56-13) labels the north-west section of the Island as:

- Pug – Upper Permian aged granodiorite and minor adamellite
- Cz – Holocene aged sand, gravel, soil; coastal sand and swamps
- Qhn – Holocene aged mangrove swamps, mudflats, saltpans.

Whilst some descriptive differences between the above geological mapping is present, descriptions from 1981 mapping has be used for detailed descriptions below.

Figure 6.12 - Regional Geology of Hummock Hill Island

LEGEND

- Development Footprint
- Miriam Vale Granodiorite
- Qhcb-QLD
- Qhe/m-YARROL/SCAG
- Qhmt-YARROL/SCAG

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6.3.2.1 PRm – Miriam Vale Granodiorite

Areas of higher elevation and basement rock underlying HHI are formed from part of the north-easterly margin of the Miriam Vale granodiorite (PRm), which is a large granitic batholith[1] from the Permium-Triassic period (286 to 213 million years before present). This forms the basement rock for the Island and surrounding waters. Previous studies (AGC Woodard-Clyde 1993) found the dominant rock type on HHI to be a microgranodiorite and aplite with a high degree of grain size variability, mineralogy and texture. This variation has been attributed to different cooling rates during formation of the area on the periphery of the main batholith.

Jointing and textural differences, in general, govern the overall geomorphology of HHI with more readily eroded coarse gronodiorite underlying lower plains and under sand deposits, with finer grained microgranodiorite forming the more elevated central ridgeline. Figure 6.13 presents some typical forms of granodiorite found on HHI. Little sign of structural instability is evident on the central granodiorite ridge of the Island, with slopes generally being considered stable.

The majority of the project area is situated on QRm, including the Clarks Road access.

Figure 6.13 - Typical Forms of Granodiorite from HHI

6.3.2.2 Qb – Coastal Beach Ridges

The 1:250,000 Geological Map Series for Monto Qld (Geological Survey of Queensland, 1981 – Sheet SG 56-1) labels low lying areas of the Island as Quaternary aged (2 Million years Before Present (BP)) beach ridges (Qb). It is more likely that the current land surface in Qb areas are Holocene age (<10,000 years BP) underlain by older Quaternary sediments.

Based on geological mapping (1:25,000 Geological Map Series for Monto Qld (Geological Survey of Queensland 1961)) there are 1,240 ha of Qb deposits on HHI in three main areas as shown in Figure 6.13, these being the west end of the Island, a coastal strip between the northern headland

1 A batholith is a large emplacement of igneous intrusive (also called plutonic) rock that forms from cooled magma deep in the Earth's crust. Batholiths are almost always made mostly of felsic or intermediate rock-types, such as granite, diorite or lighter coloured forms of andesite.

and Sandfly Creek and the eastern end of the Island. The project site is situated over 156 ha (12 %) of these deposits conserving 88 % of Qb deposits.

Areas designated as Qb on HHI are characterised by low relief ridges and are separated by inter-ridge depressions or swales, and labelled as beach ridges in geological mapping as described above. Stephens (2007) states that the Holocene aged Qb deposits are beachridge or foredune strandplains, consisting of the Tiber Point strandplain and the Norton Point strandplain (refer to Figure 6.13). The strandplains consist of Holocene age sand ridges and inter-ridge swales probably formed during the mid to late Holocene sealevel “stillstand” – the relatively stable sea level period from about 6,500 years before present (yr BP) to the present day.

Hesp (1984) describes beach ridges as the product of swash built berms, located at the high tide mark, and wind-blown (aeolian) incipient foredunes. Gradual colonisation of the swash built berm and incipient fore dune by vegetation then occurs, advancing the whole system towards the sea as shown in Figure 6.14. As vegetation colonises the foredune’s seaward face the beach ridge becomes stable and gradually becomes vegetated with larger shrubs and trees. A new foredune is built up on the sea-ward side of the recently stabilised foredune with a depression or swale between the new and old crest. He notes that “*beach ridges are in fact relict foredunes.*”

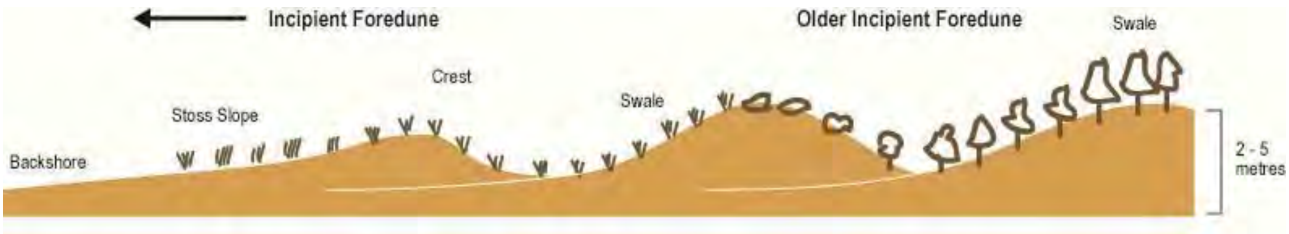


Figure 6.14 - Typical Profile and Evolution of a Beach Ridge System (Hesp 1984)

Otvos (2000) notes that the following features are common to beach ridge systems in Australia, North America and Europe as also found by Hesp (1984), Thom (1984), Tanner (1995), Otvos (2000) and Orford *et al.* (2003):

- Berm or Swash Bar – a landward sloping high tidal berm formed by high tide swash currents
- Berm Ridge/Incipient Foredune – larger and more permanent wave built intertidal ridge often with erosional scarps, located between the foreshore and landward margin of the backshore often with aeolian features
- Backshore (strandplain-type) foredune – semiparallel, narrow foredune sets that merge into relict (stabilised by vegetation) beach ridges
- Swale – a long, narrow, generally shallow, trough like depression between two beach ridges roughly aligned with the coastline and underlain by sub-tidal or super-tidal sand.

Stephens (2007) states that shore-parallel aeolian foredunes can only be preserved in a shoreline accretion setting (including short-term cut-and-fill), and in such a setting the beachface is also accreting, although the beachface sands do not have to be in the form of ridges. Any significant expanse of foredune ridges is always underlain by beachface sands. He notes that beachridges are generally prograded when an abundance of sediment exists and the offshore gradient is low such as the situation on HHI.

The linearity of the foredunes surmounting the beachface sands, and the fact that they formed directly at former positions of the shoreline shows that the HHI strandplains consist of foredune beachridges. Stephens (2007) states it is possible that the Tiber Point strandplain beachridges represent a single phase of coastal progradation. The regularity and simple form of the beachridges suggest that beach and dune stability was high during their formation.

Typical sediments of the beach ridge and swale system consists of fine-grained quartz sand, coarse sand at depth and minor organic rich silt with disseminated heavy mineral sands. Previous drilling conducted in 1993 (AGC Woodard-Clyde 1993) of the Tiber Point strandplain found these sediments to range between 0.6 m near the headland area to greater than 10 m depth towards Colosseum Inlet.

Stephens (2007) identifies the beachridges on the Tiber Point strandplain comprise beachface sediments (shelly siliceous fine-medium sand) topped by finer grained siliceous sand in low foredune ridges with linear crests that parallel the former positions of the shoreline during coastal accretion. Available drill data show that the thickness of the foredune cap varies from about 0.5 m to 1.5 m. The ridges are very regular and symmetrical, and have morphologically and topographically simple shapes.

Although the modern shoreline of the Tiber Point strandplain may still be in a state of incipient progradation (depending on the trend of present sealevel), the bulk of the foredune beachridges are also likely to have formed in the period 5,500 to 3,000 years before present (Holocene aged). Hence although the modern foredune is part of the active beach system, the landward foredune ridges are essentially relict (Stephens 2007).

Beach ridges are common features along the Queensland coast and occur in parts of the coastline and sand islands where wave action is only moderate and accumulative processes dominate or are in equilibrium.

Stephens (2007) notes the relict foredune beachridges of HHI are not unusual. Rather wherever coastal bays provide space, and there is a sand supply, wave action has produced similar strandplains. Several of these are protected in national parks and include:

- Wild Cattle Island immediately north of the Island- protected as a National Park
- Eastern Rodds Peninsula located 20 km east of the Island – protected as a National Park
- Middle Island 30 km south east of the Island – not protected as a National Park
- Eurimbula National Park 35 km south east of the Island.

Stephens (2007) also notes that extensive Holocene strandplains are also present north of HHI, located at:

- Cape Capricorn to Cape Keppel on Curtis Island – protected in a conservation park and also within the GBRWHA
- Cattle Point to Keppel Sands in Keppel Bay
- Farnborough to Bangalee, north of Yepoon.

Coastal dunes and beach ridges provide erosion buffers in major storm events where the shoreline may be eroded and subsequently re-established by natural processes. Consequently, erosion prone areas are designated along coastlines that may be vulnerable to erosion (coastal zones under the *Coastal Protection and Management Act 1995*). Current erosion prone areas on HHI are separate lots outside the current special lease and no building works, except for beach pedestrian access boardwalks are proposed in these areas.

6.3.2.3 Qm – Mangrove Swamps and Saltpans

Holocene age depositional sediments associated with deposition of slope wash and marine sediments at the mangrove fringe are present on the land-ward side of HHI. Typically the depositional sediments in these areas consist of inter-bedded sands, marine clay and gravel that may be quite thick in places, though invasive drilling has not been conducted in this or previous investigations.

AGC Woodard-Clyde (1993) found that marine sediments and muds in the vicinity of the bridge consist of a limited thickness of soft clay present along the mangrove fringe, the main channel being predominantly coarse grained sediments. A 300 m section of Clarks Road, the abutments of the proposed bridge and the boat ramp are located in Qm deposits.

6.3.3 Location of Known Mineral Resources

Reference to the Department of Mines and Energy, Major Mineral Resources, Mines and Projects, 4th Edition[2] data identifies a registered Mineral Occurrence/Inactive Prospect, No. 486524 HHI. The prospect consists of three deposits associated with "*modern coastal deposits*" associated with the relict beach ridge systems discussed above. The three deposits are named after their location on the Island as:

- West End – occurring in Lot 1, Lot 3 and Lot 7 on FD841442
- Central – occurring in Lot 3 and Lot 8 on FD841442
- Eastern – occurring in Lot 4 on FD841442.

Estimates of the resource explored under Exploration Permit for Mineral (EPM, #7164) are:

- Ilmenite - small – 5,000 to 500,000 tonnes

[2] http://www.webgis.nrm.qld.gov.au/webgis/webqmin/Run.htm

- Rutile – small - 2,000 to 200,000 tonnes
- Zircon – small - 500 to 500,000 tonnes.

An EPM renewal application dated from 1992 provides an estimate of the Island resource broken down to three main areas, these being:

- West End – 4.2 million m^3 at 2.4% heavy mineral
- Central – 1.2 million m^3 at 7.2 % heavy mineral
- East End – 7.4 million m^3 at 3.3 % heavy mineral.

The project site is located on 160 ha of the mineral sands resource representing 29% of the West End resource and 12% of the entire HHI resource. The mineral resource in the Central and East End of the island will not be directly impacted by the development.

Exploration Permit for Minerals (EPM, #7164), previously registered with Monto Minerals P/L, has expired and there are no current exploration permits or mineral development leases over the island.

6.3.4 Fossil Sites

Due to the igneous nature of the geology and lack of any sedimentary depositional sequences of a suitable age, no significant fossil sites are likely to exist or have been found on HHI.

6.3.5 Soils

6.3.5.1 Landform and Soil Classification

Soil types on HHI relate closely to underlying geology and resulting topographical landforms as found by AGC Woodard-Clyde (1993) and Dames & Moore (1995). Further soils investigation was conducted by SKM (2007) in 2005 based on methods outlined in the *Australian Soil and Land Survey Field Handbook* (MacDonald *et al*. 1990) and *Australian Soil Classification* (Isbell 2003).

Four basic landforms were identified by SKM (2007) that, in general, confirm the AGC Woodard-Clyde (1993) and Dames & Moore (1995) investigations. Identified landforms and resulting soil complexes are detailed in Table 6.3 and shown in Figure 6.15 while land unit and soil types within the development footprint are described in Table 6.4.

Table 6.3 - Summary of Land Units and Soils of HHI

Land Unit	Geology & Landform	**Factual key[1]**	Soil Description
Qb – Coastal Sand Dunes, Beach ridge and Swale Deposits			
Qb1	Low frontal dune & beach system with sparse *Casuarina spp.* and *Pandanus spp.* with a sparse ground cover of *Spinefex spp.*	Uc1.11	Beach and aeolian siliceous sands.

Land Unit	Geology & Landform	**Factual key[1]**	Soil Description
Qb2	Narrow elongate depressional swales and poorly drained depressions/drainage paths with fringing *Melaleuca spp.*	Uc2.33 Dy5.61	Siliceous sands with peaty or organic rich surficial layer and diffusely mottled sub-soils. Sandy (gleyed) podzolic soils with pale, mottled apedal very moist sandy clay.
Qb3	Undulating low dunes and beach ridges with intervening depressional swales, with moderate dense littoral vine scrub, large emergent melaleucas and Moreton Bay ash.	Uc2.21	Fairly deep siliceous sands underlain by extremely weathered granodiorite.
Czs — Cainozoic Alluvial Outwash and Residual Soil			
Czs1	Near level to very gently sloping plains and lowland drainage flats typically with mixed eucalypt woodland and locally with gum—topped box on lowland flats and melaleuca in lower—lying and depressional areas; casuarinas occur towards the seaward fringe.	Db-Dy2.13 Dy3.13 Uf6.41	Mostly deep, sandy to loamy surface (hardsetting) duplex soils (Db—Dy 2.13, Dy3.13—solodic soils) with diffusely mottled sandy clay or medium to heavy clay subsoils, locally with uniform clays or thin loamy duplex soils with brown medium to heavy clay subsoils (Uf 6.41, Db2. 13) towards to coastal zone region.
Czs2	Gently sloping outwash plains locally dominated by poplar box and blue gum, below the east facing footslopes of Hummock Hill.	Gn2.113 Dy3.43	Mainly gradational locally weak duplex soils with brown sandy surface soils over reddish to yellow brown clayey sand underlain by sandy clay or EW granodiorite below 1.5 m (approximately) (Gn2.113; Dy3.43).
Qm — Recent Coastal Mangrove Flats and Tidal Mud			
Qm1	Near flat to very gently sloping tidal mudflats saltpans with small occurrences of saltwater couch and samphire marsh grass flats discontinuously along the landward fringe.	Uf6.61 Dd2.12 Dy3.12	Typically saline uniform clays (Uf6.61) and fine sandy or clayey silts over gleyed clay subsoils; sandy surface duplex soils (Dd2.12, and Dy3.12) occur on the fringe areas of saline marshes.
Qm2	Tidal mangrove swampland flats with sparse mangroves fringing tidal inlets.	Uf6	Saline clays (Uf6) over distinctly gleyed fine sandy or silty clay substrate soils.
Pzm — Upper Permian Miriam Vale Granodiorite; Granodiorite, tonalite, Diorite			
Pzm1	Gentle to moderately steep moderate dissected footslopes and inclined plains fringing land units Pzm3 and Pzm4; slopes typically <10% mostly in the range 2—5%, with mixed eucalypt woodland chiefly ironbark, bloodwood and Moreton Bay ash.	Uc-Um2.12 Dy3.41 Dy3.43	Soils are either shallow to moderately deep sand or clayey sand (Uc—Um2.12) underlain by weathered rock, or moderate to deep brown, yellow brown or mottled duplex soils (yellow podzolics or soloths (Dy3.41) or solodic soils (Dy3.43)), which have sandy or loamy sand surface horizons commonly with a bleached sub—surface (A2) horizon and acidic to alkaline yellow—brown and grey mottled sandy clays or heavy clay subsoils underlain by EW granodiorite between about 0.6—1.0 m.

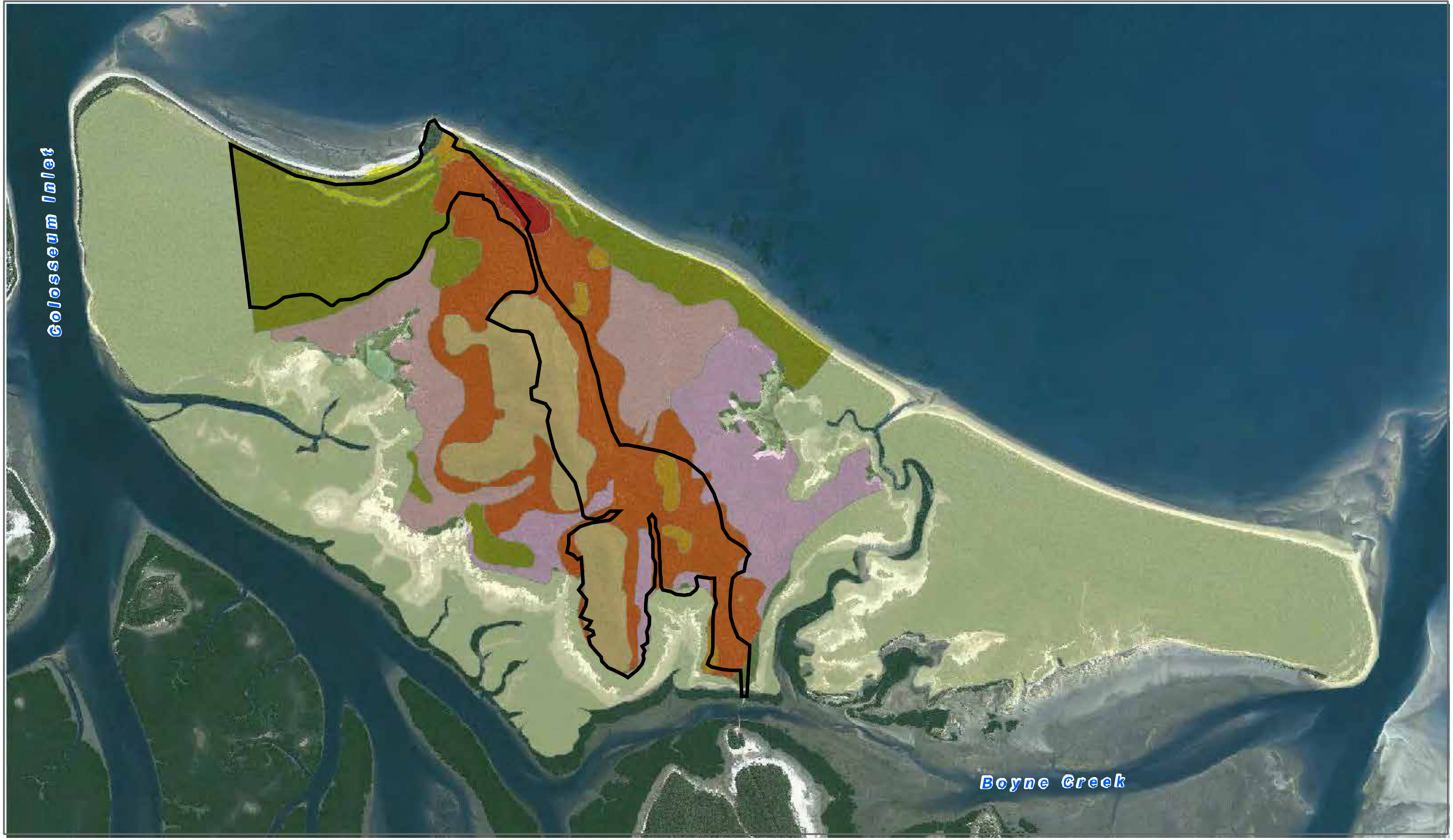
Land Unit	Geology & Landform	Factual key[1]	Soil Description
Pzm2	Broad low rounded ridge with marginal slopes in the range 10—20%; partially cleared with mixed eucalypt woodland on the steeper and lower slope areas.	Gn3.41	Soils are deep (1 m+), red earths, (which locally trend to non—calcic brown soils) with sandy clay loam surface soils and a gradual to clear change to a red slightly acid to neutral medium clay subsoil (B) horizon with medium blocky structure (Gn3.11).
Pzm3	Low rocky hills and rises with slopes mostly in the range 10—20%, with mixed eucalypt woodland chiefly ironbark, bloodwood and Moreton Bay ash.	Dy3.41 Um6.43	Soils are dominantly shallow gravelly yellow duplex soils (Dy3.4l) with acidic sandy clay subsoils underlain by EW rock between 0.2 — 0.5 m; sandy to loamy lithosols (Um6.43) occur locally mostly associated with areas of rocky outcrops.
Pzm4	Steep dissected and low rounded hilly lands with slopes in the range 20—35%, with mixed eucalypt woodland chiefly ironbark, bloodwood and Moreton Bay ash.	Um6.43 Dy3.41	Soils are dominantly lithosols (Um6.43) associated with areas of outcrop and boulders, and shallow gravelly yellow duplex soils (Dy3.4l) with acidic sandy clay subsoils underlain by EW rock between 0.2—0.5 m.

1 – to convert Factual keys to Australian Soil Classification refer to Appendix 5 of Isbell (2003)

Table 6.4 - Land Unit and Soil Types of the Project Area

Land Unit	Factual key[1]	Project Area
Qb2	Uc2.33 Dy5.61	Crossings behind Resort hotels and Beachfront villas
Qb3	Uc2.21	Beachfront Tourist Hotel Beachfront and Golf Course villa, cottages and apartments
Czs1	Db-Dy2.13 Dy3.13 Uf6.41	Colluseam villas a
Qm1	Uf6.61 Dd2.12 Dy3.12	Boyne Creek Boat Ramp, Bridge Abutments, Clarks Road (300m)
Pzm1	Uc-Um2.12 Dy3.41 Dy3.43	Village Centre, , Hillside Terraces (part), Airstrip, Headland Resort Holiday Homes,
Pzm2	Gn3.41	Foreshore homes
Pzm3	Dy3.41 Um6.43	Village Centre, Headland homes and apartments, motel, caravan park, Bushland Villas,
Pzm4	Um6.43 Dy3.41	Spa retreat, Ocean View Villas, Colloseum Villas

1 - To convert Factual keys to Australian Soil Classification refer to Appendix 5 of Isbell (2003)



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Development Footprint

Land Unit Classes

Czs1	Pzm3	Qb3
Czs2	Pzm4	Qm1
Pzm1	Qb1	Qm2
Pzm2	Qb2	

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0 250 500 750 1,000 m

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Figure 6.15 - Land Units and Soils Map

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Soil permeability testing conducted by Dames & Moore (1995) in a number of the above soil types returned permeability ranging from 0.029 m/day (Pzm1 - Solodic B Horizon) to 12.3 m/day (Pzm1– Soloth A Horizon). Results of Dames & Moore (1995) soil permeability testing are presented in Table 6.5. Soil permeability throughout the project site will influence surface runoff generation, stormwater flow, soil erosion potential and irrigation rates.

Table 6.5 - Field Measured Soil Permeabilities (after Dames & Moore, 1995)

Land Unit	Test depth (m)	Soil Type	T 25[1] (mm/min)	Permeability[2] (m/day)	Equiv SPTR[3] (Minutes)
Qb3	0.15 – 0.4	Sand (A-B horizon)	0.3	11.2	0.7
Czs1	0.075 – 0.325 0.25 – 0.55	Solodic (A Horizon) (B Horizon)	18.5 65	0.2 0.049	37.5 153
Pzm1	0.05 – 0.30 0.25 – 0.55	Soloth (A Horizon) (B Horizon)	0.3 56	12.3 0.057	0.6 147
Pzm1	0.05 – 0.30 0.25 – 0.55	Solodic (A Horizon) (B Horizon)	0.3 110	12.3 0.029	0.6 259
Pzm1	0.25-0.5	Soloth (B Horizon)	62.5	0.051	147
Pzm1	0.2 – 0.5	Solodic (B Horizon)	96	0.033	227
Pzm2	0.12 – 0.42	Red Earth (B Horizon)	6.4	0.5	15

1 – T25 mm – Time for water level in the test hole to fall 25 mm after a pre-soaking period

2 – Permeability determined in accordance with procedures given by WRC (1991)

3 – SPTR = Standard Percolation Test Rate determined in accordance with the procedure given in the *Sewage and Water Supply Act, Amendment Act 1981*, No. 81.

6.3.5.2 Soil Erosion Potential

Dense grass or other vegetative cover exists over most of the Island with little active disturbance of soils beyond existing tracks. Soil erosion was evident along some of the inland tracks particularly on steeper slopes. Soil erosion consisted mostly of sheet wash and minor rills with deposits at the bottom of slopes. One section of deeper erosion was identified at the northern base of the central ridgeline where an ephemeral creek discharged across the Pzm1 soils of the alluvial plain. A section of the erosion gully showing the Pzm1 soil is presented in Figure 6.16.

Erosion potential of disturbed areas varies with soil type across the island. The erosion potential of a soil is determined by incipient rainfall, amount of vegetation cover, length of slope, degree of slope and soil erodibility. Shallow rocky soils (Lithosols – Pzm4) have a relatively stable surface, but have a very high erosion risk due to their high slope. Hard setting texture contrast soils (Pzm1, Pzm3 and Czs1) also have a very high erosion risk due to the sandy hardsetting surface and sodic B horizon. There is also a high risk of gully erosion in areas of gum topped box and poplar box open forest (Czs2). Wind erosion is a potential issue, particularly for exposed coastal sand dune systems and it can be difficult to revegetate and restabilise areas once these sensitive areas have started to erode.

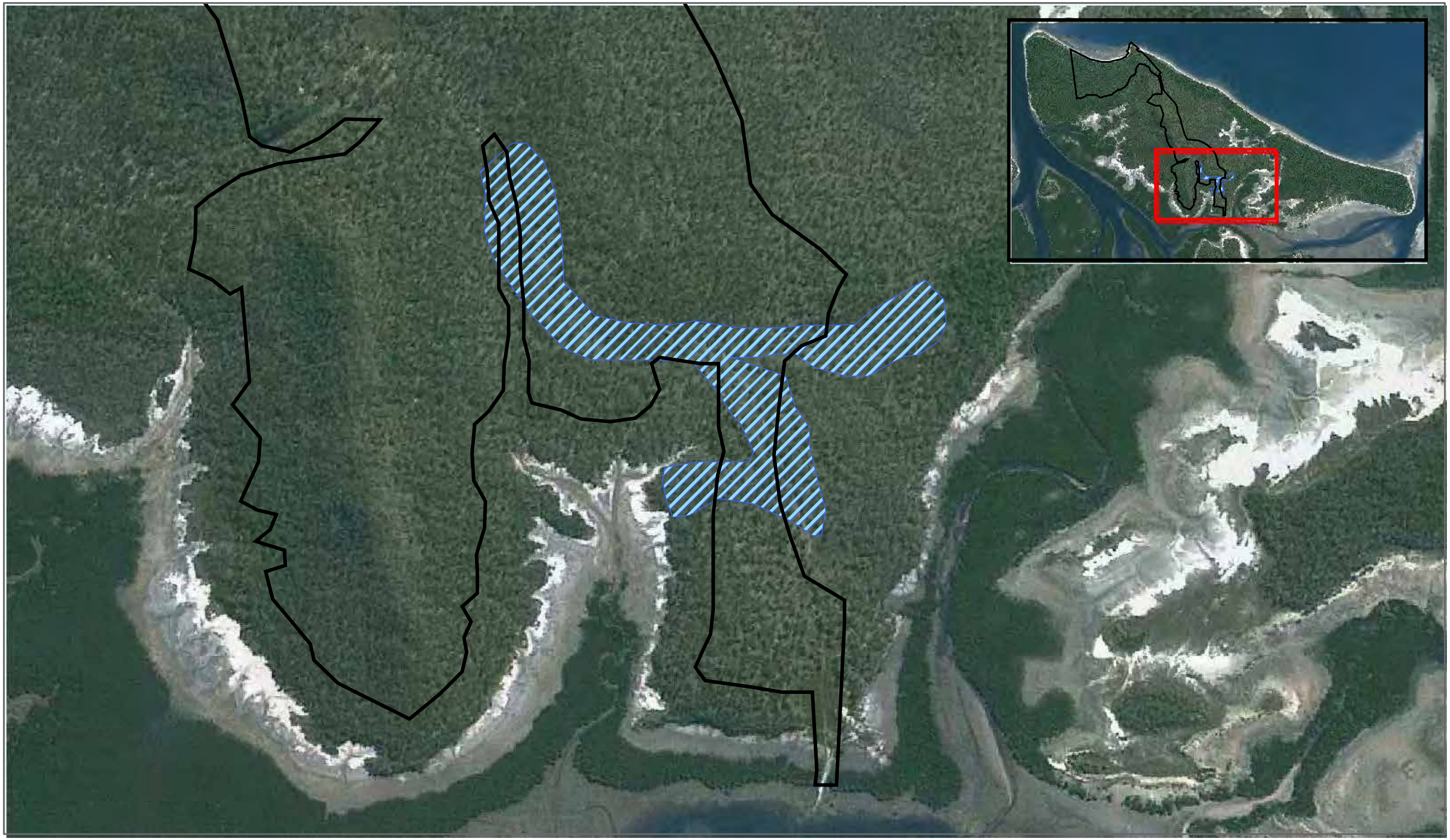
Figure 6.16 - Side of Erosion Gully in Pzm1 and Pzm4 Soils

Erosion hazards can also be based on chemical soil characteristics including exchangeable sodium percentage which predisposes soil dispersion, Calcium:Magnesium ratios which can inhibit soil dispersion, particle size distribution which is critical with respect to physical stability, R1 Dispersion Index (% dispersed silt + clays/ total silt + clays) and profile morphology and observed erosion problems. The most significant erosion risks are due to raindrop impact, sheet erosion, rills and gullies and tunnelling where soils are likely to be exposed during construction activities.

6.3.6 Water-logging and Salinity

Some areas on HHI have a natural tendency for waterlogging and subsequent increases in soil salinity due to groundwater accumulation and seepage. These areas are generally texture contrast soils, such as Pzm1 on gently undulating topography underlain by weathered granodiorite. Areas of periodic waterlogging have been identified in a number of break-of-slope areas on HHI, indicated by a change in vegetation and the presence of melaleuca trees. Where cleared of vegetation these groundwater discharge zones can become larger and more waterlogged with subsequent salinity, scalding and erosion issues.

Salinity levels in soils on HHI are low in sandy surface A horizons, but increase to high levels in the lower B horizon. The B horizons are strongly sodic and have a low Calcium:Magnesium ratio that can cause dense poorly drained clays that will disperse readily if exposed. These characteristics also mean they are very slowly permeable and are naturally prone to waterlogging in low gradient areas. Thus the changing the hydraulic balance (e.g. removing vegetation or the addition of effluent irrigation water) on these soil types could potentially cause salinity problems if it was not managed properly. Figure 6.17 presents a salinity hazard map of HHI.



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Development Footprint

Indicative Groundwater Discharge Zone

Figure 6.17- Salinity Hazard Map

0 100 200 300 400 m

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Observation during field inspections reveals two main groundwater flow systems operating in this landscape that influence the location of potential groundwater discharge areas. The first system consists of steep hills of jointed granodiorite having limited connectivity between the hills and the adjacent lower slopes (Figure 6.18) such as east of the existing airstrip and in the Bushland Residential areas. Evidence of groundwater discharge is not prominent at the break of slope at the base of these hills. Clearing of vegetation in groundwater recharge areas on the top steep hills is only weakly linked to potential groundwater discharge at the break of slope at the base of hills. As such, soil salinisation due to break of slope groundwater discharge is unlikely in these situations, even with low density development in up-slope groundwater recharge areas.

The second groundwater flow system operating on HHI is a catena or continuous hillslope system (refer Figure 6.19) within the Boyne Village and Golf Course Precincts. Groundwater discharge areas, or areas of periodic soil waterlogging occur at the break of slope and lower slope positions where there is a change in hydraulic gradient causing groundwater to “back-up” and accumulate causing soil waterlogging. Clearing of medium to tall vegetation at the break of slope can increase soil waterlogging due to lower plant soil uptake. This can lead to increased surface evaporation and subsequent salinisation of soils leading to a loss of soil fertility and in severe cases scarring. Maintaining vegetation cover at breaks in slope with low to medium height shrubs helps keep groundwater levels below the soil surface and reduces soil salinisation problems.

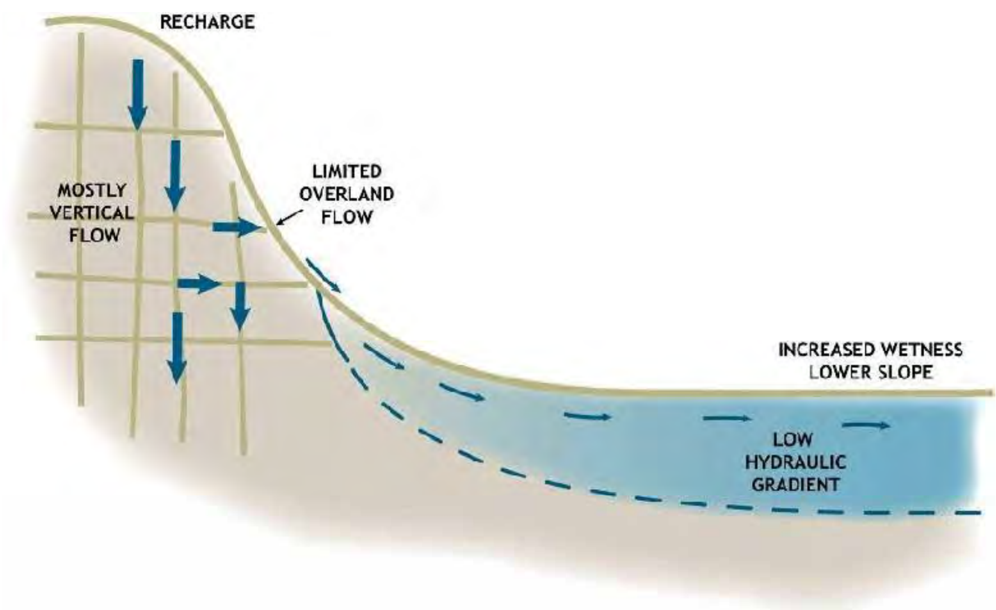

Figure 6.18 - Steep Hills or Disconnected Hillslope Model

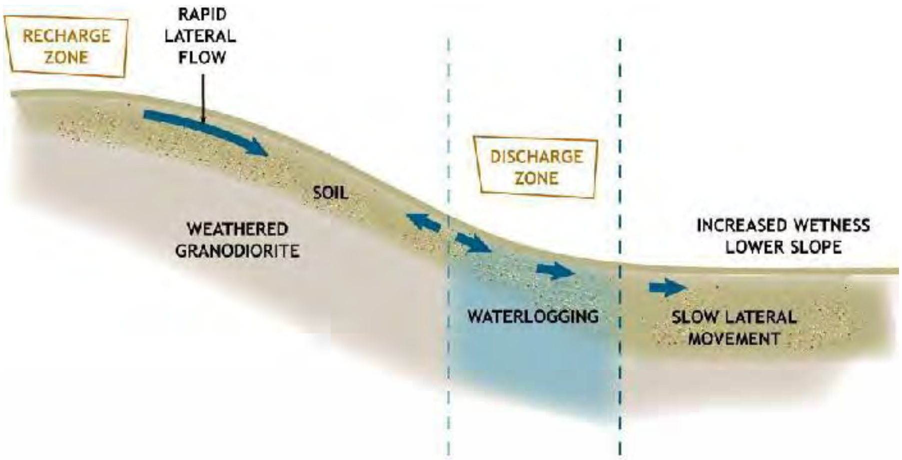

Figure 6.19 - Catena or Continuous Hillslope Model

6.3.7 Acid Sulfate Soils

Acid sulfate soils are commonly found in areas of Holocene aged (<10,000 yrs BP) sediments below 5 m AHD which accounts for much of the eastern section, western section and the mangrove fringe of HHI. There are two possible areas within the project area that may be affected by potential acid sulphate soils. These are:

- The north-west relict beach ridge and swale system area incorporating the Golf Course and Beach Resort Precinct
- The access bridge and boat ramp in Boyne Creek.

Construction activities will disturb potential acid sulphate soils in the intertidal zone with the extent depending on bridge design.

A number of boreholes were advanced (SKM 2005) to investigate the depth to hard rock in supratidal saltpans in the boat ramp area. Supratidal saltpan areas were found to have only shallow sediments of <0.5 m, often with outcrops of decomposed rock. Moving from the saltpans to mangroves the depth to rock increased to approximately 0.5 m. On the channel side of the mangroves the sediment depth was approximately 0.65 m although samples were not able to be recovered at this location.

The distribution of potential acid sulphate soils is limited to shallow mangrove mud in the tidal zone. Soils above this mangrove zone in the supratidal saltpan zone is considered to be residual soils, formed in situ on hard rock geology, rather than by deposition of marine sediments and subsequently have a low potential acid sulphate soils risk.

The sites in the vicinity of the bridge and boat ramp were sampled and analysed for potential acidity. Marine sediments within this area retumed net acidity between 0.34 and 1.12 % sulphur, above the action criterion specified in QASSIT (1998) and Dear *et al.* (2002) of 0.03%S and will therefore require treatment during construction works.

6.3.8 Contaminated Land

A search of the Environmental Management Register and Contaminated Land Register administered by DEHP did not reveal any of the land parcels on the Island to be listed as contaminated sites. However, historical use of the project area for cattle farming has left a legacy of potential contamination associated with:

- A former cattle dip located in historical cattle yards south of Tiber Point
- Diesel fuel storage near the main homestead
- A small (<4 m^2) fuel/waste oil spill area located adjacent the entrance gate of the former stockyards
- Asbestos cement sheeting used in construction of the homestead buildings.

Previous investigation of soils around the former cattle dip (AGC Woodward-Clyde 1993) found levels of arsenic (total) to range from 2.5 to 337 mg/kg. It is likely that the observed levels of arsenic are likely to be derived from the historical use of arsenic-based pesticides in the dip such as arsenic trioxide for the control of cattle ticks. Arsenic-based cattle dip formulations were removed from the market in June 1983 and the use of arsenic-based products for sheep and cattle was banned in January 1987. AGC Woodward-Clyde (1993) also found concentrations of the organochlorine pesticides Ethion to range from 1.0 to 780 mg/kg and DDT and derivatives to range between 0.17 and 1.1 mg/kg.

The National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 1999) Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater provides investigation levels and response levels for selected contaminants.

Arsenic concentrations observed from AGC Woodward-Clyde (1993) investigations exceed the Environmental Investigation Level (EIL) of 20 mg/kg in three locations adjacent to the former cattle dip, S1 (35.5 mg/kg), S2 (337 mg/kg) and S6 (175 mg/kg). The latter two sites also exceed the Health-based Investigation Level (HIL) for arsenic in a low density residential exposure scenario (100 mg/kg). It is noted that S1 and S2 are from different depths at the same location at the SE corner of the dip drying pad. A higher concentration of arsenic in S2 from 0.2 -0.4 m depth suggests some migration deeper into the soils of this area.

Historical investigations conducted by Woodward Clyde (1993) did not include an assessment of potential arsenic bioavailability or the speciation of arsenic. The above guidelines assume 100% bioavailability and are based on all potential forms of arsenic (total arsenic). Soil geochemistry and arsenic speciation may reduce the potential solubility (and subsequent bioavailability) thereby reducing potential contamination risks to human receptors during development.

Concentrations of the organochlorine pesticide DDT and its direct metabolites (DDD and DDE) found by AGC Woodward-Clyde (1993) located in the south east corner of the dip drying pad. Based on concentrations found in deeper soils at all locations sampled during the 1993 investigation vertical migration through the soil profile appeared limited. Soil contamination by DDT and derivatives appears to be limited to surface soils.

The organophosphate pesticide Ethion was also found in soils around the cattle dip during 1993 investigations. Concentrations in surface soils ranged between 1.1 mg/kg in S1 (SE corner of the dip drying pad) and 780 mg/kg in S5 (adjacent to the dip entrance gate). Deeper soils below 0.2 m in S2 and S6 returned very low levels of Ethion in comparison. This is likely due to Ethion adsorbing strongly to soil particles and being nearly insoluble in water. As such it is unlikely to leach or contaminate groundwater. A sample of water collected (SKM 2005) from the base of the cattle dip returned 299 µg/l of Ethion. Whether the sampled water was groundwater seepage or residual dip water is unknown.

No EIL or HIL is prescribed National Environment Protection (Assessment of Site Contamination) Measure 1999 for Ethion. Reference to the USEPA Region 9 Preliminary Remediation Goal (PRG) for Residential Soil is 31 mg/kg. Concentrations in S5 (780 mg/kg) on HHI exceed this value.

No assessment of hydrocarbon or asbestos contamination was made by AGC Woodward-Clyde (1993). Further investigation will be required to establish the lateral and vertical extent of contamination from arsenic and DDT and derivatives, Ethion and hydrocarbons and also asbestos prior to construction.

6.4 Surface and Groundwater Resources

6.4.1 Surface Watercourses

No perennial (permanent) freshwater watercourses are located on HHI. Freshwater drainage on HHI typically consists of ephemeral watercourses (flowing only during and immediately after rainfall events) and ephemeral wetlands that form in low lying areas after rainfall. Figure 6.20 presents the typical features of an ephemeral watercourse.

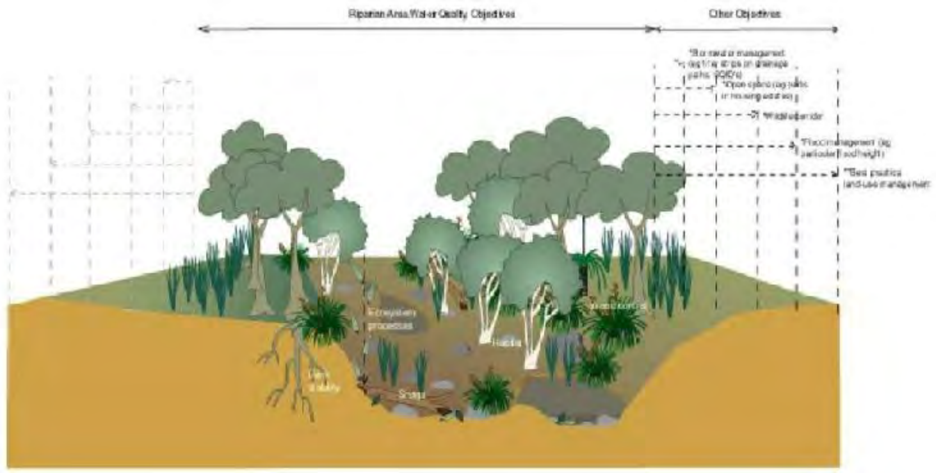

Figure 6.20 - Conceptual Model for an Ephemeral Freshwater Stream

Source: Moreton Bay Waterways and Catchments Partnership (MBWCP),SEQRWQMS, Volume 1.

Most watercourses and gullies on HHI drain from the central granodiorite ridge line, radiating outwards to the adjacent colluvial or sand plains. Many of the eastern watercourses draining the central ridge discharge as sheet flow either at the break of slope or within 200 m, and are not directly connected to adjacent receiving estuarine waters (refer to Figure 6.21). Channel widths within the ephemeral watercourses are typically very small being less than 2 m wide and of first and second order[3].

3 Stream order is determined by the number of tributaries that have merged together to form the watercourse, e.g. a single watercourse will be a first order watercourse. When two first order watercourses merge they become a second order watercourse, when two second order watercourses merge they become third order and so on.

Figure 6.21 - Freshwater Drainage Systems and Water Quality Sampling Location on Hummock Hill Island

LEGEND

- Existing Sampling Locations
- Proposed Sampling Locations
- Discharge Points
- Drainage Line
- Index Contour (5m)
- Intermediate Contour (1m)
- Development Footprint

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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6.4.1.1 Riparian Habitat and Ecological Value

Channels are poorly defined and generally do not featured distinct bed, banks or riparian zone, such as those shown in Figure 6.22. Ponding does not following periods of flow however some low lying depressions may retain water. Channels become discontinuous in flatter areas.

Riparian habitat is generally absent from watercourses draining the central ridgeline and also in channels crossing the colluvial plains. Vegetation associated with these watercourses consists of the same vegetation types as surrounding land, i.e. grasses and tree re-growth (refer to Figure 6.22). The lack of riparian habitat can be attributed to the small catchment size leading to watercourses with quick response times leading to short bursts of water flow. The general low rainfall of the area and underlying geology does not encourage the storage of groundwater and as such base-flow that can supply water to a watercourse is absent. The watercourses do not retain sufficient water to promote the growth of typical riparian vegetation such as emergent macrophytes.

Figure 6.22 – Typical Ephemeral Watercourses Draining from the Central Granodiorite Ridge

An assessment of ecological value for watercourses draining the central granodiorite ridge and colluvial plains, based on assessment criteria outlined in *Guidelines for Protecting Australian Waterways* (Bennett *et al.* 2002), is presented in Table 6.6. Based on the preliminary assessment, watercourses draining the central granodiorite ridge and colluvial plain return a low ecological value.

Table 6.6 – Ecological Value Assessment of Ephemeral Watercourses on Granodiorite and Colluvium

Criteria	Question	Y/N/U	Rating
Naturalness	Is the watercourse free from (or signs of): • Cattle disturbance • Rubbish • Poor water quality • Clearing of natural vegetation • Presence of weeds • Erosion • Dams or weirs • Channel modification	 Y N U N N N N Y	 Low
Representativeness	In comparison with similar watercourses in the area is the watercourse a good example of: • Flow patterns • Water quality • Native vegetation in the watercourse and on the banks • Aquatic wildlife • Channel features	 U U Y N N	 Medium
Diversity	Does the area support a large number of native species Does the area have a range of in-stream habitats Are there a variety of native birds commonly seen/heard in the area Are there a variety of streamside plants found in the area	N N Y N	Low
Rarity	Does the area (watercourse) support a rare, threatened or vulnerable species or those known locally or regionally as being significant Does the site have unusual natural features	N N	Low
Special Features	Are there any features present in the watercourse that makes it special	N	Low

Y – Yes, N – No, U - Uncertain

Two ephemeral watercourses are also present in each of the relict beach ridge systems east and west of the Northern Headland (Figure 6.23). Channel definition in the ephemeral watercourse east of the northern headland is limited to a sandy and muddy reach below the headland extending east for approximately 300 m. This reach contains mangrove vegetation and pools of standing water. Whilst no distinct connection was observed with adjacent marine waters it is thought that this reach receives marine water during large spring tides with storms, either as swash over or seepage through the adjacent dune.

The watercourse further to the east displays little distinct channel characteristics, such as a distinct bank and bed, forming a swale at the transition between the colluvial plain and relict beach ridge system (refer to Figure 6.23). No areas of standing water were observed during inspection of this reach of the watercourse, however, *Melaleuca spp.* were observed on the sides of the swale.

 

Figure 6.23 – Ephemeral Watercourses - East of the Northern Headland

A second ephemeral watercourse is found in the relict beach ridge system west of the headland (refer to Figure 6.21). The watercourse originates at the break of slope below the headland and approximately 100 m from the shoreline, where the granodiorite of the headland meets the relict beach ridge sands. A small farm dam is located at the head of the watercourse and did not contain water during at the time of inspection. Downstream of this dam the watercourse forms a broad swale (approx 50 m wide) with no distinct channel definition. Low shrub vegetation such as seablite (*Suaeda australis)* and bead weed (*Sarcocornia quinqueflora*) as shown in Figure 6.24, plants typically found in saltmarsh, are found in this swale. Further west, the swale narrows without discharging to the ocean (refer to Figure 6.24). No standing water was observed in this ephemeral watercourse/swale during site inspections by SKM from 2005 to 2007 period. Areas of moist ground were observed in depressions within this system. Based on the current status of this system, with lack of cross sectional channel form, the above vegetation and lack of standing water this area is considered to be more representative of a wetland (refer to Figure 6.24).

Inspection of historical aerial photography reveals this watercourse was once connected to the ocean and subject to tidal flooding up until the 1980s. Accumulation of sand since the 1990s has disconnected this watercourse from tidal waters and sealed the entrance.

 

Figure 6.24 – Two Reaches of the Watercourse West of the Northern Headland

An assessment of ecological value for ephemeral watercourses/swales in the relict beach ridges, based on assessment criteria outlined in Guidelines for Protecting Australian Waterways (Bennett *et al.* 2002), is presented in Table 6.7. Based on this preliminary assessment, ephemeral watercourses in the relict beach ridge system return a medium ecological value.

Table 6.7 – Ecological Value Assessment of Ephemeral Watercourses/Swales in Relict Beach Ridges

Criteria	Question	Y/N/U	Rating
Naturalness	Is the watercourse free from (or signs of): • Cattle disturbance • Rubbish • Poor water quality • Clearing of natural vegetation • Presence of weeds • Erosion • Dams or weirs • Channel modification	 Y N U Y N Y N Y	Medium
Representativeness	In comparison with similar watercourses in the area is the watercourse a good example of: • Flow patterns • Water quality • Native vegetation in the watercourse and on the banks • Aquatic wildlife • Channel features	 U U Y N N	Medium
Diversity	Does the area support a large number of native species Does the area have a range of in-stream habitats Are there a variety of native birds commonly seen/heard in the area Are there a variety of streamside plants found in the area	N N Y Y	Medium
Rarity	Does the area (watercourse) support a rare, threatened or vulnerable species or those known locally or regionally as being significant Does the site have unusual natural features	Y N	Medium
Special Features	Are there any features present in the watercourse that makes it special	N	Low

Y – Yes, N – No, U - Uncertain

A number of small artificial dams have been constructed within the ephemeral watercourses and gullies to supply drinking water for cattle during use of HHI for pastoral activities. The larger of these dams and the one containing water at most times of the year is located in catchments draining the central granodiorite ridge and colluvial plains (refer to Figure 6.21). The largest of these dams, located in a break in the central ridgeline contains emergent riparian vegetation. It is not known to contain fish, though a distinct ephemeral watercourse does exist downstream, connecting to the adjacent estuarine waters of Boyne Creek. A second dam located adjacent the Bushland Precinct receives drainage from the southern-most section HHI and is located at the head of a tidal inlet. Connectivity with adjacent marine waters is only likely during extreme high tides and storm flows.

6.4.1.2 Hydraulic Characteristics

No physical investigations of ephemeral watercourse hydraulics have been conducted due to their ephemeral nature and the lack of water to assess flow conditions. Water flow in the ephemeral waterways typically responds quickly to storm events due to their small area and short distance for overland flow to travel to the channel. Water levels typically rise quickly and fall rapidly.

Whilst the lack of water in watercourses has precluded investigation of flows, watercourses within the lease area have been modelled as part of Water Sensitive Urban Design for the proposed stormwater drainage system. Individual ephemeral watercourse catchment areas are less than 100 ha. Modelling for the purpose of assessing stormwater flows has amalgamated small sub-catchments to derive the drainage zones in Table 6.8.

As detailed in Table 6.8 peak flows for a 1 in 100 year storm (a major storm event) are relatively small, reflecting the small size of the catchments.

Changes in climate attributed to global warming effects are uncertain for Queensland as a whole. Rainfall in Queensland has exhibited both increasing and decreasing trends. However, the *Queensland Greenhouse Strategy* (2006) notes that the Gladstone region has recorded the greatest decreases in annual rainfall (more than 7 mm per decade). Rainfall intensity is predicted to increase leading to increases in intermittent flows in ephemeral watercourses and a subsequent greater increase in sediment transport capacity of existing ephemeral watercourses on HHI.

Table 6.8 – MUSIC Modelling of 100 Year Peak Flows within the Development Area

	Area (ha)	**Rainfall Intensity, I_{100} (mm)**	**Time of Conc., t_c (min)**	**Peak Flow (m^3/s)**
Lagoon	98.29	67	20	39.79
Bay	8.18			3.31
Town	26.45			10.71
Headland	22.79			9.23
Hummock Hill	31.19			12.63
Boyne Hill	24.51			9.92
Boyne East	34.70			14.05
Boyne West	25.13			10.17

6.4.1.3 Current Surface Fresh Water Uses

No industrial, agricultural or potable use of surface water is conducted on HHI. Ecological function forms the primary use of existing ephemeral watercourses though this is limited for watercourses draining the central ridgeline. Two man-made dams contain water and have some ecological processes associated with them.

No water allocations currently exist on HHI due to the predominantly dry ephemeral nature of creeks on HHI and lack of water flow reliability for abstraction.

6.4.1.4 Environmental Values Assessment

The *Water Act 2000* (Qld) states that a "*Watercourse means a river, creek or stream in which water flows permanently or intermittently—*

(a) in a natural channel, whether artificially improved or not; or

(b) in an artificial channel that has changed the course of the watercourse;"

Beds and banks of a watercourse are deemed to be "*…land over which the water of the watercourse or lake normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed or banks that is from time to time covered by floodwater.*" (*Water Act 2000*)

The *Environmental Protection (Water) Policy 2009* (EPP(Water)) applies to all Queensland waters and provides a framework for:

- Identifying Environmental Values for Queensland waters, and deciding the Water Quality Objectives (WQO) to enhance and protect those Environmental Values (EVs)
- Including the identified EVs and WQO under Schedule 1 of the EPP(Water).

The EPP(Water) ensures that identified EVs for water are protected through the use of a measurable indicators such as pH, conductivity, nitrogen concentration. Site specific documents are the preferred source of identifying measurable indicators for EVs under the EPP(Water).

Ephemeral watercourses on HHI or the surrounding estuarine and marine receiving waters are not listed in Schedule 1 of the EPP(Water). The EPP(Water) does state that for waters not listed in Schedule 1 the EVs to be enhanced or protected are the:

- Biological integrity of a pristine or modified aquatic ecosystem
- Suitability for recreational use
- Suitability for minimal treatment before supply as drinking water
- Suitability for agricultural use
- Suitability for industrial use.

The following documents also provide further guidance on identifying EVs and establishing water quality objectives:

- *Australian and New Zealand guidelines for fresh and marine water quality* (ANZECC & ARMCANZ 2000)
- *Queensland Water Quality Guidelines* (QWQG) (DEHP 2009a)
- *Establishing Draft Environmental Values and Water Quality Objectives* (DEHP 2013).

A series of default EVs that may be used for assessment are also provided by the DEHP (2013) Guideline and the QWQG (DEHP 2009a), and expand on those identified in the EPP(Water). These include:

- Aquatic ecosystems
  - High conservation value (HCV)
  - Slightly to moderately disturbed systems (SMD)
  - Highly disturbed systems (HDS)
- Primary industries
  - Irrigation
  - Water for farm use
  - Stock watering
  - Aquaculture
  - Human consumption of wild or stocked fish or crustaceans
- Recreation and aesthetics
  - Primary recreation (swimming)
  - Secondary recreation (boating, fishing)
  - Visual appreciation;
- Drinking water
- Industrial uses
- Cultural and spiritual values.

The DEHP (2013) Guideline – *Establishing Draft Environmental Values and Water Quality Objectives* outlines the process for the establishment of site (catchment) specific draft EVs and associated draft WQO. This process takes into consideration the current waterway condition, identification of reaches with "*high ecological values*", current and future human uses of the waterway and consultation with the community on the above aspects of the catchment. This process is designed primarily for water quality managers, local government and natural resource management bodies however, the process is considered here in identifying draft EVs for watercourses on and around HHI.

Draft EVs for freshwater, estuarine, and marine receiving waters are based on assessment of the physical nature and condition of existing watercourses and waters and current human uses either observed or through community consultation. Based on this assessment a series of EVs are provided in Section 6.4.1.5.

In terms of values relating to the location of HHI within the GBRWHA, the main contribution that surface waters of HHI make to the OUV of the GBRWHA are as a water source for listed threatened and migratory terrestrial species. This is discussed further in Section 7.2.

6.4.1.5 Surface Watercourse Environmental Values

Based on the existing condition, preliminary assessment of ecological value and current human uses of identified watercourses draft EVs are outlined in Table 6.9.

Table 6.9 - Draft EVs for Ephemeral Watercourses

Watercourse Type	SMD Aquatic Ecosystems	Visual Appreciation	Cultural and Spiritual
Granodiorite & Colluvial Plain Watercourses	✔	✔	
Relict Beach Ridge Watercourses	✔	✔	✔
Artificial Dams	✔	✔	

6.4.1.6 Water Quality Objectives

Water Quality Objectives for freshwaters on HHI are required to protect the identified EVs in Table 6.9. As freshwaters on HHI are not listed in Schedule 1 of the EPP(Water), the WQO will be the "*the set of water quality guidelines for all indicators that will protect all EVs for the water*".

In the absence of site specific data the QWQG (DEHP 2009a) and ANZECC & ARMCANZ (2000) are used for fresh waters on HHI. Under the current Island conditions these guidelines apply to water in dams only as identified ephemeral watercourses do not contain water. Application of WQO to ephemeral watercourses is difficult due to the lack of water outside rainfall events. As such reference is made to the South-East region guidelines for riparian areas outlined in Table 6.10. Maintenance of riparian vegetation is effective at reducing contaminants such as suspended solids and nutrients and the use of buffer zones assists in maintaining water quality downstream of these watercourses.

The Regional Vegetation Management Code for South East Queensland (2012) (RVMC) provides the following Performance Requirement (PR S.3) relating to the ephemeral watercourses[4] on HHI:

- To regulate the clearing of vegetation in a way that does not cause land degradation, prevents the loss of biodiversity and maintains ecological processes – maintain the current extent of assessable vegetation associated with any watercourse to provide –
  - Bank stability by protecting against bank erosion
  - Water quality by filtering sediments, nutrients and other pollutants
  - Aquatic habitat
  - Terrestrial habitat.

The acceptable solution for the above performance requirement (AS S.3, S. 3.1) requires the maintenance of a 10 m distance from "*each high bank of each watercourse with a stream order*

[4] As defined on the most recent 1:100,000 Geoscience Australia topographic map.

1 or 2." This performance requirement is consistent with the principle guideline identified in Table 6.10 and is included as an objective for ephemeral watercourses.

The 10 m riparian buffer outlined as a guideline for ephemeral watercourses is also considered to comply with the requirements of the *Fisheries Guidelines for Fish Habitat Buffer-Zones* (FHG 003), considering that the Colosseum Fish Habitat Area is the ultimate receiving water of ephemeral watercourses on HHI. As such, a 10–15 m buffer is considered appropriate guideline.

Table 6.10 – Modified South-East Queensland Guidelines for Ephemeral Creeks and Gullies

Water Type	Riparian Function		
	Ecological Processes	**Habitat**	**Bank & Bank Stability**
Ephemeral	Maintain or restore vegetation to achieve 70% canopy shade in streams less than 10m wide. This will achieve: • Moderation of temperature and dissolved oxygen extremes; • Organic cycling of leaf litter for nutrients and energy; and • Transformation of diffuse nitrogen inputs. • Maintain 10–15 m buffer from each bank (AS S.3)	Eradicate weeds and maintain or restore: • In-stream large woody debris for fish and invertebrates; • Native trees, shrubs and ground cover on the banks; and • Tree roots to provide stable under-cut banks. This also assists in maintaining biodiversity.	Maintain or restore bed and bank vegetation to minimise erosion during wet weather flows. Manage cattle access to maintain or restore bank stability and bank vegetation
Gullies	Not Applicable Maintain 10-15 m buffer from each bank (AS S.3)	Not Applicable Maintain 10–15 m buffer from each bank (AS S.3)	Maintain low vegetation to minimise erosion during wet weather flows

Consideration is also required of the *Reef Water Quality Protection Plan* (RWQPP) issued by the GBRMPA. Key objectives of the RWQPP are to:

- Reduce the load of pollutants from diffuse sources in water entering the reef
- Rehabilitate and conserve areas of the reef catchment that have a role in removing water borne pollutants.

Whilst these objectives are not quantitative and are difficult to incorporate as a specific management target they can be incorporated into the overall design philosophy for the proposed development. *Draft Interim Marine Water Quality Guidelines* have been compiled by GBRMPA but have not yet been released for public comment. Whilst they cannot be incorporated into the development of WQO at this stage their incorporation can be reviewed once fully released to assist in setting WQO consistent with the RWQPP.

Whilst recognising that ephemeral watercourses on HHI are generally dry, water flows do occur during storm events. During these events suspended sediment, nutrients and other potential contaminants could be transported from the development to downstream waters such as dams, estuaries and coastal waters. The WQO for estuaries and coastal waters require consideration in setting performance objectives for proposed mitigation measures utilising water sensitive urban design treatments.

While specifying QWQG values as WQO at the discharge point of ephemeral watercourses would guarantee that acceptable estuarine concentrations are obtained, such an approach is highly conservative and unrealistic if it is not possible to demonstrate that the objectives can be achieved, even with the latest modelling software and treatment technology

Healthy Waterways utilised load-based objectives recently in their document *WSUD: Developing Design Objectives for Water Sensitive Urban Design in Southeast Queensland* (2006). These require achievement of the following objectives when compared to unmitigated urban development:

- An 80% reduction in annual suspended solid loads
- A 60% reduction in annual Total Phosphorus loads
- A 45% reduction in annual Total Nitrogen loads
- A 90% reduction in annual gross pollutant loads.

Ephemeral watercourses on HHI discharge to estuarine waters of Colosseum Inlet and Boyne Creek that contain a range of EVs and habitat for species of national environmental significance such as dugong, *Dugong dugon*, and green turtle, *Chelonia mydas*, that use seagrass meadows for foraging. These downstream EVs have been identified as having a high ecological value. Due to the linkage between Island SMD ecosystems and the downstream estuarine and marine high ecological value systems, WQO for ephemeral watercourses have the objective of maintaining identified ecological values and resources of estuarine and marine waters in their current condition.

In recognising the importance of minimising impacts from stormwater discharges to high ecological value estuarine and marine waters water sensitive urban design treatments during the design stage will also require the following objectives to be achieved at the point of discharge:

- No increase in export of contaminants compared to existing conditions
- The preservation of existing, natural nutrient loads as far as possible.

These objectives are considered to be consistent in protecting the existing conditions in estuarine and marine waters that are protective of identified EVs and world heritage values of these systems. These objectives are also considered to be consistent with the intent of the two RWQPP objectives of reducing pollutant loads from the GBR catchment and conserving areas that have a role in removing waterborne pollutants, i.e. riparian vegetation and intertidal wetlands.

Following initial approval, further refinement of the above WQO in line with the QWQG (DEHP 2009a) to establish site specific WQO will be incorporated in future water quality planning. These WQO will be established from the proposed water quality monitoring program and based on the 20th and 80th percentile for each contaminant of concern as outlined in Appendix D of the QWQG (DEHP 2009a).

The ongoing development of site specific WQO in conjunction with best practice management measures in mitigation measures is considered to protect the WHV of the GBR and achieve the objectives of the RWQPP.

6.4.2 Existing Water Quality

Investigations recorded field parameters such as pH and electrical conductivity for waters from the relict beach ridge system and freshwater dams adjacent the former airstrip at the eastern base of the granodiorite ridge.

Conductivity of water in the ephemeral watercourse west of Northern Headland was recorded by the AGC Woodward-Clyde (1993) as 13,650 µS/cm, about one quarter that of seawater and exceeding the WQO for a freshwater watercourse. However as this watercourse contains mangrove species it is considered to be more representative of marine or transitional conditions. Such a high conductivity would be appropriate for such waters. A pH value of 7.3 was also recorded for the same area. It was noted by the AGC Woodward-Clyde (1993) that the tidal lagoon/creek east of the Northern headland would yield similar conductivities depending on the level of tidal flushing. Physico-chemical water quality of an ephemeral freshwater dam located at the base of the central granodiorite ridge yielded an electrical conductivity of 120 µS/cm and pH of 5.6. No water quality samples were collected for chemical parameters during the 1993 investigation.

Physico-chemical water quality was assessed by SKM in September and November, 2005. Freshwater was found in only one man-made dam within the lease area, located in an ephemeral watercourse in a shallow valley dissecting the central granodiorite ridge (W3). Sample site W10 is located in the ephemeral semi-tidal/storm flushed watercourse in the relict beach ridge system to east of the Northern Headland. Sample site W11 is located in an ephemeral dam south at the south of HHI (refer to Figure 6.21). Results of freshwater water quality sampling are presented in Table 6.11.

Table 6.11 – Physico-chemical Water Quality for the Freshwater Dam Sample Location W3

Site	Parameter	Temp.	Turbidity	ORP	pH	Clark DO	Conductivity	Salinity
	Unit	Celsius	NTU	mV	pH	mg/L	µS/cm	PPK
W3	Sept 05	28.9	9.6	-	-	6	149.0	0.08
W3	Nov 05	30.8	2.6	139.3	7.2	4.5	597.7	0.35
WQO		-	20	-	6.5	-	970	-

In general the existing water in the farm dam complies with WQO outlined in Section 6.4.1.6.

Clearing and thinning carried out for cattle grazing and sleeper logging has changed vegetation on HHI in a number of ways that affect water quality. Clearing for cattle grazing has consisted of a regular fire regime that reduced new under-storey growth, allowing grasses to dominate. Such clearing can increase the generation of surface sediment during storm events, potentially increasing total suspended sediment in ephemeral creek/gully systems draining the central granodiorite ridge. Evidence of continuing erosion on the colluvial plains suggests that land clearing is still creating some erosion issues, however, these watercourses do not always reach adjacent estuarine or marine receiving waters.

Logging carried out in ironbark (*Eucalyptus populnea*) areas has thinned vegetation potentially increasing the generation of surface sediment during rainfall events leading to a subsequent increase in total suspended sediment as evidenced in some minor erosion and outwash fans.

Potential contamination sources associated with former fuel storage and cattle dip activities exist in the former homestead and cattle yard area. There was no evidence observed of contaminant impact in the form of stressed vegetation or surface staining during site inspections conducted by SKM between 2005 and 2007. The relative risk of contamination from these sources to ephemeral watercourse system is considered low due to the covered fuel storage area and the cover over the cattle dip, both reducing direct contact of rainfall and subsequent surface flow contamination. The low solubility in water and high K_{OC} of DDT and Ethion found in cattle dip soils and residual dip water (refer to Section 6.3.8) means the transport of these compounds will be by attachment of fine soil particles. No evidence of soil erosion or mobilisation has been observed in these areas and as such the probability of impact to down gradient receiving waters is considered low.

6.4.3 Groundwater

AGC Woodward-Clyde (1993) reported hydrogeological assessments of HHI by Soil Survey and Exploration in 1981 and AGC Woodward-Clyde in 1992. The only notable groundwater resource identified on HHI was associated with the unconsolidated quartzose dunal sands and marine sediments located in the eastern and western sections of HHI. In both areas aquifer conditions were unconfined with a saturated thickness of less than 10 m (typically 1–4 m).

As discussed in Section0, some groundwater dependant ecosystems are present at the break of slope of low hills in the southern areas of HHI. These areas are generally indicated by *Melaleuca spp.* and have been mapped (see Figure 6.55). Some groundwater dependant *Melaleuca spp.* have also been observed it the juncture of the colluvial plains and relict beach ridge systems. No other groundwater dependant ecosystems have been identified during survey of the site.

6.4.3.1 Aquifer Characteristics

AGC Woodward-Clyde (1993) encountered unconfined groundwater approximately 0.5 to 5 m below surface on the eastern and western flanks of HHI. Groundwater movement was found to be generally toward the coastline with the water table generally representing a subdued expression of topography. Groundwater recharge occurs primarily through rainfall infiltration with losses likely to be attributable mainly to beach face seepage and evapo-transpiration by vegetation.

The flanks of the central and eastern ridgeline are underlain by residual sandy-clayey soils derived from the underlying Miriam Vale Granodiorite batholith. Whilst no near-surface groundwater resource was associated with these materials there has been no investigation undertaken to-date regarding the aquifer potential of the deeper granodioritic material. Whilst the basement materials may host some groundwater in structural defects (joints, fractures etc) this stratum will not be disturbed as part of the current proposal and further investigation is not considered necessary.

6.4.3.2 Existing Uses of Groundwater

No abstraction of groundwater is currently carried out on HHI. Current uses of groundwater are considered to be related to maintenance of natural ecosystems and ecological function of groundwater dependant ecosystems and receiving waters of groundwater discharge (where encountered).

6.4.3.3 Groundwater Environmental Values

Based on the EPP(Water), the EV for groundwater will be reflective of the use of the groundwater at its point of discharge, whether by seepage as base flow to a creek or as abstracted by a well or bore. As such, on the basis that no current water extraction[5] is conducted, groundwater EVs for HHI will be consistent with the surface water to which it reports, such as seepage to beaches and subsequent discharge to marine waters.

6.4.3.4 Groundwater Quality and WQO

AGC Woodward-Clyde (1993) reported isolated areas of fresh groundwater (<1,500 µS/cm) within sand areas of HHI; elsewhere on the eastern and western flanks of HHI, groundwater was typically brackish to saline at depth with a slight decrease in salinity noted to occur near-surface due to density stratification. The location of groundwater monitoring bores installed during the above surveys on HHI together with the inferred location of areas hosting fresh groundwater is shown in Figure 6.25.

6.5 Coastal environment

6.5.1 Regional Setting

HHI is located 200 m from the mainland separated by a shallow tidal estuary to the south (Boyne Creek) and slightly deeper tidal estuaries east and west, namely Colosseum Inlet and Seven Mile Creek. A small tidal creek called Sandfly Creek almost divides the Island in two. This is unlike the more typical continental islands of the GBRWHA/NHP which are more distant from the mainland such as Great Keppel Island (17 km), Whitsunday Island (20 km), Magnetic Island (approx 5 km), or islands such as Hinchinbrook Island that are separated from the mainland by a deep channel.

Continental islands within the immediate region that are similar to HHI, being separated from the mainland by relatively narrow tidal creeks include Curtis Island, Wild Cattle Island, Rodds Peninsula, Middle Island and Eurimbula National Park. HHI has the greatest similarity with Curtis Island and Facing Island, which also have a central rock core, sand foreshores and intertidal edges. Wild Cattle

5 It is noted that groundwater was historically abstracted from the north east beach sand aquifer to a small dam, however the infrastructure associated with this abstraction is now derelict and the dam dry.

Island, parts of Curtis Island and Rodds Peninsula are national parks and Middle Island is also protected under the *Nature Conservation Act 1992*.

HHI lies entirely within the GBRWHA and adjoins the GBRCMP, the GBRMP, and the Colosseum Fish Habitat Area (see Figure 6.35).

The GBRMP (Zone MPZ17) boundary runs from offshore to the northern tip of HHI, along the northern shoreline, and to the southern tip of the Island where it cuts across the entrance of Rodds Bay to Rodds Peninsula (see Figure 6.35). The landward limit of the GBRMP boundary on HHI is the low-water mark. The area between the low-water mark and highest astronomical tide (HAT) is included in the GBRCMP, which also covers all waters and intertidal areas of Seven Mile Creek, Boyne Creek, Sandfly Creek and Colosseum Inlet to the HAT. The GBRCMP in the HHI area imposes the same restrictions that apply to the General Use Zone of the Commonwealth GBRMP, and there is a joint management plan for both the State and Commonwealth parks. More information on management zones is provided in Section 7.6.

This section provides further information on the geological, geomorphological and coastal processes aspects of the coastal zone. Ecological values are discussed in Section 6.6.

Figure 6.25 - Inferred Regions of Fresh Groundwater (<1,500 uS/cm) on Hummock Hill Island

LEGEND

- Exploration Bore (previous groundwater
- Exploration Bore (with installed piezometer)
- Exploration Bore (no installed piezometer)
- Development Footprint
- Indicated Areas of Potable Quality Groundwater - (boundaries approx.) - (<1,500 uS/cm)

Groundwater Bore Labels
(6.63) = pH
5353 = Electrical Conductivity

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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6.5.2 Coastal Landforms and Coastal Resources

The landforms and landscape character units of HHI (as described in Section 6.8.1.2) include specific coastal units:

- LCU 7 – Coastal Headland, located on the northern tip of HHI, formed from granodiorite
- LCU 1 – Foredunes and beaches located along the northern coastline of HHI and extending partially into Colosseum Inlet and Seven Mile Creek consisting of Qb1 to Qb3 units as described in Section 6.3.5.1 with a general transition of *Spinefex spp.*, *Casuarina spp.*, *Pandanus spp.* and *Melaleuca spp.* to littoral vine forest and open eucalypt woodland (refer to Section 0)
- LCU 2 – Tidal Flats located within Colosseum Inlet, Boyne Creek, Sandfly Creek and Seven Mile Creek consisting of intertidal banks and bars with seagrass meadows, a band of mangrove species and supratidal saltpans.

These coastal units form the transitional zone between terrestrial land uses and the marine environment offshore. Both the HHI coastline and adjacent mainland coastline have extensive intertidal wetlands (resources) consisting of:

- High intertidal/supratidal claypan flats (20.7 km^2)
- Mid-tidal mangroves (44.1 km^2)
- Low intertidal/shallow subtidal mud flats and seagrass meadows
- Low intertidal rocky outcrops
- Subtidal creek and channel floors with predominantly muddy bottoms.

The Island also has open coastal habitats that predominate on the northern side, consisting of:

- Sand beaches
- Low intertidal/shallow subtidal spits, banks and shoals;
- Rocky reefs and stacks
- Offshore subtidal areas with mostly sandy bottoms
- Offshore disturbed areas (Port of Gladstone channel and dredge spoil ground).

Intertidal resources surrounding HHI and bordering the mainland act as a buffer between terrestrial and marine processes and are complex mixing zones where terrestrial outputs from watercourses are processed, filtered, stored, converted and utilised in one form or another.

6.5.3 Estuarine Characteristics

6.5.3.1 Watercourses

Colosseum Inlet and Seven Mile Creek are tide dominated estuaries located west and east of HHI respectively. Boyne Creek is an east-west oriented tidal channel that connects Colosseum Inlet with

Seven Mile Creek via a shallow channel. Sandfly Creek is a tidal creek that effectively divides HHI into an eastern and western portion.

The Colosseum estuary, which comprises Colosseum Inlet, Boyne Creek and Seven Mile Creek is 13.75 km in length and has a water area of 55 km^2 (http://www.ozcoasts.gov.au/search_data/detail_result.jsp). The estuary runs north to south with a shallow entrance in the north located between the western coast of the Island and eastern coast of Wild Cattle Island. South of the shallow entrance bar the estuary deepens to around 20 m depth and branches into a number of ephemeral and tidal creeks such as Wild Cattle Creek to the west and Boyne Creek to the south east.

The Colosseum estuary is dominated by tidal flows rather than freshwater flows. Watercourses feeding the estuaries are ephemeral discharging to the estuaries during rainfall events. The watercourses on the Island are also ephemeral and discharge to Boyne Creek and Colosseum Inlet. With little freshwater flow into the estuaries, stratification of denser saline layers and less dense fresh water is not found under normal dry weather conditions. Stratification is only likely to occur during periods of freshwater discharges.

Observations of vertical profiles for salinity and temperature collected at various locations in Colosseum Inlet and Boyne Creek during field investigations by SKM (2005) confirmed the absence of stratification under normal dry conditions as shown in Figure 6.26 and Figure 6.27.

6.5.3.2 Tides and Tidal Flows

Tides within the Gladstone region are semi-diurnal; that is two high tides and two low tides per day with one high tide greater than the other. Table 6.12 presents typical tide heights for Gatcombe Head, the nearest tidal station to the Island.

Table 6.12 - Gatcombe Head Tidal Levels

Tide	Height (m AHD*)
Mean High Water – Spring	3.5
Mean High Water – Neap	2.8
Mean Sea level	2.1
Mean Low Water – Neap	1.4
Mean Low Water – Spring	0.7

* from lowest astronomical tide

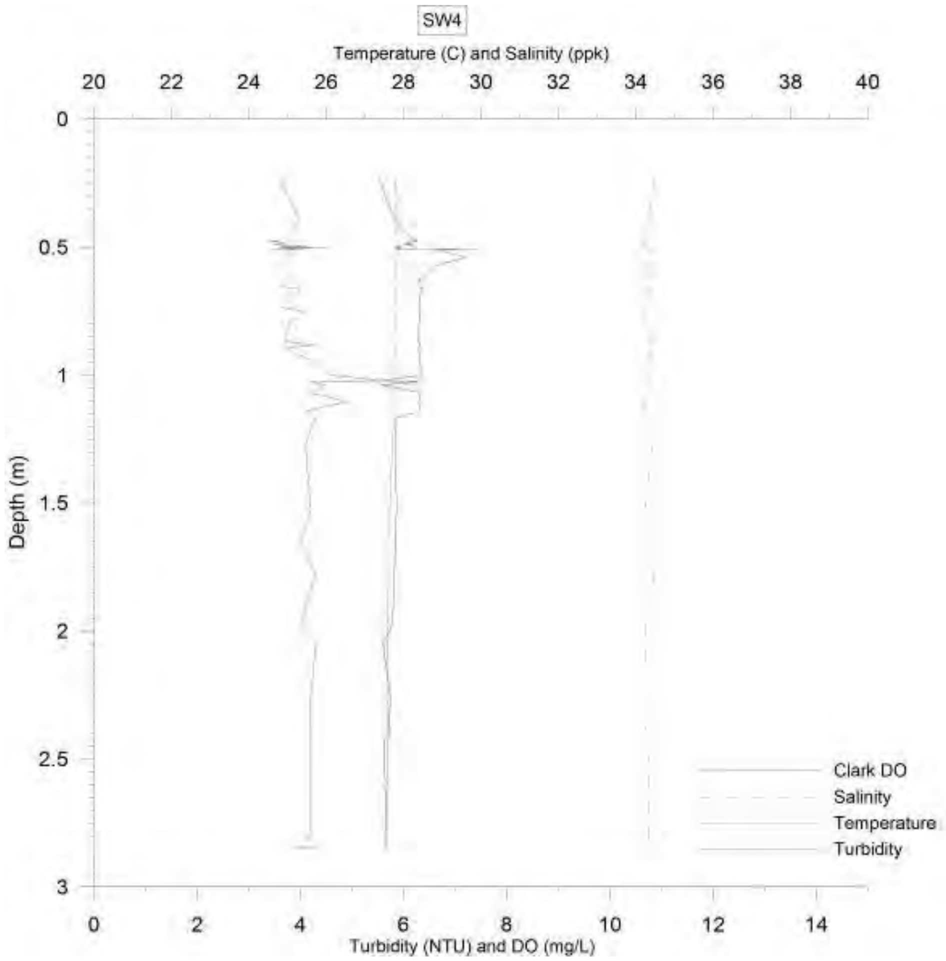

Figure 6.26 – Typical Vertical Profile at Boyne Creek (SW4)

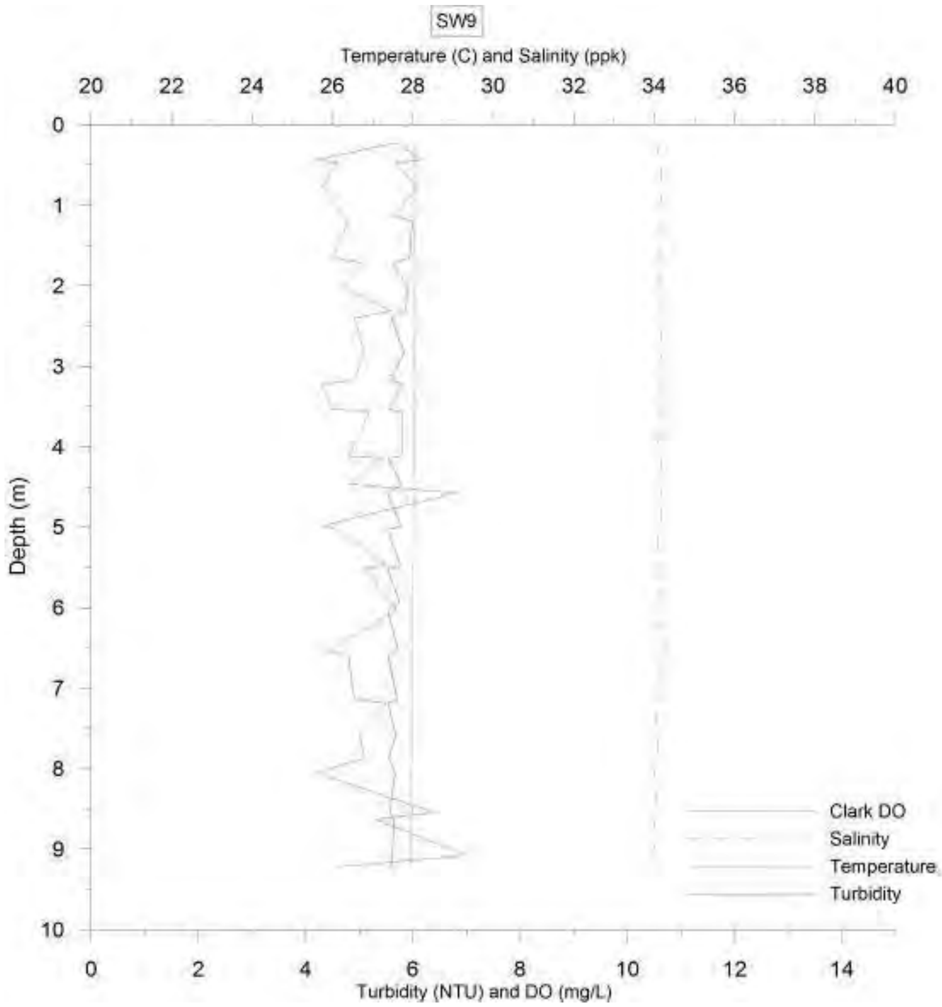

Figure 6.27 – Typical Vertical Profile at Colosseum Inlet (SW9)

Connolly et al (2006) found that estuaries in the Port Curtis (Gladstone) region were tide dominated with very little freshwater flow under normal dry conditions. Freshwater systems on the Island are limited to ephemeral watercourses that only flow to the adjacent estuaries during large storm events. With so little freshwater inputs under normal dry conditions, currents within the estuaries around the Island are driven by tides rather than freshwater flows. During large storm events when freshwater flows become more significant, the additional water will increase tide based discharge from the estuaries essentially 'flushing' the estuary. Local winds will provide some minor modification to tide driven flows, particularly in Boyne Creek where the predominant south east wind blows down the length of the Creek. However wind driven currents will be small in comparison to tidal currents.

A coastal hydrodynamic model was set up for the Port Curtis and Rodds Bay area, including HHI, by the CRC for Coastal Zone, Estuary and Waterway Management (Herzfield *et al*. 2004). This model shows that there is a large but relatively weak anticlockwise gyre in the Rodds Bay area to the north and north-east of HHI at surface. Further offshore, surface currents flow in a north-westerly direction with a shear between the gyre and offshore currents. An inshore current runs parallel to the coast directing flows from Colosseum Inlet to the north-west along the coast of Wild Cattle Island. Modelling of release of a tracer placed in Rodds Bay, midway between the eastern end of HHI and Rodds Peninsula indicated that the flushing time for this part of the estuary was about five days. The tracer was transported south into the Rodds Bay estuary and, through Seven Mile Creek and Boyne Creek, remaining in the inshore area, moving parallel to the coastline, with small amounts being carried into the Port Curtis area. Very little of the tracer was transported into offshore waters.

At low tide the existing causeway acts as a weir, obstructing tidal low that travels from east to west. Anecdotal evidence from local residents suggests Boyne Creek has silted up since installation of the causeway but there is no baseline against which to assess this. Tidal flow across supratidal saltflats are currently obstructed by the existing causeway (Figure 6.28).

Figure 6.28 - Existing Clarks Road Causeway across Supratidal Saltflats

Tidal flows within mangrove lined tributaries will be limited on the flooding tide. As these flats drain on the outgoing tide the water is directed to the tidal channel where it is “flushed” back into the adjacent estuary. During storms freshwater discharge from ephemeral watercourses will be directed down these small mangrove channels increasing flushing flows towards the estuaries where tidal flows carry the flushed water away to the main estuarine channels and out to sea. The level of flow in mangrove channels at the discharge point of ephemeral watercourses will be proportional to the storm intensity and duration.

6.5.3.3 Estuarine Cycling and Processes

Tidal mixing and marine water exchange are considered to be the dominant processes governing water quality within estuaries surrounding the Island, followed by trophic process associated with tidal flushing from intertidal wetlands. Within Port Curtis, and similarly Colosseum Inlet, Stratford and Connolly (2006) note that tidal process, freshwater flows (during storms), trophic links, severe storm/cyclone events are the key processes sustaining the function of intertidal wetlands.

Within the estuarine systems surrounding HHI, tidal processes drive the cycling of particulate nutrients and carbon as shown in the conceptual model in Figure 6.29. Without freshwater inputs from ephemeral watercourses on the Island bringing new sources of nutrients and carbon into the estuary system, nutrient cycling is limited to this tidal process together with tidal mixing from coastal waters.

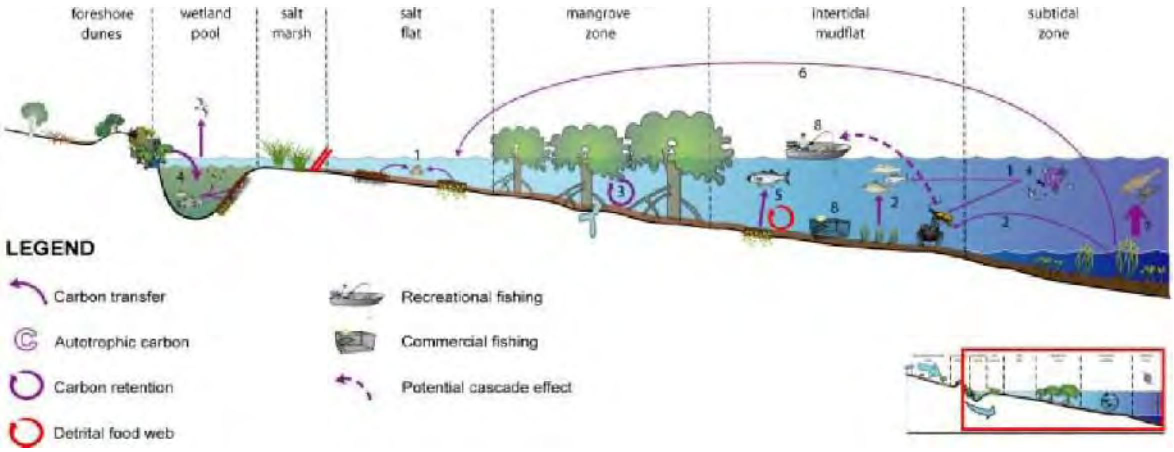

Figure 6.29 - Transfer Processes Associated with Tidal Movement (Stratford & Connolly 2006)

Periodic storm events cause ephemeral watercourses to flow and discharge freshwater laden with suspended sediments, carbon and nutrients into the estuarine system via three main tidal channels/creeks. Discharge points for overland flows from HHI are located in Boyne Creek and Colosseum Inlet. These stormwater flushes provide an important additional source of nutrients and carbon for the adjacent estuarine ecosystem around the Island which acts as a carbon and nutrient sink, cycling these products through the ecosystem as shown Figure 6.29. It is this processing that makes the estuaries productive.

6.5.3.4 National Land and Water Resources Audit

The National Land and Water Resources Audit (NLWRA 2001) classifies Colosseum estuary as a 'near-pristine' estuary with a 'slightly affected' ecological status. This classification is based on assessment against disturbance criteria, e.g. no impediments to tidal flow and natural catchment cover is >90% (note: natural cover of catchments discharging to Colosseum Inlet is substantially less than 90%). The OzCoasts Database of Australian Estuaries for Colosseum Inlet and Rodds Bay summarises NLWA data and is presented in Table 6.13.

Table 6.13 – OzCoasts/NLWA Summary Information

Data	Colosseum Inlet	Rodds Bay
Estuary Number	489	490
Condition	Near Pristine	Near Pristine
Classification	Tide Dominated	Tide Dominated
Sub-Classification	Tide Dominated Estuary	Tide Dominated Estuary
Estuary length	13.75 km	16.1 km
Catchment Area	475 km^2	231 km^2

Data	Colosseum Inlet	Rodds Bay
Tidal Period	Semi-Diurnal	Semi-Diurnal
Water Area	55 km^2	48.9 km^2
Protected	Yes (Fish Habitat)	Yes (Fish Habitat)
Amenities value	Moderate	Moderate
Conservation value	High	Moderate
Conservation threat	None	None
Ecological Status	Slightly Affected	Slightly Affected
Water Quality Assessment	No data	No data
Fisheries Value	High	Moderate
Fisheries Threat	None	None

http://www.ozcoasts.gov.au/search_data/detail_result.jsp

6.5.4 Coastal Hazards

6.5.4.1 Storm Tide Flooding

Table 2 of Queensland Climate Change and Community Vulnerability to tropical Cyclones: Ocean Hazards Assessment – Stage 3: The Frequency of Surge Plus Tide during Tropical Cyclones for Selected Open Coast Locations Along the Queensland East Coast (Hardy *et al*. 2004) report provides the following storm surge height scenarios for Tannum Sands, located 20 km north of HHI:

- 100 year ARI Storm event = 2.5 m for tide + storm surge effects with an additional 0.45 m (2.95 m) allowing for climate change increase in sea level
- 500 year ARI Storm event = 3.05 m for tide + storm surge effects and additional 0.59 m (3.64 m) allowing for climate change increases in sea level
- 1000 year ARI storm event = 3.31 m for tide + storm surge effects with an additional 0.63 m (3.94 m) allowing for climate change increases in sea level.

A review of potential storm surge levels by CES (2005) found predicted storm surge levels in the above document did not allow for wave set-up (the extra height of water from wave action). An additional 0.3 m to 0.6 m increase on predicted 100 year ARI tide plus storm surge levels was recommended by CES, resulting in a 3.3 to 3.6 m storm surge height for the Tannum Sands and HHI area. Final levels will be determined during detailed design, having reference to local and Queensland government guidelines in place at the time. Note also that the island services area, which contains water and wastewater treatment, brine evaporation beds and other potential contaminants is located above 20m AHD and towards the rear (south) of HHI, hence, well above any storm surge levels.

6.5.4.2 Erosion Prone Areas and Coastal Dunes

The shallow seabed approach slope on the northern coastline of the Island (see Figure 6.30 and Figure 6.31) regulates the amount of wave energy that reaches the foreshore by causing larger waves in the sea state to break and dissipate their energy before impinging on the sandy foreshore (CES, 2005). Offshore rocks approximately 100 m off the beach on the eastern side of the northern headland further dissipate wave energy and increase sand deposition forming a salient[6] (Figure 6.30) clearly observable at low tide. The offshore rocks and salient further protect the shoreline from erosion during storm events.

Figure 6.30 – Salient east of the Northern Headland

West of the northern headland inter-tidal flats are greater in extent with 200 - 300 m of beach exposed at low tide (Figure 6.31). Tidal sand flats are interspersed with granodiorite bedrock outcrops. A sand beach is perched above the intertidal flats with the beach toe being approximately at Mean Sea level. The sand beach slopes up onto a low foredune system which is typically vegetated by coastal grasses. This foredune system is higher and more developed at the western end of the northern beach (and is outside the development footprint). Observed changes in dune height from the base of the northern headland to Tiber Point are potentially reflective of a concurrent increase in wave energy away from the shelter of the headland and intertidal beach. Further discussion on the coastal beach ridges of HHI is contained in Section 6.3.2.2.

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[6] A salient is an area of deposition resulting in a "bulge" in the shoreline that forms behind the offshore obstacle such as rocks or small island.

Figure 6.31 – Tidal Flats west of the Northern Headland (Low Tide)

Queensland DEHP has designated erosion prone areas along the Queensland coastline in areas that may be vulnerable to sea erosion or tidal inundation within the next 50 years. The fore dune system is noted as being the most susceptible to disturbance and/or development and should remain free of development other than access ways that enable access to the beach (Qld EPA). Hind dunes and dune ridges behind the foredune are considered by DEHP to be more tolerant to disturbance and development. However, DEHP does state that permanent structures such as housing, etc. should be located outside these areas.

The current Erosion Prone Area mapping for Gladstone Regional Council (GLR1A Map 6) shows an erosion prone area of 75 m around the northern headland and 120 m along North Beach. Calculations by Coastal Engineering Solutions (CES 2005) identified that a setback of 80 m would be sufficient to protect the area up to a 1:100 year storm event.

The erosion prone area covers the existing active dune system that incorporates the backshore, incipient foredune, primary swale, older incipient foredune/s and subsequent swale/s that represents the current active dune system. This buffer zone also includes some of the remaining relict beach ridge and swale system that has been stabilised and vegetated by trees.

Erosion prone areas are not part of the lease area and are therefore not part of the development works on Lot 3 FD841422 and will remain undisturbed except for elevated public access walkways to the beaches.

6.5.5 Marine Structures and Public Access

Existing marine infrastructure within the estuarine and coastal environment around HHI include the causeway access to the Island at the end of Clarks Road and public boat ramps/access points at Turkey Beach, Foreshores Estate and Wild Cattle Creek.

The existing causeway across Boyne Creek consists of filled earthen ramps leading through saltpans and mangroves to a filled causeway reinforced with logs as shown in Figure 6.32. At low tide the causeway restricts tidal movement through Boyne Creek creating a weir effect. Anecdotal evidence suggests that the presence of the causeway has caused siltation in Boyne Creek reducing the channel depth.

Figure 6.32 – Existing Causeway across Boyne Creek at Low Tide

Existing boat ramps providing access to estuarine and coastal waters around HHI are located at Tannum Sands, Turkey Beach (concrete), Foreshores Estate (compacted earth) and Wild Cattle Creek (earth ramp) (Table 6.14 and Figure 6.33). The Wild Cattle Creek boat ramp will be upgraded to a concrete ramp as part of an approved residential development south of Tannum Sands. The mainland side of the causeway to HHI is also used as a boat ramp. Boats are also launched at the squatter communities and Mundoolin Rocks and White Point. No other marine structures are located within the estuaries or marine waters around HHI.

Table 6.14 – Public Boat Ramp Tide Access and Distances to Estuaries

Ramp	Tidal Limitations	Access	Distance* to Seven Mile Ck	Distance* to Boyne Ck	Distance* to Colosseum Inlet
Turkey Beach	All Tide	Sealed Road Concrete Ramp	10 km	16 km	25 km
Foreshores	Part Tide	Sealed & Dirt Road Dirt Ramp	7 km	5 km	0 km
Wild Cattle Creek	Part Tide	Dirt Road Dirt Ramp	17 km	10 km	5 km
Tannum Sands	Part Tide	Sealed Road Sand Ramp	20 km	15 km	10 km
Boyne Island	Part Tide	Sealed Road Concrete Ramp	22 km	17 km	12 km

*linear distance, real distances will require navigation of various waterways and can be longer

LEGEND

- Towns
- Boat Ramp
- Development Footprint
- Coastal Seagrass Meadows
- Habitat Protection Zone

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

Figure 6.33 - Existing boat ramp locations and navigation channels around HHI

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No suitable all tide boat access is currently available within a short distance of Colosseum Inlet, Boyne Creek or Seven Mile Creek. Turkey Beach is currently the only all tide boat ramp within the immediate vicinity of the Island that also has sealed road access. Community consultation has revealed that the estuaries around the Island are becoming increasingly popular for recreational boating with both the local and regional community (see also (http://www.gladstoneregion.info/Portals/3/DOCUMENTS/Brochures%20etc/GAPDL%20Gladstone%20Region%20Fishing%20Guide.pdf, http://www.fishingmonthly.com.au/Articles/Display/3011-Gladstone-planner, http://www.banana.qld.gov.au/docs/local_government/Gladstone%20Region%20Fishing%20Guide.pdf). Fishermen in the annual Tannum Hookup fishing competition, that draws competitors from State wide, use the waters around the Island. Shallow entries to Colosseum Inlet and parts of Seven Mile Creek also currently limit access to these waters from the ocean for recreational craft.

6.5.6 Coastal Water Quality Objectives

6.5.6.1 Environmental Values

Environmental values associated with water quality in the coastal and estuarine waters surrounding HHI have been derived from the EPP(Water) and are described as:

- Protection of slightly to moderately disturbed aquatic ecosystems
- Human consumption of fish and other aquatic foods
- Primary recreation
- Secondary recreation
- Visual appreciation
- Water supply (through desalination)
- Cultural and spiritual values.

These values apply equally to estuarine waters of Boyne Creek, Colosseum Inlet and Seven Mile Creek and open coastal/marine waters to the north of HHI.

Using the definitions set in the QWQG (DEHP 2009a), and guidance from the Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA 2010). Waters around HHI are defined as slightly to moderately disturbed aquatic ecosystems. This is on the basis that:

- A moderate to high amount of catchment clearing has occurred
- Runoff from the catchment is expected to be somewhat affected by agricultural and urban activities
- Marine park zoning is general use and there are no marine national park, preservation zones or other zones protecting habitats under the representative areas program in the vicinity of HHI
- Nevertheless, the estuarine and coastal habitats are largely intact and biological communities appear to be in good condition (Storey *et al.* 2007, Vision Environment 2011).

6.5.6.2 Derivation of Water Quality Objectives

Water quality objectives provide an indication of desirable water quality conditions to protect identified environmental values.

A framework for setting water quality objectives has been established under the National Water Quality Management Strategy and Queensland legislation. The EPP(Water) provides water quality objectives for a four regions of Queensland, however, location specific water quality objectives have not been set for the waters surrounding HHI. In this case guideline values are established in the QWQG, or, if the QWQG are silent, the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000).

The QWQG and *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* also set out processes for deriving location specific guidelines. This is particularly useful for parameters such as heavy metals where catchment geological conditions can influence background concentrations even where no disturbance has occurred. At present, insufficient data is available to set locally derived WQOs for the waters around HHI, however, the proponent is committed to undertaking a baseline water quality and sediment sampling program prior to commencement of construction activities. A minimum of 24 data sets will be obtained in accordance with the QWQG and *Australian and New Zealand Guidelines for Fresh and Marine Water*.

The Port Curtis Integrated Monitoring Program (PCIMP) has established ecosystem health values for the Port Curtis and Rodds Bay area, including HHI, as part of its ongoing ecosystem health monitoring. While these do not distinguish between enclosed and open coastal waters, the values are useful as local reference points.

For projects that are in or adjacent to the GBRMP, consideration must also be given to the *Water Quality Guidelines for the Great Barrier Reef Marine Park (WQG)* (GBRMPA 2010). The GBRMP lies to the north of HHI, with the boundary commencing at low tide mark along the north coast of HHI (see Figure 6.35). HHI is also entirely surrounded by the GBRCMP.

The WQG for the GBRMP are focussed on land sourced contaminants, particularly sediment, sediment bound nutrients and agricultural pesticides. The WQG for GBRMP do not set relevant water quality guidelines for enclosed coastal waters. However, guidelines for pesticides are relevant in any waters and will be adopted, even though not all of the pesticides covered in the WQG for GBRMP will be used at the project.

Guidelines for recreational use of waters are covered in the National Health and Medical Research Council *Guidelines for Managing Risks in Recreational Waters* (NHMRC 2008).

Preliminary water quality objectives for the enclosed coastal waters of Colosseum Inlet, Boyne Creek and Seven Mile Creek, were derived from:

- Water quality objectives for enclosed coastal waters in the Central Coast region set out in the QWQG

- Ecosystem health values developed for the PCIMP (Storey *et al.* 2007, Vision Environment 2011)
- Toxicant (pesticide) guidelines from the WQG GBRMP
- Default values from the Australian and New Zealand Guidelines for Fresh and Marine Water where other values do not exist.

6.5.6.3 Water Quality Objectives – Physico-Chemical Indicators – Protection of Aquatic Ecosystems

Preliminary water quality objectives for physico-chemical indicators are provided in Table 6.15. These will be reviewed once a full set of baseline monitoring data is available for the waters around HHI.

Table 6.15 – Preliminary Water Quality Objectives –Physico-Chemical Indicators

Variable	WQO (QWQG)		**Ecosystem Health Values - PCIMP**
	Enclosed Coastal Waters	**Open Coastal Waters**	
Ammonia	8 µg/L	4 µg/L	
Oxidised nitrogen	3 µg/L	3 µg/L	10 µg/L
Organic nitrogen	180 µg/L		
Total nitrogen	200 µg/L	140 µg/L	300 µg/L
Filterable Reactive Phosphorus	6 µg/L	6 µg/L	8 µg/L
Total phosphorus	20 µg/L	20 µg/L	25 µg/L
Chlorophyll A	2 µg/L	0.45 µg/L	4 µg/L
Dissolved oxygen	90-100% saturation	95-105% saturation	>80% saturation
Turbidity	6 NTU	1 NTU	20 NTU
Suspended solids	15 mg/L	2 mg/L	20 mg/L
pH	8.0-8.4	8.1-8.4	7.0-8.4

6.5.6.4 Water Quality Objectives – Toxicants - – Protection of Aquatic Ecosystems

Metals and pesticides can be toxic to aquatic organisms at certain concentrations. The WQGs for GBRMP set trigger values for key pesticides of concern in relation to runoff from agricultural catchments. These are reproduced in Table 6.16 and Table 6.17. Note that not all of these pesticides will be used at the PTP. For pesticides where species protection levels have been set, the 99th percentile species protection level will be adopted as a trigger value for further investigation in relation to water quality monitoring for the project.

Table 6.16 – GBRMP WQG Trigger Values for Selected Pesticides – High and Moderate Reliability

Pesticide	99% Species Protection	95% Species Protection
	High reliability trigger value (µg/L)	
Chlorpyrifos	0.0005	0.009
	Moderate reliability trigger value (µg/L)	
Diuron	0.9	1.6
Atrazine	0.6	1.4
Ametryn	0.5	1.0
2,4-D	0.8	30.8
Endosulfan	0.005	NA (1)

99^{th} percentile value recommended because of bioaccumulation potential

Table 6.17 - GBRMP WQG Trigger Values for Selected Pesticides – Low Reliability

Pesticide	Low Reliability Trigger Value (µg/L)
Simazine	0.2
Hexazinone	1.2
Tebuthiuron	0.02
MEMC	0.002
Diazinon	0.00003

For all other pesticides, the trigger values for marine water set out in Table 3.4.1 of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) will be adopted. The highest available species protection level will be adopted as a trigger for further investigation. Where triggers are available for freshwater and not marine water, these will be adopted as a trigger for further investigation.

As pesticide contamination of waters around HHI may already have occurred as a result of catchment runoff, baseline monitoring will be undertaken to establish existing concentrations of pesticides in water and sediment.

In relation to heavy metals, a baseline monitoring program will be established to determine existing baseline metal concentrations in water and sediment and to set trigger levels for further investigation. Determination of trigger levels for heavy metals will utilise the methodology set out in the AWQGs (ANZECC/AEMCANZ 2000).

6.5.6.5 Water Quality Objectives – Drinking Water

Drinking water supplied to the project from the desalination plant will meet the Australian Drinking Water Guidelines (NHMRC 2011). A risk assessment will be undertaken as part of detailed design to determine any trigger levels for toxicants or other water quality indicators that should be applied to the source water for the desalination plant in Boyne Creek. However, typically, toxicant trigger levels set for protection of aquatic organisms are below those at which human health effects could occur.

6.5.6.6 *Water Quality Objectives – Recreation*

NHMRC has produced a comprehensive guideline to manage risks of water based recreation, including contamination of water used for primary and secondary contact recreation (NHMRC 2008). Water quality objectives for primary and secondary recreation are set as follows:

- Enterococci and cyanobacteria are shown in Table 6.18
- Objectives for toxic chemicals are not required as objectives for protection of aquatic ecosystems are more stringent.

Table 6.18 – Water Quality Objectives – Primary Contact Recreation (NHMRC 2008)

	Level 1 Alert – Increase Surveillance	Level 2 Alert – Further Investigation	Level 3 Alert – Close area to primary contact recreation and advise against secondary contact recreation
Intestinal enterococci (95 percentile)	NA	>40 organisms / 100 mL	>200 organisms / 100 mL
Cyanobactertia	≥500 to <5000 cells/mL *M. aeruginosa* or biovolume equivalent of >0.04 to <0.4 mm^3/L for the combined total of all cyanobacteria	≥5000 to <50 000 cells/mL *M. aeruginosa* or biovolume equivalent of ≥0.4 to <4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume[a] or[b] ≥0.4 to <10 mm^3/L for the combined total of all cyanobacteria where the know toxin producers are not present	≥10 µg/L total microcystins or ≥50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥4 mm^3/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume or[b] Level 2 guideline: ≥10 mm^3/L for total biovolume where known toxins are not present or Cyanobacterial scums are consistency present[c]
Cyanobacteria – *Karenia brevis*	<1 cell/mL	> 1– < 10 cells/mL	>10 cells/mL

a The definition of 'dominant' is where the known toxin producer comprises 75% or more of the total biovolume of cyanobacteria in a representative sample.
b This applies where high cell densities or scums of 'nontoxic' cyanobacteria are present, ie where the cyanobacterial population has been tested and shown not to contain known toxins (microcystin, nodularin, cylindrospermopsin or saxitoxins).
c This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population, as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

Recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life (NHMRC 2008).

6.5.6.7 Cultural and Spiritual Values

In relation to cultural and spiritual values of surface waters, QWQG set guidelines as follows:

> *Protect or restore Indigenous and non-Indigenous cultural heritage consistent with relevant policies and plans.*

Currently, there are no relevant policies or plans in relation to indigenous cultural and spiritual values of waters around HHI. A Cultural Heritage Management Plan is in place for the development. HHI and surrounding waters are part of the GBRWHA and NHP. In this regard, water quality must be managed such that the prescribed values of the WHA and NHP are not degraded. Adherence with aquatic ecosystems protection guidelines will achieve this.

6.5.7 Coastal Water Quality

6.5.7.1 Factors Affecting Water Quality

Reducing pollutant load from non-point sources is one of two key objectives of the Reef Water Quality Protection Plan (RWQPP) (DPC 2009). The main pollutants are identified as total suspended solids, nutrients such as nitrogen and phosphorus, and pesticides such as ametryn, alrazine, diuron, hexazinone and tebuthiuron. The Great Barrier Reef Outlook Report (GBRMPA 2009) identifies a number of factors influencing the ecosystem health of the GBR, structured around physical, chemical and ecological processes.

The Colosseum Inlet and Seven Mile Creek estuaries receive discharges during and following rainfall events from ephemeral watercourses in the northern section of the Baffle Creek catchment. Colosseum Inlet receives ephemeral freshwater discharges from Twelve Mile Creek whilst Seven Mile Creek receives ephemeral freshwater discharge from Scrubby Creek. Both these catchments may be considered as modified from their natural state due to clearing of vegetation, pastoral activity and low density residential development.

Ephemeral/periodic discharges from these watercourses will influence water quality within Colosseum Inlet and Seven Mile Creek, introducing suspended sediment, nutrients, heavy metals, road runoff and anthropogenic chemicals such as pesticides to estuarine waters. These contaminants are flushed into the estuaries during storms or periods of rain where they are processed as part of the estuary tidally driven geochemical cycle. During large storms where the quantities of freshwater input to the estuaries are greater, suspended sediment nutrients and other contaminants are flushed very quickly out to sea with little processing within the estuaries.

Low density residential development on the southern end of Wild Cattle Island (the Esplanade) and fishing shacks on the southern side of the mouth of Wild Cattle Creek rely on septic tanks or similar systems for disposal of sewage waste. These systems are located in permeable sands within 50 m of Colosseum Estuary. Similarly a small number of houses at Mundoolin Rocks also process sewage waste via septic tank systems adjacent to Boyne Creek. Leaching of nutrients is likely from these settlements, adding a relatively small contribution to the existing nutrient load of Colosseum Inlet and Boyne Creek.

Intertidal wetland vegetation within the estuaries around the Island remain relatively intact, with very little physical disturbance. Intertidal vegetation such as mangroves are an important part of the estuarine processing system. Intertidal vegetation acts as part of the estuarine system taking up nutrients and converting them to biomass and carbon that eventually cycles back to the estuary as detritus. This important process is recognised by the RWQPP objectives that aim to preserve intertidal vegetation as a sink and processing mechanism for diffuse pollution sources.

HHI has partly cleared catchments that contain small ephemeral watercourses that discharge primarily to Boyne Creek and Colosseum Inlet.

6.5.7.2 Existing Water Quality

Water quality sampling was conducted by SKM (2007) in September and November 2005 from a number estuarine and marine water of locations around HHI (see Figure 6.27). Based on catchment land uses being predominantly pastoral land use, initial water quality sampling focussed on physico-chemical parameters and nutrients within estuarine and coastal waters.

Physico-chemical measurements such as pH, turbidity, dissolved oxygen were collected using a Troll 9000 (In-Situ) multi-parameter meter. Water samples were also collected to be analysed for nitrogen and phosphorous based nutrients. Physico-chemical field measurements were obtained either at two different depths (during September sampling) or continually monitored through the entire water column (November sampling).

Physico-chemical parameters were consistent with estuarine waters dominated by marine tidal inflows as demonstrated by electrical conductivities at all monitoring locations being around ranging from 60.99 to 65.45 mS/cm. Conductivities over depth displayed little variation indicating well mixed water. Dissolved oxygen concentrations ranged between 5.59 to 7.3 mg/L, were well saturated and within both the draft open coastal waters and enclosed coastal waters WQO. Dissolved oxygen concentrations were consistent between surface and deeper waters within both estuarine and coastal waters, supporting a well-mixed system with little evidence of poorly mixed areas where dissolved oxygen is likely to decline. Turbidity measured during the September sampling round exceeded both the draft open coastal and draft enclosed coastal WQO in all sampling locations. During the November sampling the draft enclosed coastal waters draft WQO for turbidity was exceeded in two sampling locations W1 and W7. Turbidity displayed little variation with depth, indicating a well-mixed vertical profile in all locations as would be expected in this estuary. Physico chemical results from field monitoring are presented in **Table 6.19**.

LEGEND

- Marine Monitoring Locations
- Proposed FreshwaterMonitoring Locations
- Discharge Points
- Drainage Line
- Index Contour (5m)
- Intermediate Contour (1m)
- Development Footprint

Figure 6.34 - Marine and Estuarine Water Quality Monitoring Locations

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Table 6.19 – Physico-chemical Results of Enclosed Coastal and Marine Water Quality Sampling

Site	Location	Depth (m)	Temp (°C)	EC mS/cm	DO (mg/L)	DO (% Sat)	ORP (mV)	Turbidity (NTU)	pH
Open Coastal Waters Draft WQO (C)		**-**	**-**	**-**	**-**	**95-105**	**-**	**1**	**8.1-8.4**
Enclosed Coastal Waters Draft WQO (E)		-	-	-	-	90-100	-	6	8.0-8.4
Date of Sampling = 09/05									
W1	Colosseum Inlet (E)	0.3 3.0	22.4 22.1	64.95 65.45	6.5 6.4	96.4 95.5	NT NT	NT NT	7.75 NT
W2	North Beach (C)	0.3 3.0	22.6 22.3	63.95 63.77	6.8 7.0	101.6 103.3	NT NT	18.6 18	NT NT
W4	BC Causeway (E)	0.3 2.5	24.2 23.7	62.9 63.1	7.3 7.3	109.3 110	NT NT	31.4 26	NT NT
W5	Mangrove Channel (E)	0.3	25.5	63	6.4	98.8	NT	12.5	NT
Date of Sampling = 30/11/05									
W1	Boyne Creek (E)	0.21 9.5	28.02 27.75	61.65 61.21	7.08 5.79	NT NT	196 195	4.4 6.5	7.78 7.76
W4	BC Causeway (E)	0.15 2.8	27.75 27.58	61.29 61.29	7.05 6.02	NT NT	192 192	3.6 4.2	7.77 7.73
W6	Mangrove Channel (E)	0.53 2.9	28.00 28.13	61.39 61.95	6.52 6.19	NT NT	200 194	5.2 5.8	7.85 7.81
W7	Colosseum inlet (E)	0.29 6.06	28.07 27.94	61.21 61.19	6.48 5.93	NT NT	190 190	3.8 7.8	7.87 7.79
W9	Entrance Col. Inlet (E)	0.44 9.22	28.05 27.96	60.82 60.99	6.13 5.59	NT NT	197 192	4.2 4.6	7.98 7.93

Note: Cells in grey exceed respective WQO

Initial water quality sampling for nutrients in September and November 2005 are summarised in Table 6.20. Ammonia concentrations ranged from 41 µg/L to 104 µg/L, exceeding the draft WQO in all sampling locations and on occasion by up to an order of magnitude. Oxides of nitrogen (NOx) exceeded the respective draft WQO at all sites during September sampling and W7 located in the central portion of Colosseum Inlet during November sampling. Total nitrogen concentrations were greater than the marine WQO in coastal waters (W2) and one location in Colosseum Inlet (W1) located near the confluence with Boyne Creek.

Total phosphorous concentrations were greater than respective draft WQO in all locations with the exception of W1. Reactive filterable phosphorous (the more bioavailable dissolved form) exceeded the respective draft WQO in all locations tested during November.

Table 6.20 – Nutrient Water Quality Results

Site	Location	NH_4 (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NOx (µg/L)	TKN (µg/L)	Total N (µg/L)	Total P (µg/L)	Reactive P (F) (µg/L)	TOC (µg/L)
Open Coastal Waters Draft WQO (C)		4	-	-	3	-	140	20	6	-
Enclosed Coastal Waters Draft WQO (E)		8	-	-	3	-	200	20	6	-
Date of Sampling = 09/05										
W1	Colosseum Inlet (E)	50	<10	24	24	<100	<100	60	<10	1000
W2	North Beach (C)	70	<10	34	34	200	200	60	<10	2000
W5	Mangrove Channel (E)	87	<10	26	26	100	100	80	<10	1000
Date of Sampling = 30/11/05										
W1	Colosseum Inlet (E)	44	<10	<10	<10	2800	2800	10	10	NT
W2	North Beach (C)	NT	NT	NT	NT	NT	NT	NT	NT	NT
W4	BC Causeway (E)	104	<10	<10	<10	<100	<100	70	21	NT
W5	Mangrove Channel (E)	NT	NT	NT	NT	NT	NT	NT	NT	NT
W6	Mangrove Channel (E)	41	<10	<10	<10	<100	<100	60	10	NT
W7	Colosseum inlet (E)	50	<10	15	15	<100	<100	70	10	NT
W9	Entrance Col. Inlet (E)	43	<10	<10	<10	<100	<100	70	10	NT

Note: Cells in grey exceed respective WQO

Results of initial water quality sampling for nutrients has returned concentrations of key nutrients such as ammonia, NOx and phosphorous that exceed the draft WQO for both open coastal and enclosed coastal waters. These results suggest that water quality in Colosseum Inlet and marine waters north of the Island are not indicative of a HEV system. However such a statement has to be considered in the light of the Central Coast Queensland Region Water Quality Guidelines (QWQG 2009) being a regional guideline and not necessarily representative of the local conditions within Colosseum Inlet. Colosseum Inlet, Boyne Creek and Seven Mile Creek have large mangrove areas and few freshwater inputs, outside storm events. The extent to which existing biological cycling of nutrients between intertidal wetlands and estuarine waters is responsible for the observed high nutrient concentrations will be further assessed as part of the proposed Water Quality Management Plan.

The PCIMP was established to monitor the ecological health of Port Curtis. The consortium of 16 major stakeholders commenced a self-funded comprehensive monitoring program in 2005 which resulted in the production of the inaugural Port Curtis Ecosystem Health Report Card (Storey et al.

2007). PCIMP undertakes annual monitoring programs that include measures of water quality, sediments and benthic communities, and seagrass and mangrove conditions. Monitoring is conducted at over 165 water sites extending from the Narrows in the north to Colosseum Inlet in the south.

As part of the program, water quality monitoring is carried out in Colosseum Inlet and on the ocean side of HHI. The PCIMP Ecosystem Health Report 2008-10 (Vision Environment 2011) found that the water chemistry and nutrients around HHI were of a high standard with some lower water clarity in the upper estuary of Colosseum Inlet where there was also slight elevations in total phosphorus levels. The monitoring confirmed good water quality across all parameters. Nutrient levels met water quality guidelines most of the time, with compliance scores of 0.9 or above for nitrate, total nitrogen and orthophosphate. Phosphate levels were elevated for some sampling events.

6.6 Marine Environment

6.6.1 Areas of Marine Conservation Significance

A number of sources were reviewed in identifying conservation and protected areas relevant to PTP. The sources reviewed were:

- DotE databases:
  - Australian Heritage Database (formerly Register of the National Estate)
  - Australian Natural Resources Atlas
  - Collaborative Australian Protected Areas Database
  - Australian Wetlands Database
  - EPBC Protected Matters Search Tool
- Environmental Reporting Tool
- *Nature Conservation Act 1992* and associated Regulations
- *Marine Parks Act 2004*
- *Marine Parks Regulation 2006*
- *Fisheries Act 1994*
- Queensland Coastal Plan (superseded)
- Queensland Department of Agriculture, Fisheries and Forestry (DAFF), Coastal Habitat Resources Information System (CHRIS) database.

A search of the Commonwealth EPBC Act Protected Matters[7] (Refer to Appendix C1) returned the results outlined in Table 6.21 for the area around HHI.

[7] www. environment.gov.au - accessed 12/01/2013

Table 6.21 - Summary Results of Conservation and Protected Areas Searches

Matters Of National Environmental Significance	No.	Details
World Heritage Areas	1	Great Barrier Reef (see also Section 7.2)
National Heritage Places	1	Great Barrier Reef (see also Section 7.3)
Wetlands Of International Significance (Ramsar Sites)	None	
Great Barrier Reef Marine Park	2	Great Barrier Reef (see also Section 7.6)
Commonwealth Marine Areas	None	
Listed Threatened Ecological Communities	None	(see however Section 7.4.2)
Listed Threatened Species	34	Refer to Section 7.4
Listed Migratory Species	50	Refer Section 7.5
Other Matters Protected By the EPBC Act		
Commonwealth Lands	None	
Commonwealth Heritage Places	None	
Listed Marine Species	91	
Whales And Other Cetaceans	12	
Critical Habitats	None	
Commonwealth Reserves	None	
Extra Information		
Register of the National Estate	1	Great Barrier Reef Region
State And Territory Reserves	5	Colosseum Inlet Colosseum Fish Habitat Area, Qld Great Barrier Reef Coastal Marine Park, Qld Rodds Bay Dugong Protection Area, Qld Wild Cattle Island National Park, Qld
Invasive Species	16	
Regional Forest Agreements	None	
Nationally Important Wetlands	2	Colosseum Inlet – Rodds Bay, Qld129 Great Barrier Reef Marine Park, Qld
Key Ecological Features	None	

6.6.1.1 Great Barrier Reef World Heritage Area and National Heritage Place

The Great Barrier Reef World Heritage Area (GBRWHA) and National Heritage Place (NHP) includes HHI itself as well as the surrounding waters including Colosseum Inlet, Boyne Creek and Rodds Bay (Figure 6.35). On the mainland the landward boundary of the GBRWHA is LAT. Further details on the GBRWHA and the values and attributes associated with HHI and surrounding waters that contribute to the OUV of the GBRWHA are provided in Section 7.2. Section 7.3 discusses the values in the context of the national heritage listing.

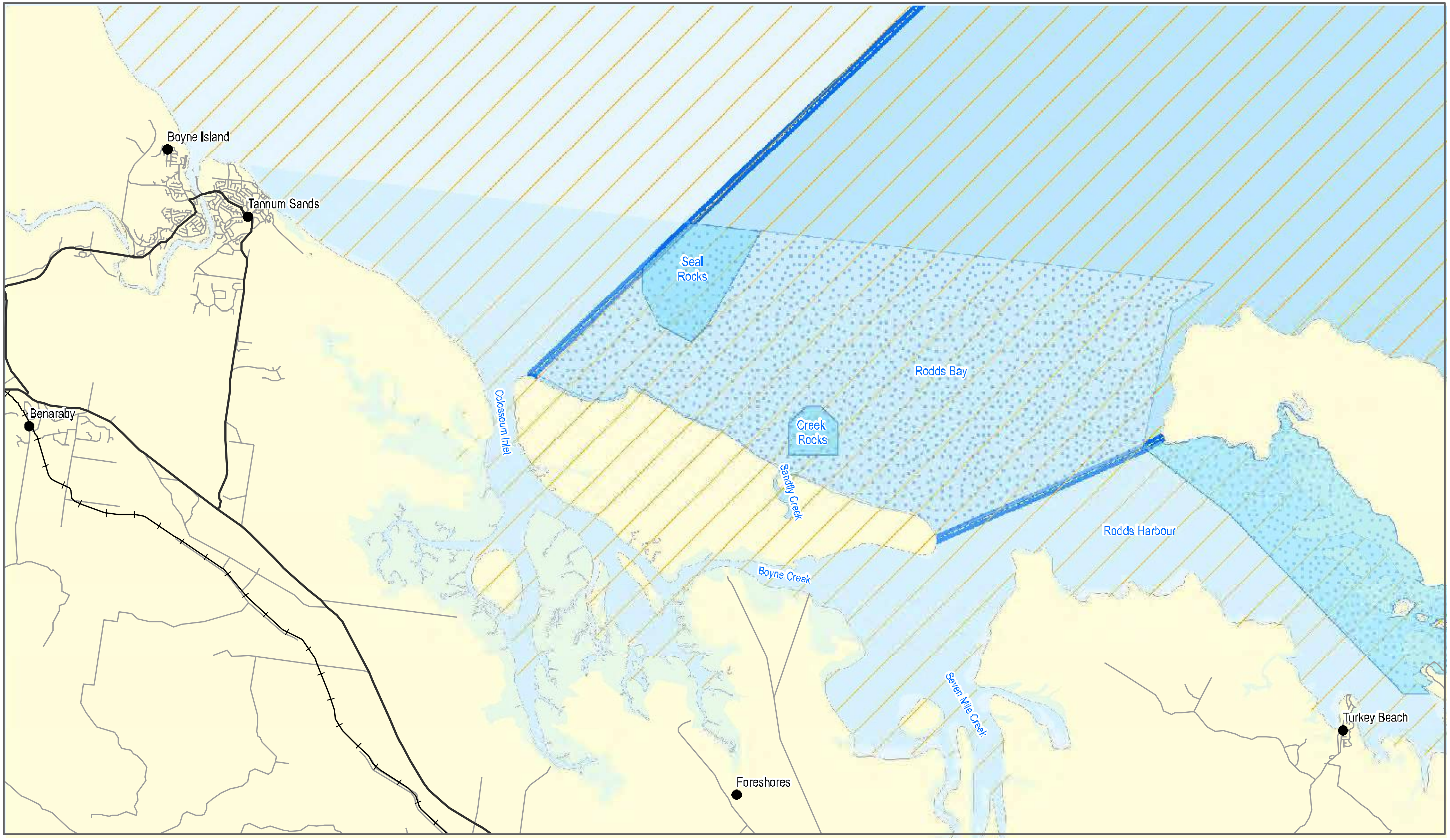
6.6.1.2 Great Barrier Reef Marine Park

HHI is situated on the landward boundary of the Great Barrier Reef Marine Park (GBRMP) Zone MPZ17 – Gladstone. The GBRMP boundary runs from offshore to the northern tip of the Island, along the northern shoreline, and to the southern tip of the Island where it cuts across the entrance of Rodds Bay to Rodds Peninsula (Figure 6.35). The area of the GBRMP adjacent to HHI is jointly administered by the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Government. The landward limit of the GBRMP boundary on the island is the low-water mark; areas between the low-water mark and HAT are classified as "internal waters of Queensland", areas above the low water mark on the Island are not part of the GBRMP but are in the Great Barrier Reef Coastal Marine Park (GBRCMP) administered by Queensland State.

Further information on the values associated with the GBRMP is provided in Section 7.6.

6.6.1.3 Great Barrier Reef Coastal Marine Park

HHI also lies on the boundary of the Queensland State GBRCMP, which covers all waters of Seven Mile Creek, Boyne Creek and Colosseum Inlet to the HAT. The GBRCMP provides protection for Queensland tidal lands and tidal waters within the Great Barrier Reef area and includes tidal rivers, creeks and mangrove areas. The GBRCMP in the HHI area imposes the same restrictions that apply to the General Use Zone of the Commonwealth GBRMP, and there is a joint management plan for the State and Commonwealth parks.



LEGEND

- Towns
- Railway
- Main Roads
- Roads
- Great Barrier Reef World Heritage Area
- Great Barrier Reef Marine Park Mackay/Capricorn

Marine Park Zoning

- Combined State and GBRMPA Administration
- Habitat Protection Zone
- General Use Zone

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

Figure 6.35 - Great Barrier Reef World Heritage Area, Great Barrier Reef Marine Park and Great Barrier Reef Coastal Marine Park Boundaries

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6.6.1.4 Nationally Important Wetlands

Colosseum Inlet is listed in the DEHP Important Wetlands Database as Colosseum Inlet – Rodds Bay – QLD129. Figure 6.36 shows the Colosseum Inlet – Rodds Bay area referred to within the Directory, which comprises 24,307 ha. This area also falls within the GBRMP and GBRCMP and is subject to management as a General Use Zone.

The Colosseum Inlet –Rodds Bay wetland includes eight identified categories of marine and coastal wetlands and is included as a nationally important wetland on five of the six listing criteria. The listing is due in part to the presence of species of flora and fauna designated as rare, vulnerable or endangered at the national or state levels. Directory entries include, amongst others:

- Seagrass beds
- 2 – 5 % of the world population of Eastern Curlew (*Numenius madagascariensis*)
- Various migratory waders
- Dugong (*Dugong dugon*)
- Green turtle (*Chelonia mydas*) feeding grounds.

Management responsibilities for the various environmental values within the Colosseum Inlet – Rodds Bay wetland lie with DAFF, DNRM, DEHP, GBRMPA, leaseholders, freehold land owners and Gladstone Regional Council.

6.6.1.5 Regionally Important Wetlands

Reference to the DEHP Wetland Mapping and Classification Program (WMCP) shows that Colosseum Inlet and Rodds Bay contain the following:

- Estuarine Wetland Regional Ecosystem
- Palustrine Wetland Regional Ecosystem.

No estuarine wetland ecosystems are mapped within the SL boundary of the proposed development (Lot 3 FD841442). Some palustrine wetland is mapped within the lease boundary but outside the development footprint with a 50 – 100 m buffer strip of native vegetation. Estuarine and palustrine wetland systems are mapped immediately adjacent the boundary of Lot 3 FD841442 (Figure 6.37).

Figure 6.36 - Nationally Important Wetlands Around Seven Mile Creek and Hummock Hill Island

LEGEND

- Development Footprint
- Coastal Seagrass Meadows
- Intertidal Wetlands

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Figure 6.37 - Queensland Wetland Map For Colosseum Inlet and Hummock Hill Island

LEGEND

Wetlands Areas
- Palustrine
- Intertidal Estuarine
- Estuarine

- Development Footprint
- Welland Protection Areas
- Welland Protection Trigger Areas

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6.6.1.6 Fish Habitat Areas

Fish Habitat Areas (FHAs) are declared to give protection to inshore and estuarine fish habitats that are important for sustaining local and regional fisheries. Once an area is declared as a FHA, it equally protects all habitat types (e.g. vegetation, sand bars and rocky headlands) from direct physical disturbance and coastal development.

Queensland DAFF has developed two levels of management for declared FHAs, each of which may be applied to the entire declared FHA or to zones within a declared FHA.

- Management level 'A' is used for locations where very strict management arrangements can be achieved
- Management level 'B' is used for locations where existing or planned uses require a more flexible management approach.

Activities that are permitted within each habitat protection zone are outlined in Table 6.22. Permits are required for any of these activities.

Table 6.22 - Summary of activities that may be authorised within each declared FHA management level

Activity	Management Level 'A'	Management Level 'B'
Limited Impact Construction of Facilities for 'A Fisheries Purpose' (E.G. Public Boat Ramps, Public Jetties).	+	+
Maintenance of Existing Facilities	+	+
Construction of Educational Facilities (E.G. Boardwalks)	+	+
Scientific research	+	+
Works for Public Health and Safety Reasons	+	+
Restoration of Disturbed Fish Habitats	+	+
Other limited impact public and private structures that are assessed as having an overriding requirement to be on tidal land or within the FHA (e.g. private jetty, public bridge)	-	+
Construction of public facilities that require only minimal, temporary disturbance to the FHA that can be totally restored (e.g. fully buried submarine pipeline)	+	+

The Colosseum Inlet FHA includes Wild Cattle Creek, Colosseum Inlet, Boyne Creek, Seven Mile Creek and Thorton Creek as defined on QLD DPIF Plan FHA-037 (Figure 6.38). Colosseum Inlet and the eastern part of Boyne Creek and Seven Mile Creek are zoned Management A. Wild Cattle Creek, northwest of HHI, and the eastern part of Boyne Creek and Sandfly Creek, which divides HHI, are zoned Management B. The causeway linking the mainland and the Island and 100 m either side is excluded from the FHA.

6.6.1.7 Dugong Protection Areas

Dugong Protection Areas (DPAs) were declared in legislation under the Queensland NC Act and Queensland Fisheries Act and the areas that are protected are gazetted under the *Fisheries Regulations 1995*. DPAs are also designated as Special Management Areas under the *Great Barrier Reef Marine Park Regulations 1983* and the Great Barrier Reef Marine Park Zoning Plan 2003. DPAs were established to protect dugongs from injury and mortality from fishing activities. DPAs are subject to two levels of protection: Zone 'A' and Zone 'B'.

Zone 'A' DPAs include all significant dugong habitats in the southern Great Barrier Reef and collectively contain over 50% of dugong numbers. In these areas, the use of offshore set, foreshore set and drift nets are prohibited, except in the Hervey Bay - Great Sandy Strait DPA, where specialised fish netting practises are allowed to continue with modifications. The use of river set nets is allowed with modifications in Zone 'A' DPAs, except in two key areas where river set nets are prohibited (the Hinchinbrook and Shoalwater Bay DPAs). Other netting practices such as ring, seine, tunnel and set pocket netting, which are not considered to pose a serious threat to dugongs, are unaffected.

In Zone 'B' DPAs, mesh netting practices are allowed to continue, but with more rigorous safeguards and restrictions than in areas outside the DPAs. Zone ‘B’ DPAs have been shown to contain about 22% of the dugong population in the southern Great Barrier Reef. The protective measures in both DPA management zones are being kept under review to ensure protection of dugongs in these areas (QLD DPI[8]).

HHI is located within the Rodds Bay Dugong Protection Zone B, as shown in Figure 6.39. The protection zone includes Colosseum Inlet, Boyne Creek, Seven Mile Creek and Rodds Bay, which border the proposed development area.

[8] http://www.gbrmpa.gov.au/corp_site/info_services/publications/dugong/sanctuaries.html accessed April 2006

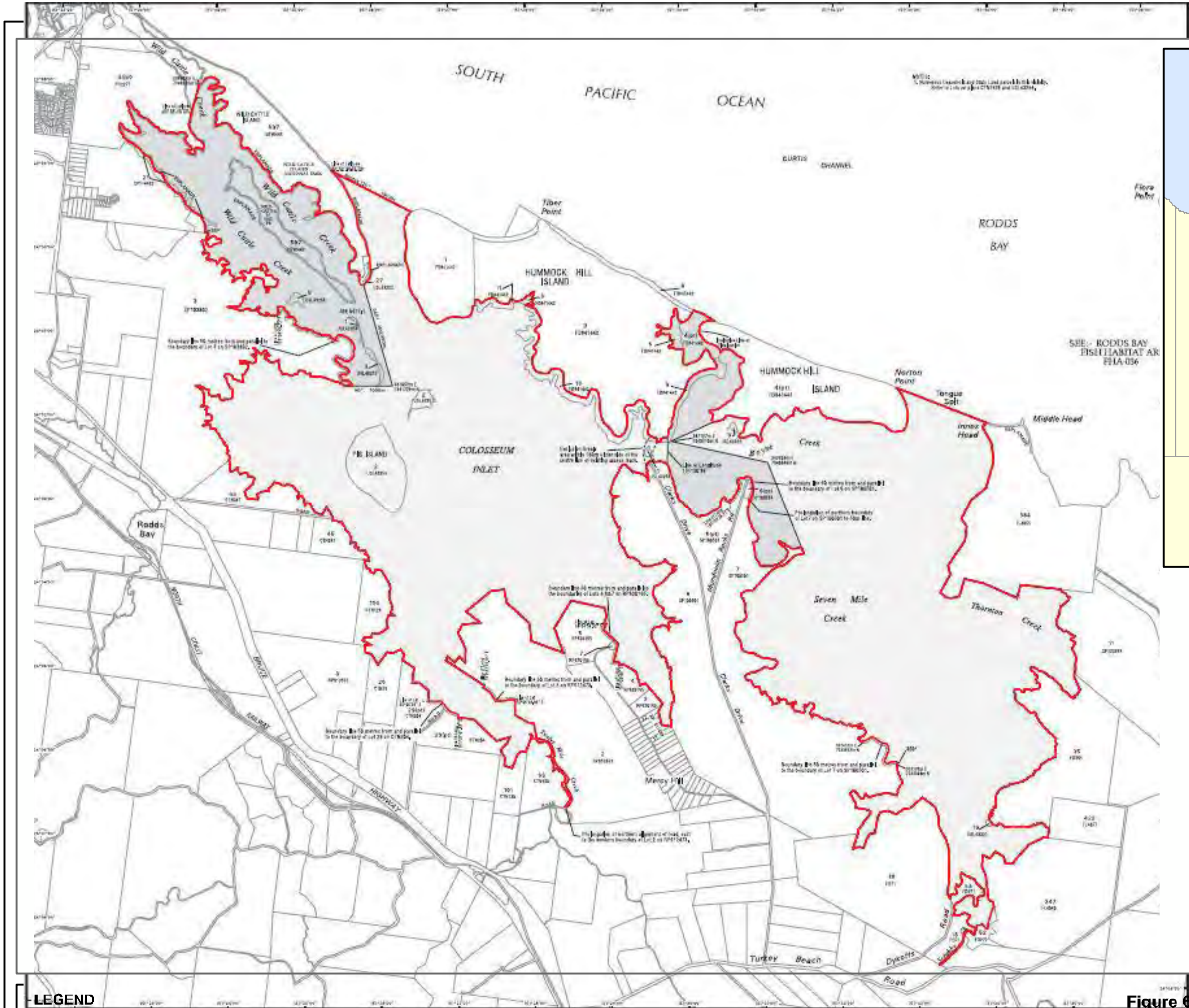

Figure 6.38 - Colosseum Inlet Fish Habitat Areas - Plan FHA-037

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- Fish Habitat Area Outer Boundary
- Management A
- Management B

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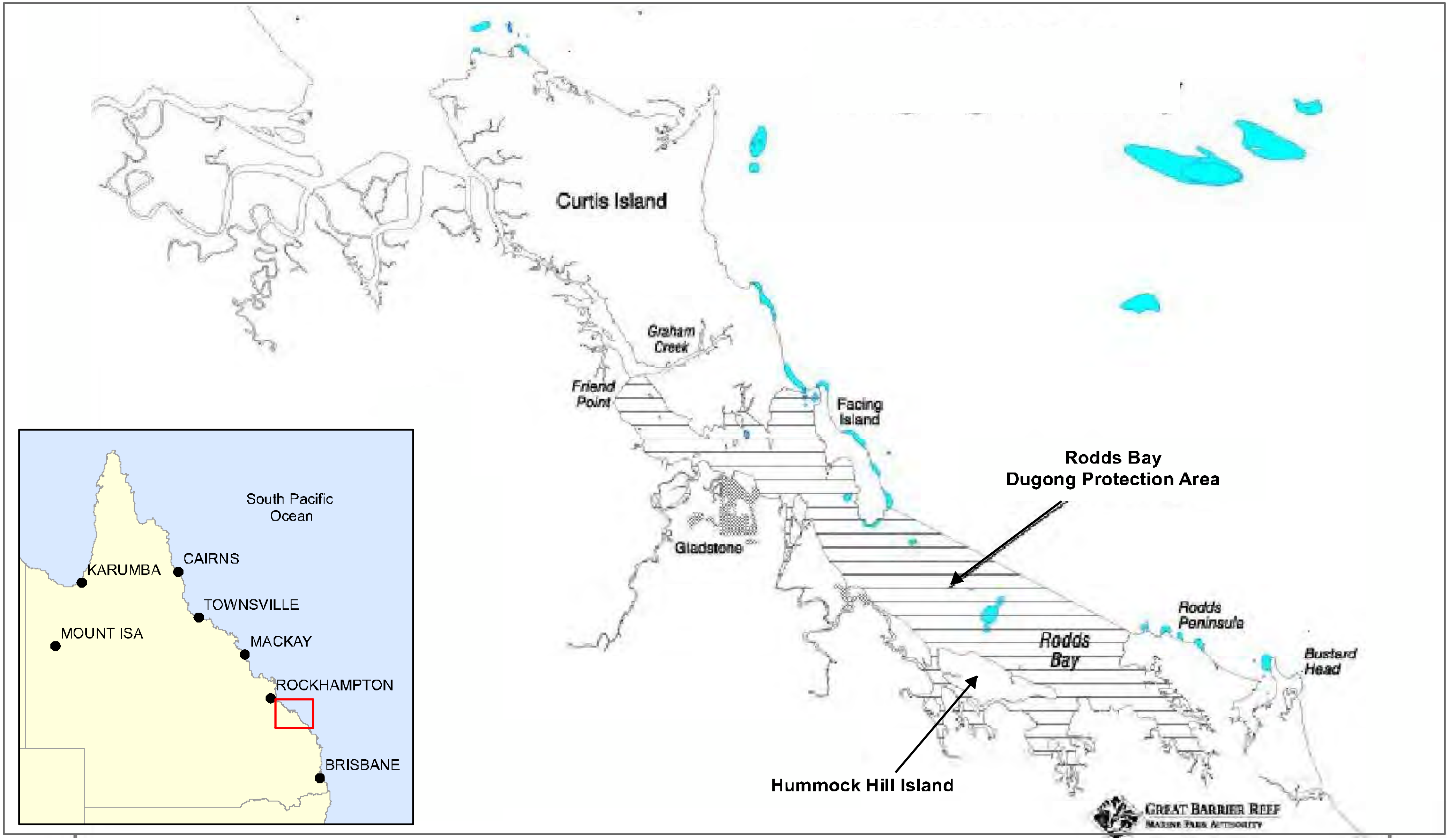

LEGEND

Dugong Sanctuary 'B'

Reefs and Shoals

Figure 6.39 - Gladstone - Rodds Bay Dugong Protection Zone

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6.6.2 Aquatic Habitats

Marine and estuarine habitats around the Island are dominated by high-salinity (35 ppt) marine conditions with little freshwater influence, low terrestrial input of total suspended matter (TSM) and medium nutrient loads in existing estuarine and marine waters. There is also an absence of stratification within the water column due to the lack of low-density fresh water from creeks and terrestrial runoff flowing over more dense, saline water.

Principal intertidal habitats surrounding the Island may be separated into two primary units with associated sub-units:

1) Sheltered (estuarine) habitats that predominate to the south and west of HHI in the estuaries (Figure 6.40), consisting of:
   - High Intertidal/Supratidal Claypan Flats
   - Mid-tidal Mangroves
   - Low Intertidal/Shallow Subtidal Mud Flats and seagrass meadows
   - Low Intertidal Rocky Outcrops
   - Subtidal Creek and Channel Floors with predominantly muddy bottoms.
2) Open coastal habitats that predominate on the eastern and north-eastern sections of the Island, consisting of:
   - Sand Beaches
   - Low Intertidal/Shallow Subtidal Spits, Banks and Shoal
   - Rocky Reefs and Stacks
   - Offshore Subtidal Areas with mostly sandy bottoms
   - Offshore Disturbed Areas such as the Port Curtis entrance channel and spoil ground.

Reference to the Queensland Wetlands map (v. 01) for Miriam Vale Shire (9249) and Calliope Shire (9149) presents the following wetland types as being present around HHI:

- Estuarine Systems (e.g. Mangroves, salt flats and estuaries) – wetlands with oceanic water that are significantly diluted with freshwater derived from land drainage
- Palustrine Systems (e.g. vegetated swamps) – wetlands dominated by persistent emergent vegetation or where water in the deepest part of the basin is less than 2 m, active wave-formed shores and bedrock features are lacking.

6.6.2.1 Palustrine Wetland

Palustrine systems are noted as occurring on the landward transition zone of HHI in some discrete areas of Colosseum Inlet. Figure 6.43 presents current Queensland Wetlands Programme mapping for HHI. Palustrine wetlands on the Island are located in two areas, generally just above the HAT line. Palustrine wetlands on the eastern side of Sandfly Creek are located around 50 – 100 m from the edge of the development and are not within the proposed PTP development area.

Figure 6.40 - Typical zonation patterns on the southern side of HHI

6.6.2.2 High Intertidal/Supratidal Claypans and Salt Flats

This vegetation zone (estimated at 2,077 ha) located on the landward side of the mangrove communities described above contain claypans, salt flats and salt marsh grasses in the areas where tidal inundation is only occasional (AGC Woodward-Clyde 1993), generally on high spring tides and during heavy rainfall (Dames & Moore 1995). The claypan areas are generally devoid of vascular plants as can be seen in Figure 6.41, except in the areas directly adjacent to mangrove communities where some salt marsh plants occur.

Figure 6.41 - Supratidal Claypans Adjacent to Clarks Road

Teasdale *et al.* (2006) describe the salt flats around Port Curtis as occupying the highest elevation within the intertidal zone and being characterised by hypersaline groundwater and high evaporation rates. They describe a clear distinction between mangrove and salt flat habitat, with mangroves on this boundary often being stunted due to the hypersaline conditions. They state that the salt flats are extremely level, typically with longitudinal surface gradients of around 10:4. Teasdale *et al.* (2006) found that in general, salt flat surface sediment was relatively unconsolidated clay with highly cohesive, low permeability clay below approximately 15 cm. The very low permeability equated to very slow transport of groundwater through the sediment, which affected salt and nutrient fluxes. They state that salt flats may not be covered by seawater for periods of a two weeks to several months, depending on the tidal curve, and that during this period porewater salt concentrations sometimes increases greatly, to as high as 200 ppt, due to evaporation. A sharp decrease in groundwater salt content from up to 200 ppt below salt flats to around 50 ppt has been found on similar salt flats in Townsville (Teasdale *et al.* 2006).

The Queensland Wetlands Program (DEHP 2012) describes bare salt flats as being indicative of hypersaline conditions and having relatively low species diversity for floral species occupying this zone. The program also states that no plant or animal is known to be endemic only to saltmarshes and salt flats of Queensland. Microbial mats (algal and bacterial) on bare salt flats are not well understood though the Program notes that such mats may contribute to the diets of several common estuarine fish and crustaceans including the banana prawn.

Typical vegetation reported by AGC Woodard-Clyde (1993) and Dames & Moore (1995) in mangrove areas on the salt flats of HHI includes low scrub of yellow mangrove (*Ceriops tagal* var *australis*), tall scrub, low closed forest and low scrub of *A. marina* var *australasica,* benthic mat communities consisting of the cyanobacteria (blue-green algae), Microcoleus, Porphyrosiphon, and halophytes such as salt couch.

Studies of similar habitat (Morton *et al.* 1988) found that relatively few fish utilised the salt marsh and salt flat habitat due to the ephemeral nature of inundation, being around once a fortnight or less as described above, and a lack of available food sources.

The Queensland Wetlands Program (DEHP 2012) note that saltmarsh wetlands provide the following ecosystem services:

- Protecting inhabited coastal areas from storm surge
- Removing and diluting storm and wastewater from urban and irrigation areas
- Providing aesthetic values
- Education and recreation services where interpretive boardwalks have been constructed
- Providing food-web support such as the supply of nutrients and food, such as plant matter, crab, gastropod and mosquito larvae, on which marine fauna of the lower intertidal zone may depend.

6.6.2.3 Mid-Tidal Mangroves

The Queensland Wetlands Program (DEHP 2012) notes that ecosystem services provided by mangroves include:

- "Provisioning services" such as providing food for humans in the form of finfish and shellfish
- "Regulating services" such as sequestering carbon (CO_2) and net oxygen production
- "Cultural services" such as opportunities for nature conservation
- "Supporting services" such as cycling of nutrients to adjoining marine lagoons and reefs.

The Queensland Wetlands Program (DEHP 2012) describes mangrove communities as being important fish nurseries where the exposed roots and tree trunks provide shelter for the juveniles of estuarine, nearshore and ocean-going fish and invertebrates. It also notes that mangroves provide abundant food for juvenile fish, and that crustaceans and molluscs are particularly abundant in mangroves, with 60 species of crabs potentially present. Mud crabs (*Scylla serrata*) are an important species associated with the mangrove zone. Mangroves are not noted as supporting a high diversity or number of birds compared to more open wetlands, but are important to some nesting species.

HHI has extensive mangrove areas on the western and southern sides of the Island, particularly in Colosseum Inlet and Boyne Creek. Some 89% of the mangrove area mapped by Olsen *et al.* (1980) between Tannum Sands and Round Hill Head was comprised of dense stands of *Rhizophora*, which also forms >85% of the mangrove area on HHI itself (Dames & Moore 1995). The *Rhizophora* zone is the widest and usually most seaward component of the mangrove fringe. It consists mainly of dense stands of the red mangrove (*Rhizophora stylosa*), usually 4 - 6 m in height (Figure 6.42). Ground cover is generally *Rhizophora* seedlings (Dames & Moore 1995). These mangrove areas are considered of high importance as nursery areas for juvenile stages of a number of species including invertebrates, fishes and crustaceans that are of recreational and commercial importance (SKM 2003).

Figure 6.42 - *Rhizophora stylosa* (red mangrove) in Boyne Creek

Mangroves around HHI have a typical pattern of zonation, described by Dowling in AGC Woodward-Clyde (1993), as follows:

1) A *Rhizophora* zone consisting mainly of *Rhizophora stylosa* (Figure 6.42) with some *Avicennia marina* var. *australasica* (grey mangrove) present at the seaward edge. *Aegiceras corniculatum* (river mangrove) is also commonly present towards the landward edge of this zone.
2) A *Ceriops* zone immediately behind the *Rhizophora* zone consisting of *Ceriops australis* (yellow mangrove) in the form of a narrow fringe generally forming a low open shrubland. Some areas within this zone may be dominated by *Avicienna marina* var *australasica* (grey mangrove). This zone is generally at the seaward edge of the claypan zone.
3) An intermittent *Ceriops* fringe at the high water mark above the claypan zone consisting of a thin fringe of *C.tagal* var. *australis*, with the fringe varying considerably in structural form and species composition with *Lumnitzera racemosa* (black mangrove) and *Excoecaria agallocha* (blind-your-eye mangrove) also present.

Based on regional ecosystem mapping the area of mangrove around HHI is approximately 439 ha (mapped as 12.1.3) and the total area of mangroves in Colosseum Inlet was mapped at 4,410 ha (refer to Figure 6.43).

LEGEND

Development Footprint

Mangroves
- Closed Rhizophora
- Closed Avicennia
- Open Avicennia
- Closed Ceriops
- Open Ceriops

Saltmarsh & Substrate
- Saltpan

Other
- Water and Terrestrial

Figure 6.43 - Intertidal Wetlands Mapped by the DPI, 2006

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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6.6.2.4 Intertidal Beaches, Banks, Shoals

Intertidal banks and shoals within Colosseum Inlet, Boyne Creek and Seven Mile Creek display a variety of habitats including:

- Sand beaches
- Unvegetated mud and sand flats and bars
- Boulder-strewn mud and sand flats
- Seagrass meadows of varying density.

A number of sand beaches occur at the high and middle intertidal level on HHI. The beaches are unvegetated but support several species of fauna including ghost crabs (*Ocypode spp.*), sand bubbler crabs (*Scopimera spp.*) and soldier crabs (*Mictyris spp.*), and in the middle intertidal burrowing whelks and bivalves (Dames & Moore 1995). The beaches are also used by nesting turtles.

The intertidal sand and mud flats and bars typically extend seaward from beaches or form spits and sand bars extending from the mouth of Colosseum Inlet and Seven Mile Creek. Oysters occupy the boulders on boulder-strewn flats (see foreground of Figure 6.41).

6.6.2.5 Seagrass Meadows

Seagrass meadows in Port Curtis and Rodds Bay cover approximately 12,000ha. They are likely to be of regional significance because they are the only known large seagrass meadows between Hervey Bay, 170 km to the south and Shoalwater Bay, 170 km to the north. The meadows are of high ecological and economic value providing important habitat and food for turtles, dugong, fish, crabs and prawns. The value of the seagrasses to dugong has been recognised by the declaration of the the Rodds Bay Dugong Protection Zone B, as shown in Figure 6.38.

A number of surveys of the seagrass meadows within Port Curtis and Rodds Bay have been undertaken since 2003. Annual monitoring programs commenced in 2009 for monitoring the impacts of the major port expansion and industrial development in the northern areas of the Port.

Queensland Department of Primary Industries and Fisheries (Qld DPIF) conducted a detailed survey of intertidal and subtidal seagrass beds around HHI and in Rodds Bay in November and December 2002. A total of 27 seagrass beds in proximity to HHI were identified by helicopter and free-diver. A mixture of both intertidal and deep-water (>5m depth) seagrass beds were identified in locations within Colosseum Inlet, Boyne Creek, Seven Mile Creek and Rodds Bay. The area of these seagrass beds ranged from 0.1 to 484 ha. Most beds were composed of aggregated patches, meaning that the seagrass meadow consisted of numerous patches of seagrass separated by gaps of unvegetated sediment. There were, however, three meadows (sites 77, 78 and 79) with continuous seagrass cover in the Twelve Mile Creek estuary mouth.

Results of seagrass surveys around HHI identified by Rasheed *et al.* (2003) are summarised in Table 6.23 and Figure 6.44.

Table 6.23 – Summary of Seagrass Meadows Identified Around HHI (Rasheed *et al*. 2003)

ID	Cover	Species	Biomass (g-dw/m^2)	Area (ha)
72	Aggregated patches	*Z. capricorni, H. ovalis*	NA	4.9 ± 1.0
73	Aggregated patches	*Z. capricorni, H. ovalis*	NA	5.9 ± 1.1
74	Aggregated patches	*Z. capricorni, H. ovalis*	NA	-
75	Aggregated patches	*Z. capricorni, H. ovalis*	NA	3.1±0.7
76	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	40.6±3.3
77	Continuous cover	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	0.1±0.1
78	Continuous cover	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	2.8±0.7
79	Continuous cover	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	13.4±1.4
80	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	2.5±1.3
81	Aggregated patches	*Z. capricorni, H. ovalis*	NA	2.2±0.7
82	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	18.5±3.5
83	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	69.7±11.0
86	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	75.2±9.3
		Colosseum Inlet Total		**238.9±34**
84	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	12.6±3.0
85	Aggregated patches	*Z. capricorni, H. ovalis, H. uninervis* (Wide)	NA	13.7±3.4
		Boyne Creek Total	-	**26.3±6.4**
87	Aggregated patches	*Z. capricorni, H. ovalis*	NA	2.0±0.4
98	Aggregated patches	*Z. capricorni, H. uninervis* (thin), *H. uninervis* (wide), *H. ovalis, H. minor*	8.5±2.4	160.7±9.5
99	Aggregated patches	*Z. capricorni, H. ovalis*	NA	20.2±1.8
100	Aggregated patches	*Z. capricorni, H. ovalis*	23.5±3.9	115.3±2.6
101	Aggregated patches	*Z. capricorni, H. ovalis*	3.2±0.8	20.5±1.4
102	Aggregated patches	*Z. capricorni, H. ovalis*	NA	6.7±0.7
103	Aggregated patches	*Z. capricorni, H. ovalis*	3.5±1.0	171.8±7.2
106	Aggregated patches	*Z. capricorni*	2.4±1.4	0.8±0.2
111	Aggregated patches	*H. spinulosa, H. uninervis (thin), Z. capricorni, H. ovalis*	7.2±2.9	4.1±1.7
112	Aggregated patches	*H. spinulosa, H. uninervis (wide)*	10.7±5.9	15.3±1.7
		Seven Mile Creek Total		**517.4±27**
71	Aggregated patches	*H. uninervis* (thin), *H. ovalis, Z. capricorni*	2.1±0.4	484.8±12.4
110	Aggregated patches	*H. uninervis* (thin), *H. ovalis, Z. capricorni*	4.2±0.6	202.3±14.4
129	Isolated patches	*H. decipiens*	6.5±1.0	0.1±0
		Rodds Bay Total		**687.1±27**

NA = Biomass not assessed at this site

The two seagrass areas in closest proximity to the proposed development (sites 84 and 85) occur in Boyne Creek, commencing approximately 200 m east of the existing causeway. Key findings are:

- Healthy seagrass communities occurred in close proximity to Port facilities, channels subject to regular maintenance dredging and dredge spoil disposal grounds, together with high-density macroinvertebrate communities
- Seagrass communities in the port included meadows of species preferred as food by dugongs, as well as dense, high-biomass meadows known to be important as nursery grounds for juvenile fishes and prawns
- The high-density seagrass areas have a high fisheries value due to their importance as nursery grounds
- Seagrass was generally confined to shallow intertidal banks, with only small areas of sub-tidal seagrass identified. This distribution was attributed to the relatively narrow intertidal areas and strong currents in adjacent deeper channels.
- Coastal seagrass meadows suitable for dugong feeding occurred throughout the survey area, with feeding trails often evident. Dugongs were observed feeding between Fishermans Landing and Wiggins Island in Port Curtis and in Rodds Bay.

LEGEND

Development Footprint

Coastal Seagrass Meadows

Figure 6.44 - Mapped Seagrass Meadows Around Hummock Hill Island (Rasheed et al., 2003)

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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In 2009 the Queensland Department of Employment, Economic Development and Innovation (DEEDI) commissioned a study to reassess the finding of the above 2002 study.

The study (Seagrasses of Port Curtis and Rodds Bay and long term seagrass monitoring, November 2009 – Thomas *et al*. 2010) was carried out in November when seagrasses were likely to have their greatest area and to be at their maximum density. Observations included biomass, area, community type, cover and species present. The study found that the distribution of seagrass areas in Port Curtis and Rodds Bay in 2009 were similar to those observed in 2002, however there had been a 10% reduction in area, mainly within the deep water meadows. The report concluded that this loss was climate related and that the variability of the seagrass coverage from year to year (as observed during annual monitoring since 2004) was primarily caused by changes in rainfall, river discharges and temperature. In the waters around HHI the study found:

- *Zostera capricorni* dominated the meadows as shown in Table 6.23 and on Figure 6.45
- Seagrass cover was relatively consistent comprising aggregated patches
- The meadows were on primarily mud sediments, with small fractions of sand and shell.

An estimate of seagrass gains and losses around HHI from 2002 to 2009 is shown on Figure 6.46.

Since the 2009 study, seagrass has been monitored quarterly at seven permanent transects at seven locations in Port Curtis and Rodd's Bay. The monitoring program was established to regularly examine the variation in seagrass conditions during the Western Basin dredging operations. In September 2011, Gladstone Ports Corporation Limited (GPC) commissioned additional monthly surveys outside of the regular quarterly monitoring to provide more frequent assessments of seagrass conditions. Currently Seagrass is being monitored at permanent transects at 10 different locations. The nearest monitoring locations to HHI are in Rodds Bay, approximately 20 km from HHI. The monthly surveys have shown that seagrass cover at Rodds Bay has remained extremely low since monitoring began in Oct 2009.

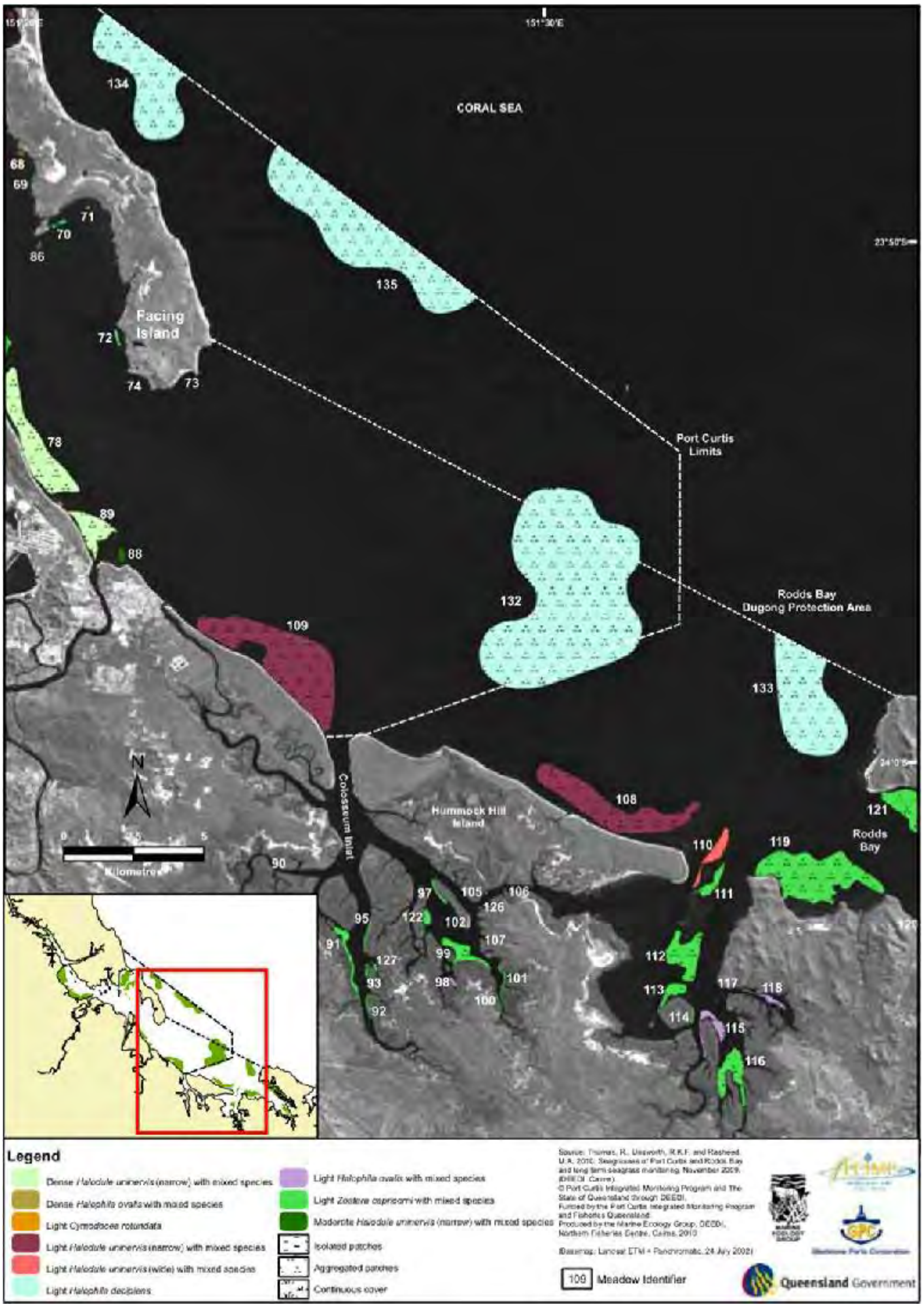


Figure 6.45 – Seagrass distribution and community types in the HHI region, November 2009 (Thomas *et al.* 2010)

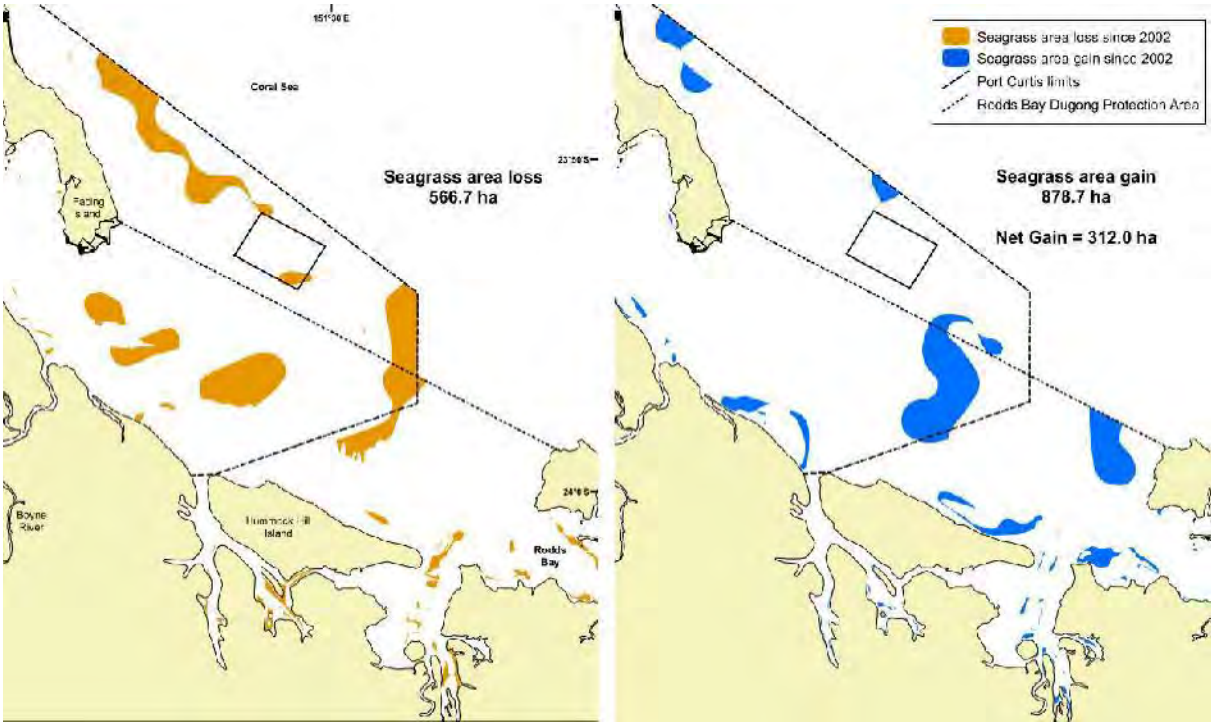


Figure 6.46 - Seagrass area loss and gain in the southern Port Curtis region from November 2002 to November 2009 (Thomas *et al.* 2010)

6.6.2.6 Low Intertidal Rocky Outcrops

A number of rocky outcrops (bommies) are located within Boyne Creek and Seven Mile Creek. Generally these outcrops are exposed during lower tides and are relatively free of aquatic vegetation, being populated by oyster beds (Figure 6.47).

Figure 6.47 - Typical Intertidal Rocky Outcrop (mid-distance) in Boyne Creek

Anecdotal evidence from local commercial and recreational fisherman and community groups suggests that some of these outcrops, particularly in western sections of the estuary adjacent and south of Bangalee, may be colonised by live coral colonies. These areas have not been previously mapped identified by previous studies and are not located within the immediate vicinity of the proposed project or associated infrastructure.

6.6.2.7 Subtidal Banks and Shoals

Subtidal banks and shoals within 4 km of the northern shores of HHI were found to be relatively devoid of vegetation by Rasheed *et.al.* (2003). Areas of subtidal seagrass were, however, found further offshore in a range of environments, including the dredge disposal area and navigation channel for Port Curtis. These include an area of subtidal seagrass (area 110 –see figure 6.10) north of the entrance to Sandfly Creek.

6.6.2.8 Rocky and Coral Reefs

A number of rocky and coral reefs are present in near shore waters located 4.5 km north of HHI, in particular Seal Rocks 2 km northeast of Northern Headland and Creek Rocks 1.3 km northeast of Sandfly Creek. Seal Rocks and Creek Rocks are both classified as HPZ under current GBRMPA Zoning (see also Section 7.6).

A number of small rock reefs occur off the northern coastline of the Island, identified from visual inspection from shore and historical aerial photography. These patch rock reefs appear to occur between the island and both Creek Rocks and Seal Rocks within 50 m of the low tide mark, as shown in Figure 6.48. Video surveys by Rasheed *et al.* (2003) revealed rubble areas around Seal Rocks, except to the southeast, with medium-density macroinvertebrate. Rasheed *et al.* (2003) did not survey the area around Creek Rocks. Anecdotal evidence also suggests a patchwork of subtidal rock reefs connecting Seal Rocks to Tiber Point.

Figure 6.48 - Patch Rock Reef Located off Shore from North Beach

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 - 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), however it is not clear whether this refers to the depth range of the entire area of coral communities or that of the transects surveyed; the datum is not reported. 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. 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.

6.6.3 Marine Mammals

Marine mammals such as whales, dolphins and dugongs are known to either migrate through or inhabit the Rodds Bay area. Whales and dolphins have been observed in the offshore waters and dugongs within estuarine and near shore waters, generally around seagrass beds meadows. This section discusses the general findings of marine mammal surveys undertaken in the region. Those species listed as threatened and/or migratory under the EPBC Act are discussed in more detail in Sections 7.4 and 7.5 respectively.

6.6.3.1 GPC Survey Results

The latest significant survey of marine megafauna species in the area was carried out in 2011 for the Gladstone Ports Corporation Limited - *Report for Marine Megafauna and Acoustic Survey - November 2011* (GPC 2011). The survey provides baseline information on the marine megafauna species encountered between Port Alma, Port Curtis and Rodds Peninsula which will be used for future monitoring and research by GPC over the next ten years. The surveys completed including aerial and boat based observations and a marine acoustic assessment. Surveys were undertaken during months of February and March 2011 (boat-based) and in April 2011 (aerial) June, 2011 (boat and aerial).

The largest numbers of megafauna were observed in Rodds Bay and Port Curtis. Boat based and aerial observations from all surveys reported a total of 181 dolphins, 14 dugong, 137 turtles, 8 snakes, 4 sharks and 27 rays across the surveyed area. Marine fauna were observed to occur in association with recreational vessel traffic, which was widespread throughout much of the survey area a, particularly in the Narrows and Port Curtis.

The timing of surveys in 2011, particularly the February/March surveys, that were undertaken after an above average and prolonged wet period, is likely to have affected the detection of the marine fauna because of the high turbidity levels of the water across the survey area. The observations are therefore likely to be a conservative estimate of the mega fauna in the area during the surveys. At the time of the second aerial surveys the water was less turbid and observations could be made at greater depths and in shallow areas. For example many rays were observed on the sea bed whereas only one was sighted in the first survey. There were also increased sightings of turtle, dugong and Indo-Pacific humpback and snubfin dolphins particularly in the southern area of Port Curtis and Rodds Bay.

Marine megafauna surveys undertaken in the Port Curtis and Rodds Bay area have not identified any other marine migratory mammals that were not listed in the protected matters search tool, including any whale species (GPC 2011).

The results of the sightings of mega fauna in the vicinity of HHI are shown in Figure 6.49 and Figure 6.50.

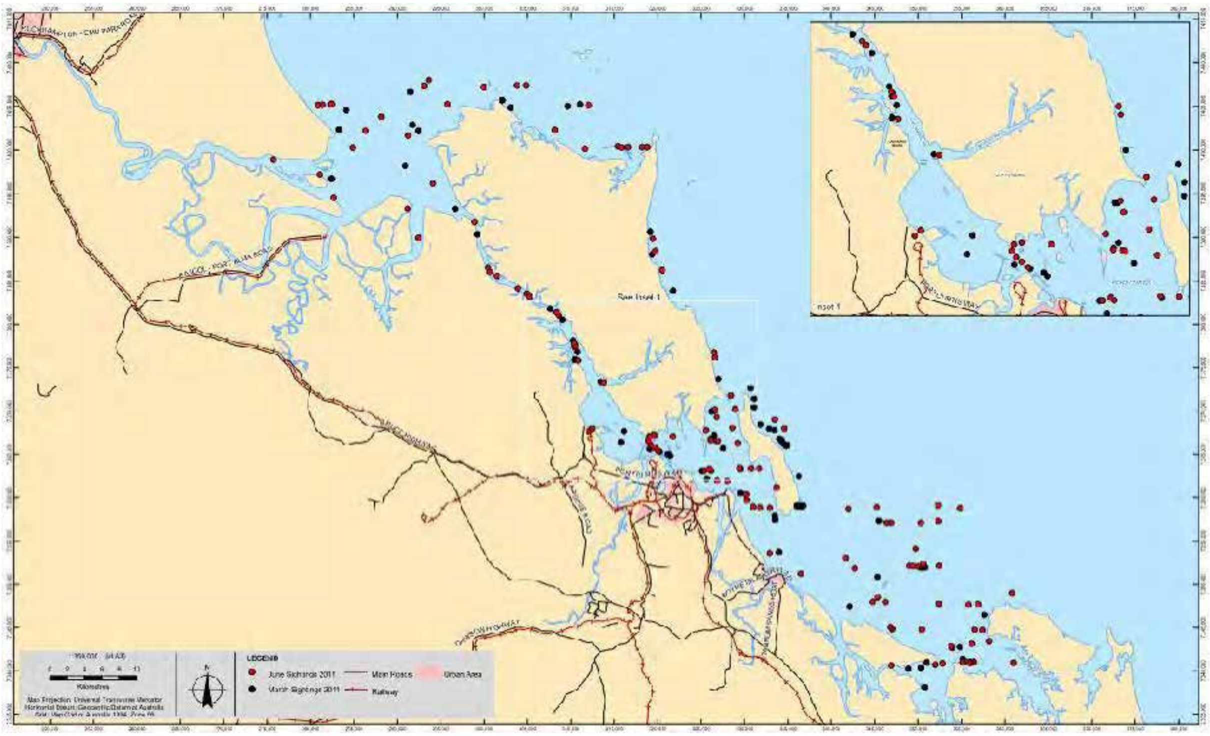


Figure 6.49 – All boat-based and aerial observations of marine fauna (GPC 2011)

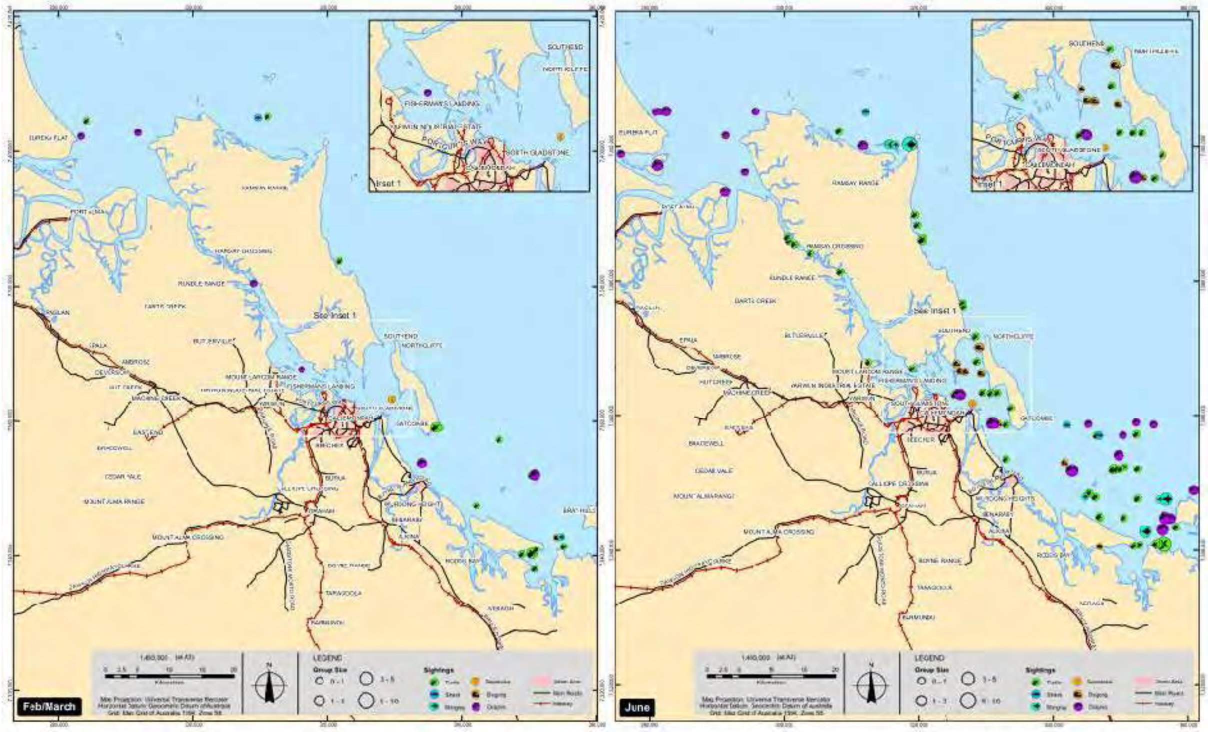


Figure 6.50 – All aerial survey observations for surveys 1 (Feb/Mar) and 2 (June) (GPC 2011)

6.6.3.2 Dolphins

Report for Marine Megafauna and Acoustic Survey -November 2011) (GPC 2011) recorded sightings of Indo-Pacific humpback dolphins across the survey area between Port Alma and Rodds Bay. A total of 85 sightings of 25 groups were made with the majority of groups sighted in the Port Curtis area. A total of 34 snubfin dolphins were observed during the boat-based surveys; all in Port Alma and to the north of Curtis Island (adjacent to Port Alma). It appears that the snubfin dolphin's most southerly limit on the east coast of Australia is Port Alma (Cagnazzi 2011), with no documented snubfin dolphin sighting records from the Narrows, Port Curtis or Rodds Bay in recent years. Two inshore bottlenose dolphins were observed north of Curtis Island. Dolphins were observed to be present in association with anthropogenic activities such as commercial fishing, ferries and slow shipping movements.

6.6.3.3 Dugongs

Waters surrounding HHI are incorporated into the Gladstone - Rodds Bay Dugong Protection Area. Anecdotal evidence from local commercial and recreational fishermen indicates that dugongs are seen within Colosseum Inlet and Seven Mile Creek, though not frequently. Little data is available on the permanent and transient populations of dugong in this area, though with their food being the more digestible Halophila and Halodule species of seagrass they are intrinsically linked to seagrass meadows.

GPC surveys observed a dugong in Boyne Creek at high tide, and another dugong was observed off the eastern end of HHI at low tide (GPC 2011).

Given the relatively remote location of HHI, 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 6.24. 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 6.24 - 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

In 2009, 13% of dugong records came from the Moreton Bay Marine Park, 23% from within the Great Sandy Marine Park and 61% from within the Great Barrier Reef Coast Marine Park. Of the 69 reported strandings, 60 were confirmed dead with the cause of death identified in 20 (33%) cases. 65% of those records were attributed to anthropogenic causes and 35% to natural causes:

- Hunting – 6
- Netting – 1
- Boat strike – 3
- DEEDI Shark Control Program – 1
- Unidentified anthropogenic cause – 2
- Natural causes – 7

In 2010, 19% of dugong records came from the Moreton Bay Marine Park, 12% from within the Great Sandy Marine Park and 62% from within the Great Barrier Reef Coast Marine Park. Of the 90 reported strandings, 79 were confirmed dead with the cause of death identified in 36 (46%) cases. 56% of those latter records were attributed to anthropogenic causes and 44% to natural causes:

- Hunting – 4
- Netting – 6
- Boat strike – 4

- DEEDI Shark Control Program – 1
- Unidentified anthropogenic activity – 5
- Natural causes – 16

More information on dugong deaths from boat strikes and other causes is provided in Section 10.4.4.

Commercial fishing and Indigenous hunting, particularly in north Queensland and the Torres Strait region (Heinsohn *et al.* 2004), provide the two main areas of uncertainty of dugong mortality from anthropogenic activities in Queensland. However, even allowing for poor reporting of dugong strandings in some areas, the reported mortality of about 85 dugong for 2010 and 63 for 2009 along the approximately 2000 km of Queensland's urban coast is considered to represent a low mortality rate among the thousands of dugong that live along this coast. This low incidence of dugong mortality is considered indicative of the effectiveness of the combined benefits of the species protection provided via the NC Act, habitat protection provided via the *Marine Parks Act 1982* and the *Great Barrier Reef Marine Park Act 1975* and associated activities in keeping dugong mortalities within sustainable levels.

6.6.4 Marine Reptiles

Marine reptiles that occur or may occur in waters adjacent to HHI include sea turtles, sea snakes and the saltwater crocodile.

6.6.4.1 Marine Turtles

The EPBC Act Protected Matters Report (refer to Appendix C1) lists five species of sea turtle that may occur or have suitable around HHI; these species and their conservation status are described in more detail in Section 7.4.4.3.

Gladstone Harbour and Rodds Bay are recognised as important foraging habitat for marine turtles (Dobbs 2007) as supported by the data recorded on aerial and boat-based surveys. In a regional context, the Capricorn Bunker section of the Great Barrier Reef is an important feeding habitat where green turtles graze on the seagrass beds and flatback and loggerhead turtles forage for invertebrates (pers comm. I. Bell, DERM 2008). Green turtles primarily feed on seagrass and as such, they have a predicted high association with seagrass beds and prevalence in this region. Additionally, Curtis Island is recognised as a consistent medium density nesting area for flatback turtles along the Queensland coast and low density nesting also occurs by green turtles (Limpus 2007). Wild Duck and Peak Islands are also identified as supporting medium density nesting populations (Limpus 1971; Limpus *et al.* 1981, 1983).. Beaches within the survey region at HHI and at Wild Cattle Island and Tannum Sands also support low density marine turtle nesting in some years.

GPC has undertaken surveys of marine turtles as part of its marine megafauna monitoring program (GPC 2011). In aerial surveys undertaken on 21 April 2011 and 13 June 2011, and covering the coastal area from Port Alma to Rodds Peninsula, identified 79 marine turtles. Of these, 29 were in the Rodds Bay area, including Boyne Creek and Seven Mile Creek. More turtles were seen at low tide in this location. Individual species of turtles observed during marine surveys could not be determined.

Boat based surveys were also undertaken in February-March 2011 and June 2011. These surveys included transects in the Rodds Bay area and to the north of HHI, but transects were not undertaken in the more enclosed waters of Seven Mile Creek and Boyne Creek.

The GPC report also noted that turtle numbers in the Port Curtis area were considerably lower in 2011 compared to surveys undertaken in April 2009, May 2009 and July 2009. Boat based surveys also covered the area from Port Alma to Rodd's Peninsula. A total of 68 turtles were observed comprising 29 green turtles, two hawksbill turtles and four loggerhead turtles, as well as 33 unidentified turtles. Of these, one loggerhead turtle was observed in the Rodds Bay area and one green turtle.

Flatback turtle were not positively identified from the boat based surveys but are known to nest at low density and frequency on HHI and are also known from the waters around HHI (SKM 2007, Dames and Moore 1995). The GPC surveys were not undertaken during the nesting period and hence, may have missed internesting use of the area by flatback turtle.

Anecdotal data from local fishermen and boat operators suggests the green turtle to be the most abundant turtle species within estuarine and marine waters around the Island. The leatherback turtle is a pelagic oceanic species that rarely ventures inshore except to nest; no leatherback turtle nesting sites have been identified in the vicinity of HHI. The presence of hawksbill turtles in the vicinity of HHI has not been verified.

Aerial surveys by Queensland Parks and Wildlife Service (Qld PWS) identified low levels of nesting by the flatback turtle (*Natator depressus*) on the Main Beach of the Island (Limpus *et al.* 2000). Qld PWS conducted a survey of turtle nesting on the Island over a three-day period in December, 2006 (Hodge *et. al.* 2007).

The 2006 Qld PWS survey confirmed low-density nesting activity (two fresh tracks and five old tracks) by flatback turtles on the east of the northern headland on HHI (see Figure 6.52). Nesting activity was limited to the northeast-facing beach between Sandfly Creek and the northern headland. No nesting activity was observed on the north-facing beach west of the northern headland. Observations of return tracks from nesting attempts were reported to display evidence of disorientation. Return tracks consistently kinked to the northwest as shown in Figure 6.51. QLD PWS attributed the cause of the disorientation to light pollution from the Boyne Smelter or QAL Refinery, which are visible on the horizon 18 km to the west. Whilst the beaches of the Island are suitable for turtle nesting Qld PWS concluded that they are not a major nesting area.

Report for Marine Megafauna and Acoustic Survey -November 2011 (GPC 2011) observed that marine turtles were found to be wide-ranging with relative high abundance in Port Curtis and Rodds Bay. Turtles were observed near jet skis and small tinnies and dugong were observed near frequent recreational vessel movement near Pelican Banks and South End. Of the observed green turtles, 17%

were adults and 83% sub-adults. Two hawksbill turtles (one adult and one sub adult) were sighted on the seaward side of Facing Island, in association with numerous other turtles during the first survey period only. Four loggerhead turtles were sighted (all adults); one in Rodds Bay and two on the seaward side of Facing Island and one within Port Curtis.

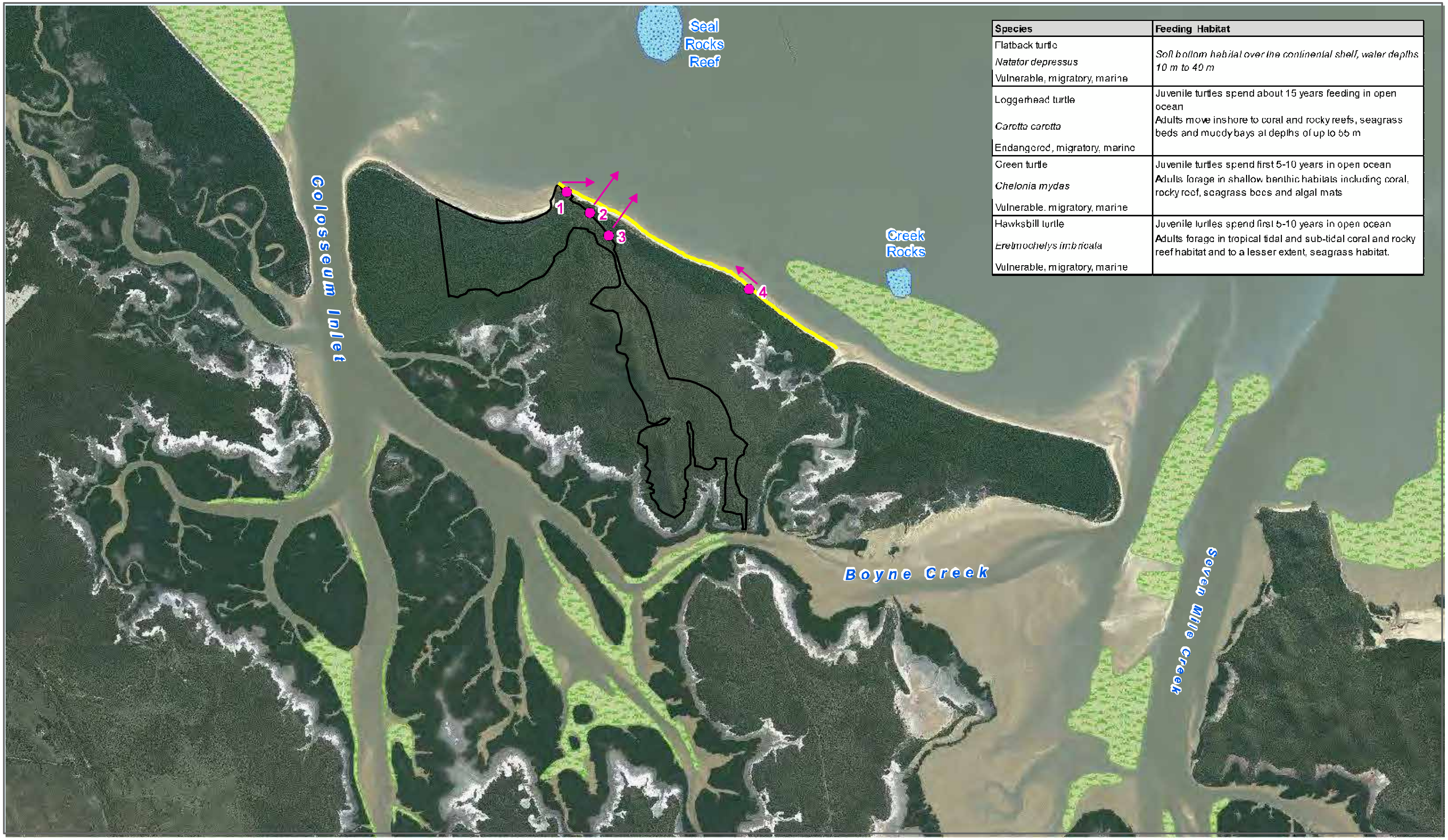
Figure 6.51 - Return Flatback Turtle Tracks Showing Possible Disorientation to North

A summary of Qld EPA stranding and mortality data for marine turtles throughout Queensland in 2001/2002 is presented in Table 6.25. A total of 529 (2001) and 526 (2002) recorded and reported incidents of turtle mortality were included for these years.

Table 6.25 - Marine Turtle Summary Stranding and Mortality Data for Queensland, 2001/2002

Cause	Total 2001	% of total	Total 2002	% of Total
Natural Causes				
Disease	22	4	14	3
Depredation	1	0.2	4	1
Other	6	1	4	1
Human Related				
Boat Strike	83	16	65	12
Dredging	5	1	7	1
Shark Contact	4	1	5	1
Tangled Rope/Fishing Line/Bags, Ghost Nets	11	2	23	5
Tangled In Crab Pots & Floats	18	4	29	6
Ingested Foreign Material	7	1	9	2
Non-Permitted Indigenous Hunting	9	2	4	1
Other	2+1?	0.4	7	1
Undetermined	360+3?	68	354+17?	67
TOTAL	529+4?	-	526+17?	-

? – unconfirmed report



Species	Feeding Habitat
Flatback turtle *Natator depressus* Vulnerable, migratory, marine	*Soft bottom habitat over the continental shelf, water depths 10 m to 40 m*
Loggerhead turtle *Caretta caretta* Endangered, migratory, marine	Juvenile turtles spend about 15 years feeding in open ocean Adults move inshore to coral and rocky reefs, seagrass beds and muddy bays at depths of up to 55 m
Green turtle *Chelonia mydas* Vulnerable, migratory, marine	Juvenile turtles spend first 5-10 years in open ocean Adults forage in shallow benthic habitats including coral, rocky reef, seagrass beds and algal mats
Hawksbill turtle *Eretmochelys imbricata* Vulnerable, migratory, marine	Juvenile turtles spend first 5-10 years in open ocean Adults forage in tropical tidal and sub-tidal coral and rocky reef habitat and to a lesser extent, seagrass habitat.

LEGEND

- Photo Point Locations
- Minor Nesting Area
- Development Footprint
- Soft Bottom Habitat
- Seagrass Meadows
- Coral/Rocky Reef

Figure 6.52 - Nesting and Foraging Habitat for Turtles near HHI

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Figure 6.53 – Beach to West of Headland at High Tide

Undetermined causes of mortality within Queensland waters represent the greatest number recorded for these two years; boat strikes were the most frequent cause of stranding and mortality when the cause could be identified. Where the cause could be attributed to human activities, green turtles were the most frequently affected species, followed by loggerhead turtles and hawksbill turtles.

Green turtles also have the highest incidence of recorded entanglement in and ingestion of marine litter in Queensland waters (Qld EPA, 2001/2002). The higher numbers recorded for green turtles is due to the natural occurrence of this species in the near-shore and estuarine environment. As such green turtles will be the most common species interacting with human activities in estuarine and near shore waters.

6.6.4.2 Crocodiles

Anecdotal evidence from the local community suggests the presence of saltwater crocodiles (*Crocodylus porosus*) within the Colosseum Inlet and Seven Mile Creek Systems, though population numbers are thought to be very low. The area is near the southern limit of the range of saltwater crocodiles, and Qld EPA (2007) state for the Fitzroy catchment region "*because of the area's climate, it is questionable whether this region ever had the capacity to maintain a large crocodile population without a continuing influx of migrants from more productive coastal systems to the north, most of which are now affected by agriculture.*"

This species is known to occur in low densities in the Fitzroy River, and may be an occasional vagrant further south. Numbers in the Fitzroy River are considerably lower than in catchments further north, with less than 0.5% of the Queensland population. Records from two surveys conducted by Qld EPA (2007) within the Fitzroy River (north of Gladstone) region show that populations within the area are likely to have an average density of 0.1, or 0.1 non-hatchlings (>70 cm length or >1 year old) counted per square kilometre of waterway surveyed.

A survey undertaken by the Queensland DERM between September 2009 and February 2010 did not identify any estuarine crocodiles in waterways south of the Fitzroy River (Sullivan *et al.* 2010). The survey included Wild Cattle Creek, immediately north-west of HHI, Colosseum Creek (Colosseum estuary) and Turkey Beach.

The salt-water crocodile is listed as vulnerable under the *Nature Conservation Act 1992*. Surveys in 2009/2010 confirmed a limited population recovery (Sullivan *et al.* 22010).

A total of six unidentified sea snakes were sighted during boat-based surveys in 2011, where one was observed in Port Alma, one on the eastern side of Curtis Island and four in the Narrows (GPC 2011).

6.6.5 Marine Fish

At the regional level coastal waters of the Curtis Coast form the zoo-geographical boundary between northern tropical waters and southern temperate waters, leading to a large biodiversity within the regions fisheries (Olsen *et al.*, 1980). Previous surveys (Dames & Moore 1995) found 19 estuarine/coastal fish species and 10 reefal/pelagic species were targeted by recreational and commercial fisheries within waters around HHI. Yellowfin bream (*Acanthopagrus australis*), mullet (*Mugil* spp.), whiting (*Sillago* spp.), flathead (*Platycephalus fuscus*) and garfish (*Hemiramphis* spp.) have been noted as particularly dependant on tidal wetlands, which are present around the Island, as nursery grounds. Reference to the Qld DPIF Declared Fish Habitat Summary for Colosseum Inlet notes barramundi, blue salmon, bream, estuary cod, flathead, grey mackerel, grunter, jewfish, king salmon, mangrove jack, queenfish, sea mullet, school mackerel, whiting, banana prawns, endeavour prawns, king prawns, mud crabs as being key fisheries values.

Although the area as a whole has a relatively high diversity of fish species targeted by fisheries, species diversity and abundance in Colosseum Inlet at given individual sites appear to be relatively low. Currie & Connolly conducted trawl surveys of shallow-water demersal fishes by for the study *Intertidal Wetlands of Port Curtis* (Connolly *et al.*, 2006). The mean abundance of fishes at four sites adjacent HHI, including two sites in Colosseum Inlet immediately west of the Island and two sites immediately offshore of the northern coastline, was in the range 0-3 individuals per species per 600-m trawl. Species richness was also low at these four sites, at 0 – 3 taken per trawl. Three sites further offshore of the north shore of the Island displayed higher mean abundances, of 4-21 individuals/species/trawl, and generally higher species richness, of 2-3 species/trawl and one site and 5 – 9 species/trawl at the other two.

Rays and sharks were observed in shallow, clear waters in the southern area of the survey area and at the north eastern tip of Curtis Island amongst shallow intertidal flats. The protected matters search tool identified the possible presence of the whale shark (*Rhincodon typus*), and HHI is within the distribution range of this shark. More information on the likely occurrence of this species is provided in Section 7.4.4.4.

6.6.6 Macroinvertebrates

Key commercial macroinvertebrates in estuarine and marine waters adjacent to HHI are sand crabs (*Portunus pelagicus*), mud crabs (*Scylla serrata*), banana prawns (*Penaeus merguiensis*) and saucer scallops (*Amusium balloti*) (AGC Woodard-Clyde 1993).

Video surveys by Rasheed *et al.* (2003) revealed medium-density macroinvertebrate communities (macroinvertegrates visible in 10-80% of video frames) on rubble reefs surrounding Seal Rocks, except to the southwest. An area of rubble north and west of Seal Rocks (region 14) was dominated by bryozoans, hard corals, hydroids and echinoids, with a low density (<6 individuals per site) of colonial hard corals and a medium density (6-20 individuals per site) of solitary hard corals. Another area (region 17), west of Seal Rocks, consisted of rubble reef and coral bommies interspersed with open substrate; hard coral density in this area was medium for colonial hard corals and low for solitary hard corals. Rasheed *et al.* (2003) did not survey the area around Reef Rocks. Table 6.26

outlines the species found in these areas, as well as two areas (regions 11 & 12) of low macroinvertebrate density (macroinvertebrates visible in <10% of video frames) adjacent to the rubble areas. Site 11 was located in the lowest macroinvertebrate density community consisting of bare open substrate with small holes created by burrowing worms, crustacean or fish. Site 12 was located in a low density benthic community dominated by large areas of open substrate, interspersed with occasional groups of macroinvertebrates.

Table 6.26 - Macroinvertebrate Densities around Seal Rocks (Rasheed *et al*. 2003)

Phylum		Region 11	Region 12	Region 14	Region 17
Annelida	Polychaeta	-	L	M	L
Ectoprocta	Encrusting bryozoan	-	L	H	H
	Erect byrozoan	-	L	L	M
Cnidaria					
Zoantharia	Zoanthids	-	L	L	-
Anthozoa	Anemones		-	L	-
	Colonial hard corals	-	-	L	M
	Solitary hard corals	-	L	M	L
	Soft coral	-	L	L	M
Hydrozoa	Hydroids	-	L	M	H
Echinodermata	Asteroid	-	-	L	-
	Crinoid	-	L	L	L
	Echinoid	-	M	M	L
	Holothuroid	-	-	L	-
	Ophiuroid	-	L	L	L
Urochordata	Ascidians	-	L	L	L
Porifera	Sponges	-	L	L	M
Arthropoda					
Crustacea	Brachyuran (crab(s))	-	-	M	-
	Penaeid prawn	-	L	L	L
	Stomatopod	-	-	L	L
	Amphipod	-	L	L	M
Pycnogonida	Sea spiders	-	-	L	-
Mollusca	Bivalves	-	L	L	M
	Gastropods	-	L	L	M
	Cephalopods	-	L	L	L
	Mollusc egg mass	-	L	L	-

L = low, average of <6 individuals per site M = medium, average of 6 – 20 individuals per site
H = high, average of >20 individuals per site
Each site constitutes a 4-minute video tow, representing a transect approximately 100 m long

6.6.7 Recreational Fisheries

Recreational fishing in the waters of Colosseum Inlet and Boyne Creek consists predominantly of line fishing and crab-pot setting (Dames & Moore 1995). Access to local waters is typically via boat ramps from Foreshores estate, Boyne Island, Tannum Sands, Turkey Beach and the causeway at the end of Clarks Road. Based on the 2010 statewide recreational fishing survey (Taylor et al. 2012), it is estimated that more than 42,000 recreational fishers live in the Fitzroy residential region, the statistical unit surrounding HHI in regard to place of residence. Community consultation with local stakeholders has confirmed the value of recreational fisheries to the local population.

Table 6.27 shows the 20 most commonly caught species and the fate of the catch in the Rockhampton coastal waters region, which is the statistical unit surrounding HHI in regard to where the catch occurs. Data from this survey were collected and analysed by DAFF using survey responses of local residents who partook in recreational fishing. The data was provided by DAFF upon request. Whitings, hussar, sweetlips, worwongs and mud crab were most commonly caught in the region, although the single largest catch category was “other species”, a mix of species not otherwise identified.

Table 6.27 - Recreational fishing statistics for the Rockhampton coastal waters region

Species	No. individuals caught	No. individuals harvested	No. individuals released
Whiting, sand	152292	53098	99194
Whiting, trumpeter	90164	42038	48126
Hussar	87354	35722	51632
Sweetlips & morwongs	73257	40799	32459
Crab, mud	51688	14031	37658
Bream, yellowfin	44831	15875	28957
Parrotfish	40189	24087	16101
Cod, marine	33494	6514	26981
Bream, pikey	32854	11391	21464
Coral trout	27171	15992	11179
Emperor, red	23946	8007	15939
Emperor, redthroat	23241	13778	9463
Emperor, other	18105	14328	9277
Snapper, other tropical	11833	7443	4390
Flathead, dusky	11640	4245	7395
Snapper, stripey	10077	5632	4445
Mulloway/jewfish	9763	7524	2240
Trevally	9762	4977	4785
Prawns	5695	5695	0
Mackerel, spanish	2553	2354	199
Other species	195194	69514	125680

(Source: DAFF, 2013)

The Rockhampton coastal waters region encompasses all inshore coastal and offshore waters between Agnes Waters, approximately 35 km sought of HHI, to Byfield National Park, 150 km to the north. Recreational data from sites in the immediate vicinity of HHI, including Wild Cattle Island, Colosseum Creek, Rodds Bay and Turkey Beach, were examined, however, DAFF advised that the available data at the level of these individual site were unreliable.

6.6.8 Commercial Fisheries

Waters adjacent in the HHI region include the southernmost reaches of commercial tropical species such as barramundi (*Lates calcarifer*) and threadfin salmon (*Polydactylus sheridani*), and the northern most reaches of southern temperate species such as winter whiting (*Sillago maculata*) and snapper (*Pagrus auratus*). Mud crabs are the main species targeted within Colosseum Inlet and Boyne Creek by commercial operators, with banana prawns targeted in offshore waters. All of these species use shallow inshore and/or estuarine habitats during at least part of their life cycles.

Four fisheries units cover the marine waters adjacent to HHI, these being S30, S31, T30 and T31. These essentially bisect the area into western (S grids) and eastern (T grids) sections. These are 30 nautical mile grids and thus include waters at considerable distance from HHI. Each of the grids is subdivided into smaller units on a six nautical mile grid. The smaller fisheries units covering estuarine and inshore waters in the immediate vicinity of HHI are:

- Unit S30.20 – offshore waters north-north-west of HHI
- Unit S30.24 – waters west-north-west further along the coastline from HHI, incorporating the Boyne River and Tannum Sands
- Unit S30.25 – waters north-west of HHI
- Unit S31.5 – waters south-west of HHI, including the majority of Colosseum Inlet and the western section of Boyne Creek
- Unit T30.16 – offshore waters north-north-east of HHI
- Unit T30.21 – waters north-east of HHI including Rodds Harbour and Rodds Bay
- Unit T30.22– waters east of HHI, north of Rodds Peninsula
- Unit T31.1 - waters south-east of HHI, incorporating the eastern section of Boyne Creek and Seven Mile Creek.

Table 6.28 summarises 2006-2012 commercial fisheries data for offshore and inshore waters around HHI. No catch data for individual species are available. For reasons of confidentiality, DAFF does not report catch data when fewer than five licensed operators work in a unit during the year, thus a report of less than five boats indicates a low fishing effort in a given year.

The waters offshore of the Island are exploited by otter trawlers of the East Coast Trawl Fishery (ECTF) targeting species such as banana prawns and scallops. Combined, the estimated mean annual commercial value of this fishery in the waters adjacent to Island was $86,523, for a total of 8.8 tonnes landed by 10 boats over 50 days' effort per year.

Table 6.28 - Summary of commercial fisheries otter trawl effort and value for HHI waters

Year	Grids	Boats	Tonnes	Days	Gross value of product (Aus $)	Grids	Boats	Tonnes	Days	Gross value of product (AUS $)
2006	Western (s) grids[1]	7	3.4	27	$31,825	Eastern (t) Grids[1]	7	2.5	23	$26,501
2007	Western (s) grids	< 5	-	-	-	Eastern (t) Grids	< 5	-	-	-
2008	Western (s) grids	6	5.5	20	$47,697	Eastern (t) Grids	< 5	-	-	-
2009	Western (s) grids	7	14.5	72	$126,122	Eastern (t) Grids	8	1.7	13	$22,565
2010	Western (s) grids	10	11.6	54	$103,691	Eastern (t) Grids	7	2.3	15	$22,498
2011	Western (s) grids	8	9.3	32	$85,553	Eastern (t) Grids	8	2.8	22	$39,553
2012	Western (s) grids	< 5	-	-	-	Eastern (t) Grids	< 5	-	-	-

(Source: DAFF, 2013)

[1]Note: WESTERN (S) GRIDS include the 6 Nm grids, S30.20, S30.24, S30.25 and S31.5, surrounding and adjacent to the western side of HHI. EASTERN (T) GRIDS include 6 Nm grids, T30.16, T30.21, T30.22 and T31.1, surrounding and adjacent to the eastern side of HHI

The waters offshore of the Island are exploited by otter trawlers of the East Coast Trawl Fishery (ECTF) targeting species such as banana prawns and scallops. Combined, the estimated mean annual commercial value of this fishery in the waters adjacent to Island was $86,523, for a total of 8.8 tonnes landed by 10 boats over 50 days' effort per year.

Commercial fishing effort within Colosseum Inlet, Boyne Creek and Seven Mile Creek consists of smaller beam trawlers, otter trawlers and crab potters. A total of less than five boats operating were recorded for all instances of beam trawlers, and consequently tonnage and estimated value were not released or included.

Commercial mud crab operations are licensed to operate in waters near HHI. Each license allows the commercial operator to set a maximum of 150 crab pots. Mud crab pot fishery catch data for the western (S) and eastern (T) grids of HHI are presented in Table 6.29.

Based on data obtained the average mud crab annual fishery value is $244,985 for the western and eastern grid sites around HHI. Anecdotal evidence from local commercial fisherman suggests that fishing effort is also conducted in other grids and for other species to supplement mud crab income.

Table 6.29 - Mud Crab Pot Data for Grids S31 (Colosseum Inlet) & T31 (Rodds Bay)

Year	Grids	Boats	Tonnes	Days	Gross value of product (aus $)	Grids	Boats	Tonnes	Days	Gross value of product (Aus $)
2006	Western (s) grids [2]	8	7.47	278	$119,480	Eastern (t) grids [2]	< 5	-	-	-
2007	Western (s) grids	7	12.8	384	$205,072	Eastern (t) grids	< 5	-	-	-
2008	Western (s) grids	7	12.0	315	$192,368	Eastern (t) grids	< 5	-	-	-
2009	Western (s) grids	< 5	-	-	-	Eastern (t) grids	< 5	-	-	-
2010	Western (s) grids	< 5	-	-	-	Eastern (t) grids	8	6.2	158	$99,520
2011	Western (s) grids	< 5	-	-	-	Eastern (t) grids	< 5	-	-	-
2012	Western (s) grids	< 5	-	-	-	Eastern (t) grids	< 5	-	-	-

(Source: DAFF, 2013)

[2]Note: WESTERN (S) GRIDS refers to four 6 Nm grids, S30.20, S30.24, S30.25 and S31.5, surrounding and adjacent to the western side of HHI. EASTERN (T) GRIDS refers to four 6 Nm grids, T30.16, T30.21, T30.22 and T31.1, surrounding and adjacent to the eastern side of HHI

6.7 Terrestrial Flora and Fauna

6.7.1 Introduction

The ecological features of HHI have been surveyed extensively over a period of 20 years and this work is supplemented by additional survey work undertaken in association with other coastal projects within the Curtis Coast region of Queensland.

This section provides general information on survey effort and findings, including surveys targeting species listed under the EPBC Act. For those ecological communities and species listed as threatened or migratory under the EPBC Act, a more detailed assessment of occurrence, habitat preferences and other matters relevant to determining impacts on these communities and species is provided in Section 7.4 (listed threatened species and ecological communities) and Section 7.5 (listed migratory species).

The biodiversity values of HHI can be summarised as follows:

- HHI has relatively low fauna species diversity, likely due to a combination of the lack of permanent freshwater on HHI, being fully isolated from the mainland and historic grazing and burning regimes
- Surveys undertaken since 1988 have, collectively, identified:
  - 28 native mammal species, including 17 species of bat, with one vulnerable species, the grey-headed flying fox observed foraging (see also Section 7.4.3.3)
  - 125 bird species, including the vulnerable black-breasted button quail (see also Section 7.4.3.2, several migratory birds (see Section 7.5.1) and migratory shorebirds (see Section 7.5.2)
  - 14 terrestrial reptiles, none of which are considered threatened
  - 4 native amphibian species
- Substantial or important populations of any native fauna species have not been identified in any of the surveys
- There are no rare, endemic or unique populations of plants or animals on HHI
- There are several endangered regional ecosystems (see Section 0) and one EPBC listed endangered ecological community (see Section 7.4.2)
- Suitable habitat for a small number of threatened species is present on HHI. Those listed under the EPBC Act are discussed in Section 7.4.

6.7.1.1 Mapping and Database Review

The following mapping and databases were reviewed for this assessment:

- RE Mapping (Version 6.0) produced by DNRM was reviewed to determine the distribution of REs in the locality of the site

- A list of significant flora species known from the locality was generated from the Herbrecs Database search completed in 2006 for the study area, incorporating a 30 km radius of the subject site
- Queensland Government Wildlife Online was completed in April 2013. No EPBC Act listed species were identified within a one kilometre radius of the centre point of PTP. Two NC Act listed species were identified by this search, the vulnerable beach stone curlew (*Esacus magnirostris*) and near-threatened eastern curlew (*Numenius madagascariensi*). Results of a search of a 25 km radius are provided in Table 6.30.
- EPBC Act Protected Matters Database Search results are provided in Appendix C1 and a more comprehensive assessment of the likelihood of occurrence of listed ecological communities and species is provided in Sections 7.4 and 7.5.

Table 6.30 – Queensland Wildlife Online database search – Terrestrial - 25 km radius, April 2013

Scientific Name	Common Name	Status - EPBC Act	Status – NC Act	Sighting records	Specimen records
Macronectes giganteus	southern giant-petrel	E	E	5	0
Turnix melanogaster	black-breasted button-quail	V	V	7	0
Xeromys myoides	water mouse	V	V	7	0
Phascolarctos cinereus	koala (southeast Queensland bioregion)	V	V	1	0
Cycas megacarpa		E	E	6	3
Apatophyllum olsenii		E	V	3	3
Cupaniopsis shirleyana	wedge-leaf tuckeroo	V	V	6	0
Germainia capitata		V	V	1	1

6.7.1.2 Ecological Surveys

Ecological surveys on HHI and the surrounding marine environment have been undertaken numerous times over the past 20 years. Some have been focused on the development of HHI while others, such as those engaged by GPC included the environment in the vicinity of HHI as part of the investigation area.

The ecological surveys that have been used in the preparation of this EIS are detailed in Table 6.31. Given the extent of the surveys, the seasonality (covering multiple seasons), and the compliance with relevant guidelines at the time, the survey effort is considered to be adequate for targeted MNES species.

Table 6.31 - Ecological Survey Effort

Company	Year	Survey
AGC Woodward-Clyde	1993	Flora and fauna surveys utilising the following methods: • Diurnal avifauna surveys over four days • Elliott trapping at five sites, utilising 25 traps per site for four nights • Hair tubes were deployed at each of the five mammal trapping sites • Spotlighting was completed for 2.5 hours per night over three nights • Recording of frog calls for later identification • Searches for scats, tracks and traces of terrestrial fauna.
Dames & Moore	1995	Supplementary flora and fauna surveys of the island undertaken in December 1994. The study comprised a bird surveys at 54 survey sites, with 10 minutes survey effort expended at each site. Bird surveys at 54 sites, over a total of 540 minutes (9 hours) are considered adequate to have recorded a representative suite of avifauna from the island. When combined with the opportunistic and targeted observations of CQU and SKM, overall search effort for birds must be considered adequate.
Central Queensland University	2005	Flora and fauna surveys involving the following methods: • Methodology for the flora surveys was based on the Queensland herbarium methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland (EPA 2005a). The Island was traversed on foot over a six day period between 23 and 28 May 2005 to describe the vegetation structure and composition • Site data was collected as quaternary sites during traverses whenever the vegetation communities changed. Dominant woody species and significant herbaceous species were recorded for each site and the vegetation structure was classified according to Walker and Hopkins (1990) for non-rainforest communities, and Webb (1978) was used for rainforest communities. The site locations were recorded using a Garmin 12XL GPS and additional site data were also noted including locality, landform and soils • The vegetation communities recorded were related to the RE types depending on the land zone they occurred within, vegetation structure and species present. Only terrestrial plant communities were surveyed. Intertidal and sub tidal communities were not mapped in detail as these are not within the development footprint. The majority of the field effort was focused on the areas of development on HHI, however an effort was made to classify each vegetation community occurring on the Island • A six day terrestrial fauna survey was undertaken in conjunction with the flora survey. The survey focused on the likelihood of species of significance occurring on the Island and within the area of development or areas likely to be influenced by the development. This fauna survey involved the search for fauna and signs of fauna such as tracks and traces.
Sinclair Knight Merz (SKM)	2007	Targeted field surveys to review the status of regional ecosystems and a number of threatened species (considered potential occurrences based on database records) on the Island. The methodology incorporated: • Review of current RE mapping across the development area. This involved walked traverses of each mapped remnant polygon in the development area, and collection of quaternary data[9] at 22 sites • Elliott trapping to target the Water Mouse in potential habitat at the bridge site to the Island. A single transect of 25 small Elliott traps was

[9] Quaternary site data are used primarily as a record of field traverses and to verify regional ecosystem/vegetation mapping. These sites are generally entered on spreadsheets or databases. Quaternary sites may be collected at regular intervals along a traverse, and/or made where REs/vegetation communities change. Quaternary sites are recorded via a proforma.

Company	Year	Survey
		established and traps were baited with cat food. Traps were set for four nights, with a total of 100 trap nights • Systematic 30 minute searches for the Black-breasted Button Quail at ten sites in littoral vineforest communities. These search plots comprised active searches over a 50 m radius around a central search point • Spotlighting for two hours per night over five nights, incorporating approximately 8 km of walked or driven transect per night • Nocturnal call playback at six sites over five nights for nocturnal birds and mammals including the powerful owl, masked owl, barking owl, koala, squirrel glider and yellow-bellied glider • Anabat survey using two Anabat units for five nights per unit, with a total of 10 recording nights at separate 10 sites • The Herpetofauna survey methodology was designed to target significant species such as the yakka skink (*Egernia rugosa*), as listed under the EPBC Act and/or *Nature Conservation Wildlife Regulation 1994*. Survey methodology included physical searches (diurnal) in all habitats for a total of approximately 20 person hours on the subject site • A series of koala search plots were established. These plots generally coincided with quaternary vegetation plots and involved searches for animals, scats and scratches over a 50 m transect, completed by two observers. A total of 26 Koala search plots were completed.
Greening Australia	2008 - 2010	Detailed onsite mapping of vegetation and REs for the preparation of an offset proposal under the Queensland *Vegetation Management Act 1992*.
Resident and Migratory Shorebird Surveys Undertaken for GPC	2011 - 2012	Nine migratory shorebird surveys of the entire Curtis Coast between the Fitzroy River Delta at Port Alma in the north and Rodds Peninsula in the south undertaken on behalf of Gladstone Ports Corporation between January 2011 and October 2012 (GHD 2011a,b,c,d; Sandpiper Ecological Surveys 2012a,b,c; Wildlife Unlimited 2012). These surveys provide the most detailed data relevant to this EIS, reporting the spatial locations of high tide roosting sites, mapping the spatial extent of low tide foraging habitats, and reporting the total number of individuals of each shorebird species counted at each site surveyed. Shorebird count data were reported for each individual high tide roost site for five of the surveys, with total counts reported for each survey region for all surveys. These surveys were conducted in different months in both summer (November, October, January-March) and winter (August) months, and in general accordance with the survey guidelines of EPBC Draft Migratory Shorebird Guidelines (DEWHA 2009b,c). The nine surveys exceed the minimum recommended survey effort of five surveys (four in summer and one in winter) outlined in the survey guidelines.

6.7.2 Regional Ecosystems

6.7.2.1 Desktop Assessment

Mapping produced by DNRM identified 14 REs as being present on HHI. Of these five are not located within the project site. The mapping was reviewed and confirmed by surveys undertaken by the by CQU (2006) in 2005, Queensland EPA/Herbarium in 2006, and SKM in 2007. The current RE mapping for HHI is shown on Figure 6.55 and the areas of each regional ecosystem on the island and within the PTP boundary are shown in Table 6.32.

Table 6.32 - DNRM RE Distribution on HHI

RE	Description	Area on HHI (ha)	Within Development Area (ha)
12.1.1	*Casuarina glauca* open forest	31.10	0.25
12.1.2	Saltpan vegetation including grassland, herbland and sedgeland	369.80	23.80
12.1.3	Mangrove shrubland to low closed forest	437.70	0.11
12.2.2	Microphyll/notophyll vine forest on beach ridges	189.90	0.00
12.2.11	Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest	926.60	185.00
12.2.14	Fore dune complex	65.50	0.10
12.3.3	*Eucalyptus tereticornis* woodland to open forest	154.80	0.00
12.3.6	*Melaleuca quinquenervia*, *Eucalyptus tereticornis*, *Lophostemon suaveolens* woodland	60.90	0.00
12.3.10	*Eucalyptus populnea* woodland	160.10	1.00
12.12.7	*Eucalyptus crebra* woodland	137.70	23.15
12.12.8	*Eucalyptus melanophloia* woodland	10.60	0.00
12.12.12	*Eucalyptus tereticornis* and E. crebra dominated forests	406.20	175.00
12.12.19	*Themeda triandra* grassland and wind-sheared shrubland and woodland.	1.00	0.29
12.12.28	*Eucalyptus moluccana* open forest	28.70	0.00
TOTAL		2980.60	218.94

6.7.2.2 Ecological Survey Findings

Ecosystem mapping completed by AGC Woodward-Clyde (1993) reported nine broad vegetation communities across HHI:

- Western Sand Dunes (Beach Ridge Eucalypt Open Forest) – summarised as eucalypt open forest which was dominated by *E. teriticornis, E. tesselaris, E. intermedia*, to a height of 20 m on beach ridges and Melaleuca forest (*M.quinquenervia, M. dealbata, M.viridiflora*) in the lower swales
- Central Northern Coastal Littoral Vine Scrub – located south of Tiber Point and consisting of three zones, the beach strandline vegetation, littoral vine scrub behind the frontal dune system (noted to be the most diverse community on the Island) and a discontinuous fresh water swamp that runs along the landward edge of the littoral vine forest and eucalypt open forest occurring adjacent the granodiorite shelf
- Granodiorite Substrate Zone – observed in 1993 studies on the elevated parts of HHI underlain by solodic and skeletal (Lithosols) soils over the granodiorite parent material and noted to consist of five types of eucalyptus woodland, recognised by the following dominant canopy species

- Ironbark (*E. crebra/dreponaphylla*) dominated woodland with minor *E.Intermedia*
- Poplar box (*E. populnea*) dominated woodland with minor *E. tereticornis*, *E. intermedia*, *E. crebra*, *M. viridiflora*, *C. glauca*
- Gum topped box (*E. molluccana*)
- Silver leafed ironbark (*E. melanophloia*)
- Mixed eucalypt (*E.intermedia,E. trachypholia, E. crebra, E. dreponaphylla, E. tereticornis, E. tesselaris*
- Melaleuca Shrubland/Open Forest – was noted to occur on coastal flats adjacent to the saltpans.

Dames & Moore (1995) expanded further on the significance of identified ecosystems from the IAS (AGC Woodward-Clyde 1993), in particular the poplar box (*E. Populnea*) and gum-topped box (*E. mollucana*) dominated woodland on the granodiorite substrate zone and the littoral vine forest on the coastal sand dune communities. Dames &Moore (1995) provide an estimation of areas for the main vegetation types, as described in Table 6.33.

Table 6.33 - Vegetation Areas (Dames & Moore 1995)

Vegetation Type	Total Island (ha)	Lease Area (ha)
Cleared and/or heavily grazed	66.5	65.5
Littoral Scrub	213.6	93.3
Mosaic of Eucalypt Woodland Forest Types	682	122.4
Saltpan	371.3	54.31
E. populnea, *E. teriticornis*, *E. drepanophylla* tall open woodland	62.4	62.4
E. populnea woodland	59.4	59.4
Parallel beach ridge vegetation	477.6	82.4
Allocasaurina/Melaleuca low woodland and low open forest	166.2	75.7
E. teriticornis tall open forest	19.0	19.0
E. mollucana open forest	18.2	18.2
Sporobolus virginicus low grassland	6.6	1.8
P. cayera woodland with emergent E. teriticornis and E. tesselaris	123.9	18.4
Melaleuca open forest	28.5	9.1
Mangroves	407.4	11.9
Strand vegetation	47.8	-

As the vegetation communities described by Dames and Moore do not correspond with contemporary RE descriptions, it is not possible to provide a comparative analysis.

Mapping of HHI REs was completed by CQU (2006) in 2005. CQU mapped 13 REs on four Land Zones within the lease boundary (see Table 6-34). Survey of REs for the Island was based on data collected from 143 sites within the lease area over a six day period as shown in Figure 6.54 and based on Queensland Herbarium Methodology. Approximately 103 terrestrial plants species were recorded during the CQU study.

Floristic data collected by CQU (2006) in May 2005 was used to apply for an update to the 2003 RE map for the lease area, held by the DNRM. Significant differences to mapping provided by CQU and final DNRM mapping can be observed. Interpretation of assemblage composition and areal distribution (polygon shape) differs significantly between the two surveys. The map amendment request triggered a field assessment by Queensland Herbarium staff.

The confirmatory survey completed by Queensland EPA/Herbarium (Joy Brusche) resulted in an amendment to the 2003 vegetation coverage. The current RE mapping is presented in Figure 6.54 and listed in Table 6.32.

Field survey (SKM in 2007) found that the current regional ecosystem map held by DNRM was in fact an accurate representation of vegetation patterns across the study area. Although there are minor disparities relating to regional ecosystem extents, the regional ecosystem map is considered to be of sufficient accuracy to be relied upon for planning purposes.

Table 6-34 - Regional Ecosystems Mapped on HHI

RE Type	Status*	Short Description
Landzone 1 - Tidal flats and beaches		
12.1.1	Of Concern	*Casuarina glauca* on estuarine deposits
12.1.2	Not of Concern	*Sporobolus virginicus* on estuarine deposits
12.1.3	Not of Concern	Mangrove shrubland/forest on estuarine deposits
Landzone 2 - Coastal dunes		
12.2.2	Of Concern	Microphyll rainforest on coastal dunes
12.2.11	Not of Concern	*Eucalyptus tereticornis* dominated forests on sands
12.2.14	Not of Concern	Foredune complexes of *Allocasuarina spp.* and *Spinifex spp.*
Landzone 3 - Alluvium		
12.3.3	Endangered	*Eucalyptus tereticornis* dominated forests on alluvial plains
12.3.6	Not of Concern	*Melaleuca spp.* dominated woodlands on alluvial plains
12.3.10	Endangered	*Eucalyptus populnea* dominated forests on alluvial plains
Landzone 12 - Hills and lowlands on granitic rocks		
12.12.7	Not of Concern	*Eucalyptus crebra* and *E. erythrophloia* woodland on hills
12.12.8	Of Concern	*Eucalyptus melanophloia* woodland on hills
12.12.12	Of Concern	*Eucalyptus tereticornis* and *E. crebra* dominated forests
12.12.28	Of Concern	*Eucalyptus moluccana* open forest on alluvial plains

* status in 2005

A number of discharge zones have been identified on the Island, as discussed in Section 6.3.6, and these areas have the potential to support groundwater dependent ecosystems such as *Melaleuca spp.*

LEGEND

- Survey Location
- Development Footprint

Figure 6.54 - Location of the flora survey sites on HHI (CQU 2006)

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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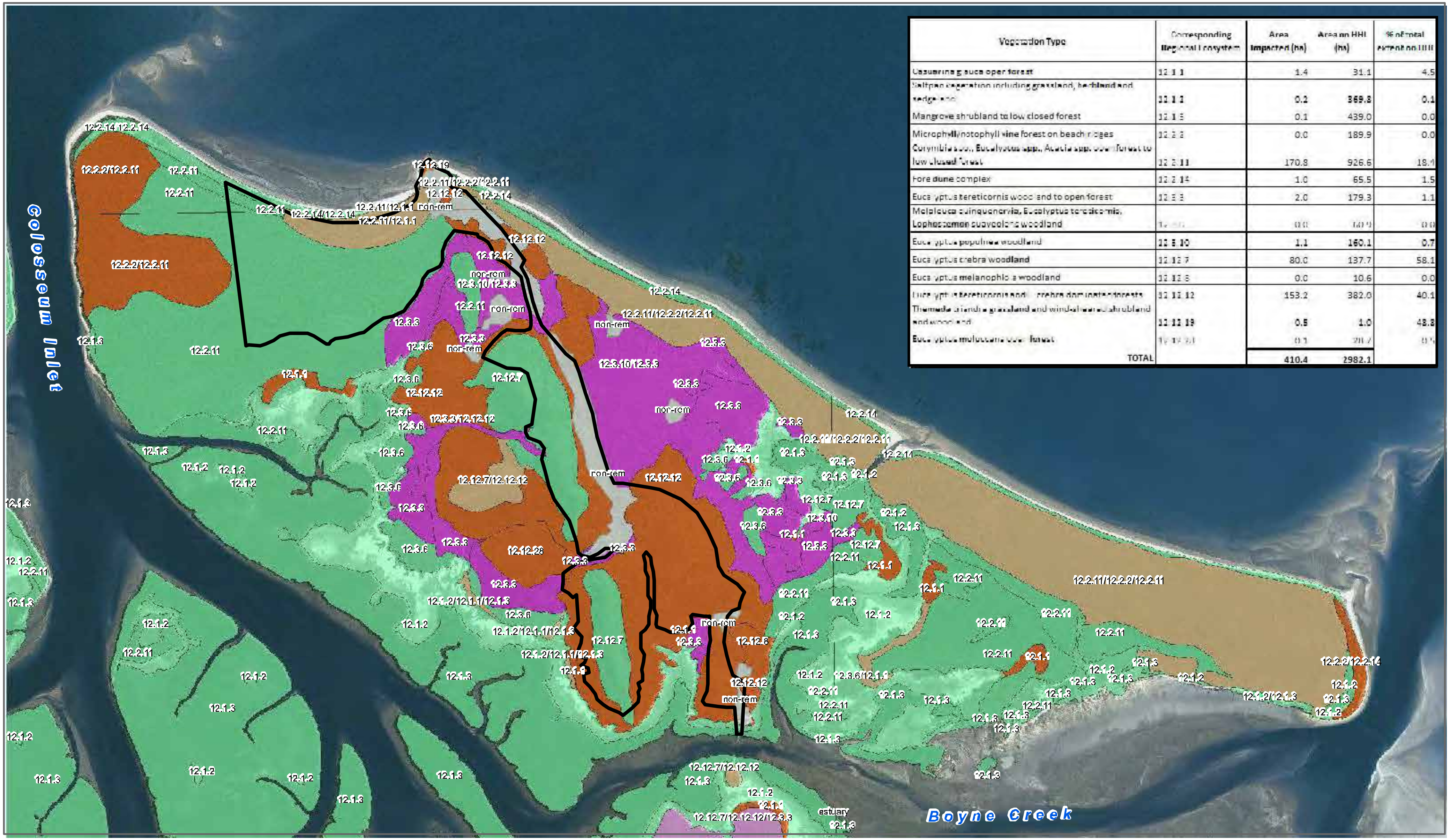

Vegetation Type	Corresponding Regional Ecosystem	Area Impacted (ha)	Area on HHI (ha)	% of total extent on HHI
Casuarina glauca open forest	12.1.1	1.4	31.1	4.5
Saltpan vegetation including grassland, herbland and sedgeland	12.1.2	0.2	369.8	0.1
Mangrove shrubland to low closed forest	12.1.3	0.1	439.0	0.0
Microphyll/notophyll vine forest on beach ridges	12.2.2	0.0	189.9	0.0
Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest	12.2.11	170.8	926.6	18.4
Fore dune complex	12.2.14	1.0	65.5	1.5
Eucalyptus tereticornis woodland to open forest	12.3.3	2.0	179.3	1.1
Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland	[illegible]	[illegible]	[illegible]	[illegible]
Eucalyptus populnea woodland	12.3.10	1.1	160.1	0.7
Eucalyptus crebra woodland	12.12.7	80.0	137.7	58.1
Eucalyptus melanophloia woodland	12.12.8	0.0	10.6	0.0
Eucalyptus tereticornis and E. crebra dominated forests	12.12.12	153.2	382.0	40.1
Themeda triandra grassland and wind-sheared shrubland and woodland	12.12.19	0.5	1.0	48.8
Eucalyptus moluccana open forest	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL		410.4	2982.1	

LEGEND

- Development Footprint

Regional Ecosystem (DERM, 2012)

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub Dominant
- Not Of Concern
- Non-remnant

Figure 6.55 - Vegetation Communities

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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6.7.2.3 Regional Ecosystem Values and Threats

Some of the of REs recorded from HHI are identified more broadly as providing habitat for rare and endangered fauna or are generally accepted as being representative of unique floristic assemblages limited in extent within Queensland and or the region. Table 6.35 outlines special values of and known threats to the REs known from the Island, as described in the DNRM Regional Ecosystem Description Database (REDD). Where a particular RE corresponds to an MNES value, a cross reference is provided to where further information is given in Section 7. Note that most of the REs on HHI might provide foraging habitat for the following species:

- Grey-headed flying fox (see Section 7.4.3.3)
- Migratory terrestrial birds (see Section 7.5.1).

Table 6.35 - Threats and Special Values of REs

RE	Special Values/Observed Values	Known Threats/Observed Threats	VM Act Status	Biodiversity Status
12.1.1	Provides estuarine wetland habitat.	Subject to weed invasion, particularly groundsel (*Baccharis halimiflora*). Groundsel is present on HHI within this RE.	Of concern	Endangered
12.1.2	Habitat for water mouse, *Xeromys myoides*, in southern part of the bioregion particularly in areas immediately adjacent to mangroves. Refer 7.4.3.1 for discussion on water mouse. Migratory shorebird roosting and foraging habitat (refer Section 7.5.2).		Least concern	No concern at present
12.1.3	Habitat for water mouse, *Xeromys myoides*, in southern part of the bioregion particularly in areas immediately adjacent to saltpans. Refer 7.4.3.1 for discussion on water mouse.		Least concern	No concern at present
12.2.2	Potential abitat for rare and threatened flora species including *Acianthus amplexicaulis, Alyxia sharpei, Xylosma ovatum, Dansiea elliptica* and *Acronychia littoralis*. Refer Section 7.4.3.15 for further discussion on occurrence of threatened flora. Habitat for black-breasted button quail. Refer Section 7.4.3.2. Corresponds to threatened ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* (refer Section 7.4.2)	Continues to be threatened by clearing for coastal residential development. Also subject to extensive weed invasion over 90% of its pre-clear distribution (*Rivina humilis, Passiflora suberosa, Lantana camara, Catharanthus roseus, Panicum maximum, Asparagus spp., Salvia spp.*) and localised human disturbance from recreational and vehicle tracks.	Of concern	Endangered

RE	Special Values/Observed Values	Known Threats/Observed Threats	VM Act Status	Biodiversity Status
12.2.11	Rainforest species sometimes present as sub canopy or understorey. This is the case on HHI.		Least concern	No concern at present
12.3.3	While *Eucalyptus tereticornis* remains common in the landscape, very few intact stands remain. *Eucalyptus tereticornis* grows into a very large hollow-forming tree and has a special significance for fauna species, especially in drier areas. Large, hollow forming examples of this species are present on the Island. Potential koala habitat (see Section 7.4.3.14) Landzone 3 may provide habitat for brigalow reptiles (See Section 7.4.3.7)	*Eucalyptus tereticornis* will regenerate readily but there is a lack of recruitment to replace old trees in stands that are logged, thinned or grazed and regularly burnt.	Endangered	Endangered
12.3.6	Potential koala habitat (see Section 7.4.3.14) Landzone 3 may provide habitat for brigalow reptiles (See Section 7.4.3.7)			
12.3.10	Largely confined to western margins of bioregion. Some relatively intact remnants present in road reserves. This regional ecosystem is generally restricted to the overlap zone between SEQ and the Brigalow Belt Bioregion. Potential koala habitat (see Section 7.4.3.14) Landzone 3 may provide habitat for brigalow reptiles (See Section 7.4.3.7)	Cleared and thinned for grazing and agriculture.	Endangered	Endangered
12.12.7	Habitat for rare and threatened flora species including *Acacia grandifolia*. Refer Section 7.4.3.15 for further discussion on occurrence of threatened flora.		Least concern	No concern at present
12.12.8	This regional ecosystem does not occur on any other islands within the GBRWHA.	Less steep areas have been extensively cleared for pasture.	Of concern	Of concern
12.12.12	This regional ecosystem does not occur on any other islands within the GBRWHA. Potential koala habitat (see Section 7.4.3.14)	Extensively cleared for pasture.	Of concern	Of concern
12.12.28	No particular features	Data on clearing rate between 1995 and 1997 indicates that the RE continues to experience an annual loss in excess of 1% of current extent per year. The area remaining is likely to fall below 30% within 5-10 years.	Of concern	Of concern

6.7.2.4 Ecological Condition and Threats

Evidence of historical grazing and logging activity is obvious across the study area, with substantial areas of sub-mature or regrowth vegetation, including many areas which barely qualify as remnant vegetation under the VM Act based on their low height[10] in comparison to undisturbed vegetation elsewhere on the Island. Historical disturbance is particularly evident on lower slopes and alluvial plains of HHI, where many canopy Eucalypts are of even age and exhibit none of the indicators of old growth vegetation (e.g. tree hollows).

AGC Woodward-Clyde (1993) noted that sleeper cutters had operated on the Island in the past and concentrated on ironbark species to the extent that few commercially viable specimens remained at the time of the 1992/93 survey. The dry climate and relatively harsh growing conditions do not favour the rapid growth of plant species to maturity, and the relatively short period of time (20 years) which has passed since these observations were made has not resulted in an obvious increase in the number of large specimens of ironbark in the project.

6.7.3 Essential Habitat

Queensland Government uses regional ecosystem mapping and information on habitat preferences for NC Act listed threatened species to determine essential habitat for these species.

In addition to reference to actual survey records, the Queensland Government approach to mapping essential habitat is based on the following factors:

- Vegetation: The species or types of vegetation that the species is associated with
- RE: the RE that the species is most commonly associated with
- Land zone: This is the underlying geology associated with an RE
- Altitude: The range of altitudes at which the species is found
- Soils: The type of soils on which a species is most commonly found
- Position in landscape: A more precise description of the landscape features the species is commonly associated with. For example creek banks, levees, lower slopes, hillsides and ridges.

Where essential habitat mapping is theoretical, that is, wherever there are no confirmed sightings of a species, essential habitat mapping can be challenged either:

- by demonstrating that less than three of the essential habitat factors for a particular species are present
- where an appropriate level of survey effort has been carried out, by demonstrating that the species is not present at the site at any stage of its lifecycle.

[10] To meet the remnant criteria, the predominant vegetation layer must attain a height of at least 70% of the height of the predominant undisturbed canopy.

HHI is mapped as containing Essential Habitat for the koala, *Phascolarctos cinereus*, and the wallum froglet, *Crinia tinnula*. Essential habitat for koala corresponds with REs 12.3.3, 12.3.6, 12.3.10 and 12.12.12 (see Figure 6.55). Essential habitat for wallum froglet corresponds to RE 12.3.6 as shown on Figure 6.55.

Neither species has been recorded during five separate fauna surveys. In addition, there are no records of either species within relevant databases and both appear to be absent from the Island. This view is supported by the following observations:

- Extensive spotlighting effort has been expended on the Island, and several arboreal mammal species has subsequently recorded. The koala is readily detectable during spotlighting surveys, however spotlighting surveys have not detected koala.
- In the absence of site records, the koala can be detected by indirect evidence of occurrence, including the presence of faecal pellets and characteristic scratch marks on tree trunks. None of the observers who have completed survey on the Island have noted any such evidence of koala occurrence. Koala call playback has also been used to detect koalas, but did not produce any positive results.
- Despite the extensive suite of regional ecosystems listed as providing essential habitat for the wallum froglet, the species occurs in comparatively few REs and is limited by the presence of certain critical microhabitats, including the presence of a dense understorey of sedges or ferns, presence of suitable breeding sites (ponds of low pH with a deep humic layer) and proximity to semi-permanent or permanent wetlands. None of these essential microhabitats are present.

On the basis of survey effort and habitat assessment, it has been concluded that the wallum froglet is not present on HHI, and essential habitat for the wallum froglet is also absent. Further discussion on likelihood of occurrence of koala is provided in Section 7.4.3.14, and it is not considered that koala is present on HHI.

The Queensland essential habitat mapping has not identified essential habitat for any other EPBC listed animals.

6.7.4 Terrestrial Flora

The EPBC Act protected matters search undertaken in October 2012 identified seven flora species with the potential to occur on HHI as follows:

- *Cupaniopsis shirleyana* (wedge-leaf tuckeroo) (vulnerable)
- *Germainia capitata* (vulnerable)
- *Phaius australis* (lesser swamp-orchid) (endangered)
- *Streblus pendulinus* (Siah's backbone, Sia's backbone, Isaac wood) (endangered)
- *Taemiophyllum muelleri* (minute orchid, ribbon-root orchid), (vulnerable)
- *Cycas megacarpa* (endangered)
- *Cycas ophiolitica* (endangered).

A search of the Queensland HERBRECS and Wildnet database identified records of EPBC threatened plants within the Gladstone Regional Council (GRC) area and within a 25 km radius of HHI as shown in Table 6.36. No records were identified within one kilometre of HHI.

Table 6.36 - EVNT Flora listed in the HERBRECS/ Wildnet Databases

Scientific Name	Common Name	EPBC Act Status	Records within:		Suitable habitat on HHI? (1)
			GRC area	25 km of HHI	
Acacia eremophiloides		V	1		No
Alectryon ramiflorus	Isis tamarind	E	1		No. Microphyll vine forest present but not likely to occur on sandy coastal soils
Apatophyllum olsenii		V	6	3	No. Inhabits granite ridges and granite boulder outcrops in open forest or tall shrubland with *E.exserta*, *Lophostemon confertus* and *Xanthorrhoea johnsonii*.
Atalaya collina	Yarwun whitewood	E	15		No. Located in semi-evergreen vine thicket or 'dry rainforest'
Bulbophyllum globuliforme	Hoop pine orchid	V	2		No. Only occurs in conjunction with hoop pine
Cossinia australiana		E	6		No. Known from Araucarian vineforests or vine thickets on fertile soils.
Cupaniopsis shirleyana	wedge-leaf tuckeroo	V	28	6	Refer Section 7.4.3.15
Cycas megacarpa		E	49	6	Refer Section 7.4.3.15
Fontainea rostrata		V	1		No. Occurs on soil derived from metamorphic rock, in notophyll vine forests.
Fontainea venosa		V	15		No. Occurs on Araucarian microphyll vineforests where rainfall is 1000 mm.
Germainia capitata		V	14	1	Refer Section 7.4.3.15
Graptophyllum ilicifolium	holly-leaved graptophyllum	V	3		No. Suitable soils and vegetation types not present on HHI
Macadamia jansenii		E	16		No. Grows in complex notophyll vine forest
Medicosma elliptica		V	22		No. Found at 200-580m above sea level.
Parsonsia larcomensis	Mt Larcom Silk Pod	V	7		No. Occurs at heights from 350 to 750m above sea level
Pimelea		V	1		No. Suitable soils and vegetation types not present

Scientific Name	Common Name	EPBC Act Status	Records within: GRC area	25 km of HHI	Suitable habitat on HHI? (1)
leptospermoides					on HHI.
Samadera bidwillii (Quassia bidwillii)		V	4		No. Suitable soils and vegetation types not present on HHI.
Sophora fraseri	brush sophora	V	3		No. Suitable soils and vegetation types not present on HHI.
Triunia robusta		E	2		No. Occurs near streams and rivers.
Xanthostemon oppositifolius	southern penda	V	3		No. Commonly found along watercourses. Suitable vegetation types not present on HHI.

*E = Endangered; V= Vulnerable, NT = Near threatened
(1) Based on SEWPaC Species Profile and Threats Database

In terms of unique flora values, Batianoff and Dillewaard (1996) investigated the flora of GBR continental islands, with some surprising results, including the following:

- There are only three endemic species across the entire GBRMP, of a total of 2,195 species known from the continental Islands. The vast majority of the continental Island flora (99.86%) is also represented on the mainland
- There are low levels of dissimilarity (in terms of species composition) between and across continental Islands of the GBR, spanning from the wet tropics south to the Capricorn region.

No EVNT or threatened flora species have been recorded on HHI during the surveys undertaken between 1993 and 2007. The likelihood of occurrence of flora listed under the EPBC Act is discussed in Section 7.4.3.15.

Levels of weed infestation are generally low, however a number of weeds have been identified on HHI during field surveys including groundsel (*Baccharis halimiflora*), lantana (*Lantana camara, Lantana montevidensis*), and prickly pear (*Opuntia stricta v stricta*). Rubber vine (*Cryptostegia grandiflora*) has spread through the littoral vine thicket community.

6.7.5 Terrestrial Fauna

6.7.5.1 Introduction

This section presents results of field surveys which have been undertaken over a period of 20 years. The surveys found that HHI has relatively low fauna species diversity, likely due to a combination of the lack of permanent freshwater on the island, being fully isolated from the mainland and historic grazing and burning regimes.

For fauna species listed as threatened or migratory under the EPBC Act, further information, including a more detailed assessment of likelihood of occurrence is provided in Sections 7.4 and 7.5 respectively.

6.7.5.2 Birds

One-hundred and twenty-five species of avifauna have been recorded from the Island by the collective surveys of Bill Carter and Associates in 1988 reported in AGC Woodward-Clyde (1993), AGC Woodward-Clyde (1993), Dames and Moore (1995), CQU (2006) and SKM (2007), these are listed in Table 6.37. Several rare or threatened species have been recorded, namely the black-breasted button-quail, beach thick-knee and eastern curlew.

The diversity of species observed is typical of a coastal habitat mosaic which includes terrestrial and marine ecosystems.

Table 6.37 - Avifauna Recorded from the Study Area

Family	Scientific Name	Common Name	EPBC Act Status
Megapodidae	*Alectura lathami*	Australian brush-turkey	N
Phasianidae	*Coturnix ypsilophora*	brown quail	N
Turnicidae	*Turnix melanogaster*	black-breasted button-quail[11]	V
Anatidae	*Dendrocygna eytoni*	plumed whistling-duck	N
	Anas gibberifrons	grey teal	N
	Cygnus atratus	black swan	N
	Chenonetta jubata	Australian wood duck	N
	Anas superciliosa	Pacific black duck	N
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe	N
Anhingidae	*Anhinga melanogaster*	darter	N
Phalacrocoracidae	*Phalacrocorax melanoleucos*	little pied cormorant	N
	Phalacrocorax varius	pied cormorant	N

[11] The characteristic platelets of a Button-quail have been recorded the Littoral Vineforest community east of the headland. Based on habitat preferences in the region, these are likely to have been made by Turnix melanogaster. Other, more common quail species do not create platelets.

Family	Scientific Name	Common Name	EPBC Act Status
	Phalacrocorax sulcirostris	little black cormorant	N
	Phalacrocorax carbo	great cormorant	N
Pelecanidae	*Pelecanus conspicillatus*	Australian pelican	Ma
Ardeidae	*Egretta novaehollandiae*	white-faced heron	N
	Ardea alba	great egret	M, Ma
	Ardea intermedia	intermediate egret	Ma
	Ardea ibis	cattle egret	M, Ma
	Nycticorax caledonicus	nankeen night heron	N
Threskiornithidae	*Threskiornis molucca*	Australian white ibis	Ma
	Threskiornis spinicollis	straw-necked ibis	Ma
	Platalea regia	royal spoonbill	N
Accipitridae	*Accipter cirrhocephalus*	collared sparrohawk	N
	Accipter fasciatus	brown goshawk	N
	Aviceda subcristata	Pacific baza	N
	Pandion haliaetus	osprey	M, Ma
	Elanus axillaris	black-shouldered kite	N
	Haliastur sphenurus	whistling kite	Ma
	Haliaeetus leucogaster	white-bellied sea-eagle	M, Ma
	Aquila audax	wedge-tailed eagle	N
Falconidae	*Falco cenchroides*	nankeen kestrel	Ma
Rallidae	*Porphyrio porphyrio*	purple swamphen	Ma
	Gallinula tenebrosa	dusky moorhen	N
	Fulica atra	Eurasian coot	N
Scolopacidae	*Numenius madagascariensis*	eastern curlew	M
	Numenius phaeopus	whimbrel	M
	Tringa nebularia	common greenshank	M
	Tringa stagnatilis	marsh sandpiper	M
	Limosa lapponica	bar-tailed godwit	M
Jacanidae	*Irediparra gallinacean*	comb-crested jacana	N
Buhinidae	*Burhinus neglectus*	beach thick-knee	V
Haematopodidae	*Haematopus longirostris*	pied oystercatcher	M
	Haematopus fuliginosus	sooty oystercatcher	M
Charadriidae	*Elseyornis melanops*	black-fronted dotterel	M
	Vanellus miles	masked lapwing	
	Charadrius mongolus	lesser sand plover	M
	Charadrius leschenaultia	greater sand plover	M

Family	Scientific Name	Common Name	EPBC Act Status
	Charadrius ruficapillus	red-capped dotterel	M
Laridae	*Sterna caspia*	caspian tern	N
	Sterna albifrons	little tern	N
	Sterna bergii	crested tern	N
Columbidae	*Phaps chalcoptera*	common bronzewing	N
	Ocyphaps lophotes	crested pigeon	N
	Geopelia striata	peaceful dove	N
	Geopelia humeralis	bar-shouldered dove	N
Cacatuidae	*Calyptorhynchus banksii*	red-tailed black-cockatoo	N
	Calyptorhynchus funereus	yellow-tailed black-cockatoo	N
	Cacatua roseicapilla	galah	N
	Cacatua galerita	sulphur-crested cockatoo	N
Psittacidae	*Trichoglossus haematodus*	rainbow lorikeet	N
	Trichoglossus chlorolepidotus	scaly-breasted lorikeet	N
	Glossopsitta pusilla	little lorikeet	N
	Aprosmictus erythropterus	red-winged parrot	N
	Platycercus adscitus	pale-headed rosella	N
Cuculidae	*Cacomantis variolosus*	brush cuckoo	N
	Cuculus saturates	oriental cuckoo	N
	Eudynamys scolopacea	common koel	Ma
	Scythrops novaehollandiae	channel-billed cuckoo	Ma
Centropodidae	*Centropus phasianinus*	pheasant coucal	N
Strigidae	*Ninox connivens*	barking owl	N
	Ninox novaeseelandiae	southern boobook	N
Tytonidae	*Tyto alba*	barn owl	N
Podargidae	*Podargus strigoides*	tawny frogmouth	N
Caprimulgidae	*Eurostopodus mystacalis*	white-throated nightjar	Ma
Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar	N
Alcedinidae	*Alcedo azurea*	azure kingfisher	N
Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra	N
	Todiramphus macleayii	forest kingfisher	Ma
	Halcyon chloris	collared kingfisher	N
Meropidae	*Merops ornatus*	rainbow bee-eater	M
Coraciidae	*Eurystomus orientalis*	dollarbird	Ma
Maluridae	*Malurus lamberti*	variegated fairy-wren	N
	Malurus melanocephalus	red-backed fairy-wren	N

Family	Scientific Name	Common Name	EPBC Act Status
Pardalotidae	*Pardalotus punctatus*	spotted pardalote	N
	Pardalotus striatus	striated pardalote	N
	Gerygone laevigaster	mangrove gerygone	N
	Gerygone olivacea	white-throated gerygone	N
	Gerygone palpebrosa	fairy gerygone	N
	Smicrornis brevirostris	weebill	N
Meliphagidae	*Philemon citreogularis*	little friarbird	N
	Philemon corniculatus	noisy friarbird	N
	Entomyzon cyanotis	blue-faced honeyeater	N
	Manorina melanocephala	noisy miner	N
	Meliphaga lewinii	Lewin's honeyeater	N
	Lichenostomus chrysops	yellow-faced honeyeater	N
	Lichenostomus fsciogularis	mangrove honeyeater	N
	Melithreptus albogularis	white-throated honeyeater	N
	Lichmera indistinct	brown honeyeater	N
	Myzomela obscura	dusky honeyeater	N
Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler	N
Pachycephalidae	*Pachycephala pectoralis*	golden whistler	N
	Pachycephala rufiventris	rufous whistler	N
	Colluricincla harmonica	grey shrike-thrush	N
	Colluricincla megarhyncha	little shrike-thrush	N
Dicruridae	*Monarcha leucotis*	white-eared monarch	N
	Monarcha melanopsis	black-faced monarch	Ma
	Myiagra rubecula	leaden flycatcher	N
	Grallina cyanoleuca	magpie-lark	Ma
	Rhipidura rufifrons	rufous fantail	Ma
	Rhipidura leucophrys	willie wagtail	N
	Dicrurus bracteatus	spangled drongo	Ma
Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike	Ma
	Coracina papuensis	white-bellied cuckoo-shrike	Ma
	Coracina tenuirostris	cicadabird	Ma
	Lalage leucomela	varied triller	N
Oriolidae	*Oriolus sagittatus*	olive-backed oriole	N
	Sphecotheres viridis	figbird	N
Artamidae	*Artamus leucorhynchus*	white-breasted woodswallow	N
	Cracticus torquatus	grey butcherbird	N

Family	Scientific Name	Common Name	EPBC Act Status
	Cracticus nigrogularis	pied butcherbird	N
	Gymnorhina tibicen	Australian magpie	N
Corvidae	*Corvus orru*	torresian crow	N
Corcoracidae	*Corcorax melanorhamphos*	white-winged chough	N
Passeridae	*Taeniopygia bichenovii*	double-barred finch	N
	Neochmia temporalis	red-browed finch	N
Dicaeidae	*Dicaeum hirundinaceum*	mistletoebird	N
Hirundinidae	*Hirundapus caudacutus*	spine-tailed swift	M
	Hirundo neoxena	welcome swallow	Ma
	Hirundo ariel	fairy martin	N
Motacillidae	*Anthus novaeseelandiae*	Richard's Pipit	N
Sylviidae	*Megalurus timoriensis*	tawny grassbird	N
	Cisticola exilis	golden-headed cisticola	N
Zosteropidae	*Zosterops lateralis*	silvereye	Ma

N = Not Listed Ma = Marine M = Migratory V = Vulnerable

6.7.5.3 Mammals

Thirty-three species of mammal have been recorded from the Island by the collective surveys of Bill Carter and Associates in 1988 reported in AGC Woodward-Clyde (1993), AGC Woodward-Clyde (1993), Dames & Moore (1995), CQU (2006) and SKM (2007), these are listed in Table 6.38. The species assemblage observed is typical of coastal habitats in the region.

A single threatened mammal species has been recorded, namely the grey-headed flying fox which is considered vulnerable under the EPBC Act. This species was observed foraging on the island, but no roosts of this or other bats (flying fox or microbat) species were observed (see also Section 7.4.3.3).

The Wildlife Online database also contains records of sightings of the EPBC Act vulnerable water mouse. Surveys undertaken on HHI have not recorded this species, including targeted trapping surveys in the vicinity of the proposed boat ramp and bridge, however suitable habitat is present (see also Section 7.4.3.1).

Table 6.38 - Mammals Recorded from the Study Area

Family	Scientific Name	Common Name	EPBC Act Status
Tachyglossidae	*Tachyglossus aculeatus*	echidna	N
Peramelidae	*Isoodon macrourus*	northern brown bandicoot	N
Phalangeridae	*Trichosurus vulpecula*	common brushtail possum	N
Petauridae	*Petaurus breviceps*	sugar glider	N
	Petaurus norfolcensis	squirrel glider	N
Pseudocheiridae	*Petauroides volans*	greater glider	N
	Pseudocheirus peregrinus	common ringtail possum	N
Macropodidae	*Macropus giganteus*	eastern grey kangaroo	N
	Macropus parryi	whiptail wallaby	N
	Wallabia bicolour	swamp wallaby	N
Pteropidae	*Nyctimene robinsoni*	eastern tube-nosed bat	N
	Pteropus poliocephalus	grey-headed flying fox	V
	Pteropus scapulatus	little Red Flying Fox	N
Rhinolophidae	*Rhinolophous megaphyllus*	eastern Horseshoe bat	N
Molossidae	*Saccolaimus flaviventris*	yellow-bellied sheathtail bat	N
	Tadarida australis	white-striped mastiff bat	N
Vespertillionidae	*Chalinolobous gouldi*	Gould's wattled bat	N
	Chalinolobous morio	chocolate wattled bat	N
	Chalinolobous nigrogriseus	hoary wattled bat	N
	Miniopterus australis	little bentwing bat	N
	Mormopterus beccari	Becarri's mastiff bat	N
	Mormopterus norfolkensis	eastern freetail bat	N
	Mormopterus species 2.	a freetail bat	N
	Myotis macropus	southern myotis	N
	Nyctophilus bifax	northern long-eared bat	N
	Scotorepens sanborni	northern broad-nosed bat	N
	Vespadelus pumilis	eastern Forest Bat	N
Muridae	*Mus musculus*	house mouse	N
	Rattus fuscipes	bush rat	N
Canidae	*Canis familiaris*	dog	N
Felidae	*Felis cattus*	cat	N
Bovidae	*Bos taurus*	cow	N
Leporidae	*Oryctolagus cuniculus*	hare	N

N = Not Listed Ma = Marine I = Introduced M = Migratory V = Vulnerable

6.7.5.4 Reptiles

A total of fourteen terrestrial reptile species has been recorded from the Island by the collective surveys of Bill Carter and Associates in 1988 reported in AGC Woodward-Clyde (1993), AGC Woodward-Clyde (1993), Dames and Moore (1995), CQU (2006) and SKM (2007), these are listed in Table 6.39. None of the species recorded are identified as EVNT in Queensland under the NC Act or listed as threatened under the EPBC Act.

Table 6.39 - Reptiles Recorded from the Study Area

Family	Scientific Name	Common Name	EPBC Act Status
Scincidae	*Carlia folorium*		N
	Carlia pectoralis		N
	Cryptoblepharus virgatus	wall skink	N
	Ctenotus robustus	eastern striped skink	N
	Ctenotus taeniolatus	copper-tailed skink	N
	Lerista fragilis	eastern mulch-slider	N
Gekkonidae	*Gehyra dubia*	tree dtella	N
	Heteronotia bynoei	Bynoe's gecko	N
	Oedura rhombifer	zigzag velvet gecko	N
Agamidae	*Diporiphora australis*	eastern two-lined dragon	N
	Pogona barbata	bearded dragon	N
Varanidae	*Varanus gouldi*	sand monitor	N
Colubridae	*Denrelaphis punctulata*	common tree snake	N
Elapidae	*Pseudechis porphyriacus*	red-bellied black snake	N

6.7.5.5 Amphibians

A total of five amphibian species has been recorded from the Island by the collective surveys of Bill Carter and Associates in 1988 reported in AGC Woodward-Clyde (1993), AGC Woodward-Clyde (1993), Dames and Moore (1995), CQU (2006) and SKM (2007), these are listed in Table 6.40. None of the species recorded are considered to be rare or threatened in Queensland or at a National level. A substantial nocturnal survey effort has been expended by numerous observers over an extended period, suggesting that amphibian survey effort has been adequate and that the low diversity of species recorded is indicative of low habitat quality.

Table 6.40 - Amphibians Recorded from the Study Area

Family	Scientific Name	Common Name	EPBC Act Status
Myobatrachidae	*Limnodynastes peroni*	striped marsh frog	N
Hylidae	*Litoria fallax*	eastern dwarf tree frog	N
	Litoria gracilenta	dainty tree frog	N
	Litoria rubella	desert tree frog	N
Bufonidae	*Bufo marinus*	cane toad	N

HHI has been searched by ecologists on four occasions over a 15 year period and during a range of seasons with particular emphasis on the locating the wallum froglet in the wetter areas of the island. As the species is highly vocal during all months of the year in response to rainfall, it would have been recorded if present.

Moreover, the wallum froglet reaches its northern distributional limit on the mainland at Litabella National Park near Bundaberg. It has never been recorded north of that location despite intensive search effort by many observers at many sites. The Litabella National Park population remains questioned (Hines *et al*. 1999). Surveys of apparently suitable habitat in the mainland at Turkey Beach in 2005 revealed the occurrence of large populations of *Crinia parinsignifera*, which is easily confused by inexperienced observers with *Crinia tinnula* (J. Richard, per obs). This observation adds weight to the suggestion that the Litabella National Park population may have been misidentified. Not only are essential microhabitats for the species lacking on HHI, the area does not lie within the known distribution of the species.

6.7.6 *Migratory Shorebirds*

6.7.6.1 *Field Survey Findings*

AGC Woodward-Clyde (1993) and Dames & Moore (1995) recorded five migratory shorebird species on HHI and SKM (2007) recorded seven species, all of which were also recorded in the 2011/2012 surveys undertaken for GPC.

Surveys conducted by SKM during March 2007 recorded a concentration of shorebird activity on the landward side of the Island, where extensive intertidal wetlands, marine plains and saltmarshes occur. A targeted search effort over five days on the eastern and northern ocean beaches, the bridge site and other accessible intertidal areas recorded only a small number of Lesser and greater sand plovers and red-capped plovers, which are common species on sandy beaches in the region. Other species are likely to occur occasionally, however, habitat of highest quality is associated with marine deposits.

The GPC surveys are significantly more extensive, covering migratory shorebird roosting and foraging habitat from the mouth of the Fitzroy River to Rodds Peninsula. Hummock Hill Island falls within the Mundoolin/Colosseum grouping of sites, with the other groupings of sites being Port Curtis, Fitzroy Estuary, North Curtis and Rodds Peninsula. While there are variations in the species present and abundance of species at sites in each of these groupings, each grouping provides significant migratory shorebird habitat, with results of the 2013 summer survey shown in Table 6.41. Note that the survey report identified possible decreased numbers at Port Curtis associated with dredging and large industrial projects under construction.

Table 6.41 – Comparison between Shorebird Sites – 2013 Summer Survey (Wildlife Unlimited May 2013)

	Port Curtis	Fitzroy Estuary	North Curtis	Mundoolin Colosseum	Rodds Peninsula
Total Birds	2170	2562	2296	3250	602
Total Species	13	15	13	16	8
Number of sites (high and low tide)	41	29	35	31	20

The GPC surveys (GHD 2011a,b,c,d; Sandpiper Ecological Surveys 2012a,b,c; Wildlife Unlimited 2012) recorded a total of 24 migratory shorebird species within the review study area, including 22 species within the Mundoolin/Colosseum survey area and 15 species within the Rodds Peninsula survey area (Table 6.42). As HHI lies within the Mundoolin/Colosseum conglomerate of sites, and near Rodds Bay, survey results for these two site groupings are examined in more detail.

In total, 24 migratory shorebird species have been recorded in the study area during previous surveys included in the review. The EPBC Act protected matters search tool database predicted the occurrence of 19 migratory shorebird species on HHI, including one species, little curlew, *Numenius minutes*, that has not been recorded within the study area (Table 6.42). All species recorded are of least concern in relation to conservation status except for eastern curlew, *Numenius madagascariensis*, which is listed as Near Threatened under the *Nature Conservation Act 1992*.

Table 6.42 - Migratory Shorebirds Recorded in Database Searches and Field Surveys of HHI, Mundoolin/Colosseum (MC) and Rodds Peninsula (RP)

Scientific name	Common name	Status		PM	IAS	EIS	GPC	
		EPBC	NC Act	HHI	HHI	HHI	MC	RP
Pluvialis fulva	Pacific golden plover	M	LC	X			X	X
Pluvialis squatarola	grey plover	M	LC	X			X	X
Charadrius bicincutus	double-banded plover	M	LC				X	
Charadrius mongolus	lesser sand-plover	M	LC	X	X	X	X	X
Charadrius leschenaultii	greater sand-plover	M	LC	X		X	X	X
Gallinago hardwickii	Latham's Snipe	M	LC	X			X	
Limosa lapponica	bar-tailed godwit	M	LC	X	X	X	X	X
Limosa limosa	black-tailed godwit	M	LC	X			X	
Numenius madagascariensis	eastern curlew	M	NT	X	X	X	X	X
Numenius phaeopus	whimbrel	M	LC	X		X	X	X
Numenius minutus	little curlew	M	LC	X				
Xenus cinereus	terek sandpiper	M	LC	X			X	X
Tringa brevipes	grey-tailed tattler	M	LC	X			X	X
Tringa incana	wandering tattler	M	LC					X
Tringa nebularia	common greenshank	M	LC			X	X	X
Arenaria interpres	ruddy turnstone	M	LC	X			X	X
Calidris tenuirostris	great knot	M	LC	X			X	X
Calidris canutus	red knot	M	LC	X			X	
Calidris alba	sanderling	M	LC				X	
Calidris ruficollis	red-necked stint	M	LC	X			X	X
Calidris acuminata	sharp-tailed sandpiper	M	LC	X	X		X	
Calidris ferruginea	curlew sandpiper	M	LC	X			X	
Limicola falcinellus	broad-billed sandpiper	M	LC				X	
Tringa stagnatilis	marsh sandpiper	M	LC			X	X	
Actitis hypoleucos	common sandpiper	M	LC	X	X			X

Abbreviations: NC Act – *Nature Conservation Act 1992*; PM = EPBC Act Protected Matters Search Tool Database; IAS = surveys undertaken for the IAS and IAS Supplement (AGC Woodward-Clyde 1993; Dames & Moore 1995); EIS = combined results of IAS surveys and surveys undertaken for the EIS (SKM 2007); GBC = surveys undertaken on behalf of Gladstone Ports Corporation in 2011 and 2012 (GHD 2011a,b,c,d; Sandpiper Ecological Surveys 2012a,b,c; Wildlife Unlimited 2012); M = Migratory; NT = Near Threatened; X = species recorded.

6.7.6.2 Migratory Shorebird Populations

Of the studies included in this review, only the GPC surveys reported total migratory shorebird population sizes. These surveys recorded a total population size of between 830 and 3,264 migratory shorebirds in the combined Mundoolin/Colosseum and Rodds Peninsula survey areas (Table 6.43).

Migratory bird data from the range of studies undertaken was reviewed, collated and analysed by BAAM (2013, Appendix E). Given that migratory shorebirds move regularly between feeding and roosting areas, the Rodds Peninsula and Mundoolin/Colosseum areas are considered by BAAM as a conglomerate site, as shown on Figure 6.55, which includes migratory shorebird habitat on HHI as well as on the adjacent mainland.

As expected, winter (August) counts were lower than summer (November to March) counts; most migratory shorebirds migrate to northern hemisphere breeding grounds during the austral winter. The total population size exceeded 2,000 birds in nearly all summer counts (Table 6.43). Overall, 72% of the migratory shorebird population in the Mundoolin/Colosseum/Rodds Peninsula area roosted at roost sites in the Mundoolin/Colosseum survey area and 28% in the Rodds Peninsula survey area. Roost sites on HHI accounted for 13% of migratory shorebirds roosting within the Mundoolin/Colosseum survey area during the five of the nine surveys where roosting totals were reported for each roost site individually.

Table 6.43 - Total Migratory Shorebird Population Sizes

Month	Sites Surveyed			Migratory Shorebird Population		
	MC	RP	Total	MC	RP	Total
Jan-2011	16	18	34	1,747 (49)	1,241	2,988
Feb-2011	27	?*	?*	2,121	550	2,671
Mar-2011	23	?*	?*	1,784	412	2,196
Aug-2011	26	18	44	498	332	830
Jan-2012	24	20	44	1,908 (105)	967	2,875
Feb-2012	27	22	49	2,467 (98)	797	3,264
Mar-2012	24	21	45	1,457 (117)	509	1,966
Aug-2012	24	18	42	697	630	1,327
Oct-2012	25	20	45	2,546 (1034)	851	3,397

* Reported site totals included sites outside the Rodds Peninsula survey area.

Numbers in parentheses are totals for high tide roost sites on HHI, reported for five surveys where these data could be distinguished.

Due to some survey limitations, the population totals reported in Table 6.44 should be regarded as minimum estimates (see also Appendix E). Nonetheless, the surveys of the Mundoolin / Colosseum and Rodds Peninsula survey areas appear to have consistently surveyed the most important roosting sites, including the most important roost sites reported by Driscoll (1996), so are likely to have surveyed the majority of migratory shorebirds present in these areas.

The combined Mundoolin/Colosseum and Rodds Peninsula area supports a varying proportion of the East Asian-Australasian flyway population of different migratory shorebird species, with the maximum counts exceeding 0.1% of the flyway population for ten species and 1% of the flyway population for one species (Table 6.44). The relevance of these data is discussed below.

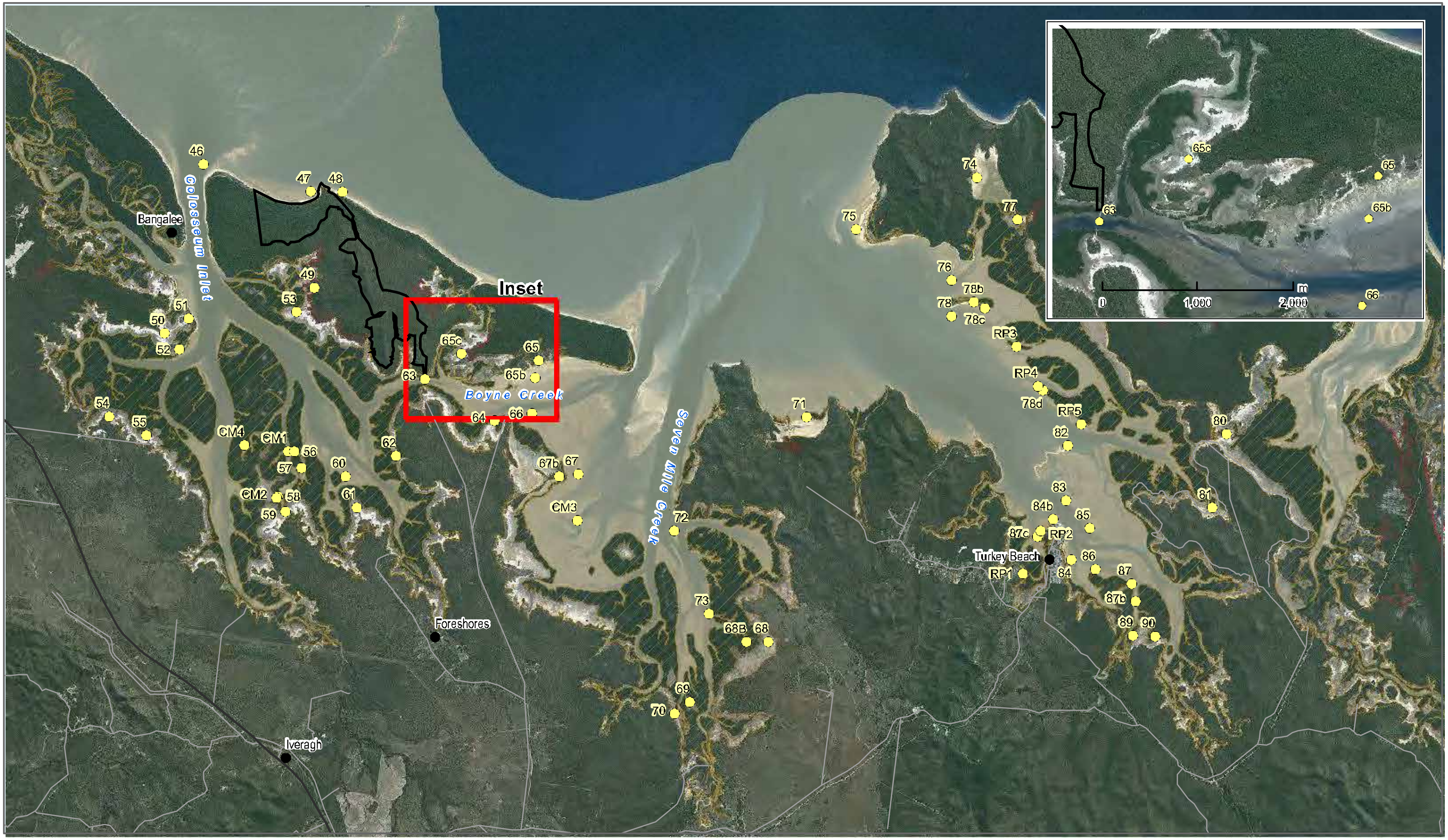
6.7.6.3 Roosting Habitat

The GPC surveys identified a total of 62 shorebird roost sites in the study area, 37 in the Mundoolin/Colosseum survey area and 26 in the Rodds Peninsula survey area (GHD 2011a,b,c,d; Sandpiper Ecological Surveys 2012a,b,c; Wildlife Unlimited 2012) (Figure 6.56).

Roosting sites occur on claypans, sand banks, sandy beaches, rocky points and in fringing mangroves. The use of particular roost sites varied with the tidal cycle; during neap tides shorebirds occurred in smaller flocks over a wider area, becoming more concentrated at fewer sites during spring high tides.

During the GPC surveys, the maximum high tide count exceeded 1,000 shorebirds at two sites in the Mundoolin/Colosseum survey area (sites 65 and 67), and exceed 300 shorebirds at two sites in the Mundoolin/Colosseum survey area (sites 64/66 and 71) and two sites in the Rodds Peninsula survey area (sites 75 and 76). By comparison, Driscoll (1996) reported two sites exceeding a maximum high tide shorebird count of 1,000 birds, one in the Mundoolin/Colosseum survey area (equivalent to site 66) and one in the Rodds Peninsula survey area (site 75), and two sites exceeding 300 shorebirds in the Rodds Peninsula survey area (sites 75 and 76).

HHI supports nine roost sites (see Figure 6.56) and approximately 13% of the Mundoolin/Colosseum roosting population overall. Based on the results of five surveys that reported counts for individual roost sites (GHD 2011a; Sandpiper Ecological Surveys 2012a,b,c), the most important roosting areas is three roost sites in the southeast (numbers 65a,b,c on Figure 6.56) that supported up to 993 migratory shorebirds. Two roost sites on the central west shoreline (numbers 49 and 53) together supported up to 47 migratory shorebirds (see Appendix E, Table A1.3). The remaining roost sites appear to be of very minor importance; three roosts (numbers 46, 47 and 48) on the sandy coastline in the northwest of the island together supported up to five migratory shorebirds, and one roost site at the causeway (site 63) supported up to only one migratory shorebird.



LEGEND

- Towns
- High Tide Roosting Locations
- Main Roads
- Roads
- Development Footprint

Wetland Areas

- Palustrine
- Intertidal Estuarine
- Estuarine

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Figure 6.56 - Migratory Shorebird Intertidal Foraging Habitat - Mundoolin-Colosseum and Rodds Bay Survey areas

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Table 6.44 - Total Counts of Each Migratory Shorebird Species Recorded During Each Survey Event

Species	Jan-11	Feb-11	Mar-11	Aug-11	Jan-12	Feb-12	Mar-12	Aug-12	Oct-12	Max	0.1% level	% of popln
Pacific golden plover	0	0	0	0	18	13	1	3	10	18	100	0.018
grey plover	12	54	50	5	44	51	58	2	28	58	125	0.046
double-banded Plover	0	0	0	0	0	0	0	1	0	1	50	0.002
lesser Sand-Plover	90	87	66	0	120	261	300	107	209	300	140	0.214
greater Sand-Plover	36	25	70	2	73	3	53	25	112	112	110	0.102
Latham's Snipe	0	0	0	0	0	0	0	0	1	1	100	0.001
bar-tailed godwit	1033	623	575	292	620	969	546	557	772	1,033	325	0.318
black-tailed godwit	0	0	0	2	0	0	0	0	0	2	160	0.001
eastern curlew	217	547	93	303	291	411	66	313	342	547	38	1.439
whimbrel	228	469	299	87	210	273	136	20	159	469	100	0.469
terek sandpiper	153	175	142	0	338	225	90	0	153	338	60	0.563
grey-tailed tattler	99	229	388	78	322	203	371	104	393	393	50	0.786
wandering tattler	0	0	0	0	1	1	1	0	0	1	nd	
common greenshank	15	3	0	0	27	19	6	0	23	27	60	0.045
ruddy turnstone	3	26	58	1	40	41	23	1	20	58	35	0.166
great knot	233	101	148	48	433	368	109	46	513	513	375	0.137
red knot	8	0	8	0	0	0	0	0	16	16	220	0.007
sanderling	0	6	0	0	0	0	0	0	0	6	22	0.027
red-necked stint	329	73	101	11	184	316	200	147	621	621	325	0.191
sharp-tailed sandpiper	0	0	0	0	1	1	0	0	0	1	160	0.001
curlew sandpiper	0	4	14	0	0	0	2	0	25	25	180	0.014
broad-billed sandpiper	0	0	0	0	0	1	0	0	0	1	25	0.004
marsh sandpiper	0	0	0	0	0	0	0	1	0	1	100-1000	0.001
common sandpiper	1	0	0	0	0	0	0	0	0	1	25	0.004
Unidentified	227	249	184	1	153	108	4	0	0	249		
Total	**2,684**	**2,671**	**2,196**	**830**	**2,875**	**3,264**	**1,966**	**1,327**	**3,397**			

Counts highlighted in grey represent counts that exceed 0.1% of the flyway population, and counts in bold text exceed 1% of the flyway population. See Appendix E, Table A1.2 for species count data disaggregated between Mundoolin/Colosseum and Rodds Peninsula areas.

6.7.6.4 *Foraging Habitat*

The GPC surveys mapped migratory shorebird inter-tidal foraging habitats throughout the Mundoolin/Colosseum and Rodds Peninsula area; the distribution of these habitats in the Mundoolin/Colosseum is shown in Figure 6.56, adapted from Figure 5 in GHD (2011c). The total area of intertidal foraging habitat was at least 2,069 ha in the Mundoolin/Colosseum survey area and 1,244 ha in the Rodds Peninsula survey area (GHD 2011c). The principal foraging habitats on HHI are extensive sandy mudflats fringing the south-eastern portion of the island (Figure 6.56).

6.7.7 Movement Corridors

6.7.7.1 *Recognition of Corridor Values on HHI*

State, regional and local corridors in South East Queensland have been identified in the *Biodiversity Planning Assessment (BPA): South East Queensland South Landscape Expert Panel Report* (EPA 2005b). No corridors as defined by this document have been mapped as occurring on the Island. The Biodiversity Planning Assessment itself does, however, recognise HHI as a part of a major Bioregional Corridor, notwithstanding that the site is entirely cut off from the mainland under all tidal conditions.

6.7.7.2 *Site Assessment*

Although subjected to long-term ongoing disturbance by grazing and logging activity, HHI remains largely vegetated, with few canopy gaps exceeding 100 m in width. Fauna movement across the Island is considered to be relatively unrestricted at present due to this high level of connectivity. Exceptions to this general pattern include the following:

- Specialist inhabitants of the littoral vineforest (e.g. black-breasted button quail) are likely to be largely restricted to that vegetation type, with the exception of larger scale dispersal movements (for example, dispersal from the natal range or dispersal following habitat destruction)
- Species typical of riparian zones and wetlands are not provided with an intra-island dispersal pathway, as there are no extensive wetland or waterway systems.

Movement of birds and bats to and from the Island and the mainland are expected to be relatively unrestricted given relatively short dispersal distances. Smaller terrestrial herpetofauna and mammal populations on the Island are likely to be effectively isolated, with a considerable crossing distance across a hostile habitat (estuary) likely to prevent dispersal and negate the value of HHI as dispersal habitat. Larger terrestrial mammals are capable of crossing to the Island on low tide, either by swimming and wading or directly across the constructed causeway. Many larger terrestrial mammals are accomplished swimmers, and would have little difficulty navigating a narrow channel.

LEGEND

Development Footprint

Wildlife Corridor

Figure 6.57 - Post Development Wildlife Corridors

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Further discussion on the potential for fauna listed as threatened under the EPBC Act to migrate between HHI and the mainland is provided in Section 7.4.

HHI is a part of the east Australia flyway for migratory shorebirds, and extensive marine habitats on the landward side of the Island are significant in this regard. This is discussed further in Section 7.5.2.

6.7.8 Insects and Associated Health Risk

HHI supports several habitat types which favour mosquito and biting midge, including ocean beaches, tidal mudflats, mangroves, saltmarshes and estuarine habitats. These habitats therefore represent potential sources of insect pests. Site observations indicate that the greatest abundance of biting insects occurs in estuarine habitats, consistent with patterns of abundance elsewhere. There are very few sources of freshwater which could support populations of floodplain mosquitoes, and this group is unlikely to represent an ongoing management issue.

The development is predominantly located in portions of the Island which are either removed from potential source populations or located on elevated areas with consistent windy conditions. As such, biting insects are considered unlikely to represent a major management issue for the project.

A relatively small proportion of the development is located in an area which could receive insect pests during ideal conditions for dispersal from wetland habitats. Prevailing south-easterly winds could move insect pests into the near-coastal precincts of the development.

No physical modification of biting insect habitat or chemical control is considered necessary or appropriate, given the sensitivity of receiving environments.

6.8 Landscape and Visual Amenity

6.8.1 Landscape Character

Landscape character on the Island has been defined from various elements of land cover, land form and land use.

6.8.1.1 Land Cover

Land cover on HHI is dominated by native woodland and forest. Four major ecosystems have been identified on the Island:

- Grey ironbark woodland in the centre of the island extends along the crest of the main range and down into the plains
- Open dry sclerophyll forests and woodlands in the north section of the island
- Foredune communities along the coast, contain she-oaks, spinifex and a stand of littoral vine forest

- Mangrove, salt marsh and seagrass communities located in the intertidal zone on the southern side of the island.

6.8.1.2 Land Form

Six broad land form patterns are represented on the Island based on MacDonald *et al.* (1990). Table 6.45 outlines and describes the main landforms identified on HHI and Figure 6.2 illustrates the slope and land form analysis in relation to the development footprint.

Table 6.45 - Landform Patterns on HHI (after MacDonald *et al.* 1990)

Landform Pattern	Landform Descriptors
Beaches	Very gently inclined to gently inclined aggraded slopes at <5%, occasionally gently undulating plain with a wave built berm at the slope crest, intertidal.
Sand Plains	Very gently inclined to gently inclined aggraded gently undulating plain with relict parallel beach ridges with slopes between 5-10%.
Tidal Flats	Very gently inclined to gently inclined aggraded gently undulating plain, intertidal.
Colluvial Plains	Gently inclined to moderately inclined aggraded slopes between 5-10% undulating rises typically forming the waning lower slope.
Low Hills	Gently inclined to moderately inclined eroded rolling rises with slopes between 10-20% on granodiorite with occasional tors.
Central Ridge	Moderately inclined to steep ridge with slopes greater the 20% with a crest leading to maximal upper slopes that lead into waning mid and low slopes, eroded, steep low hills to steep hills with drainage depressions and ephemeral creeks.

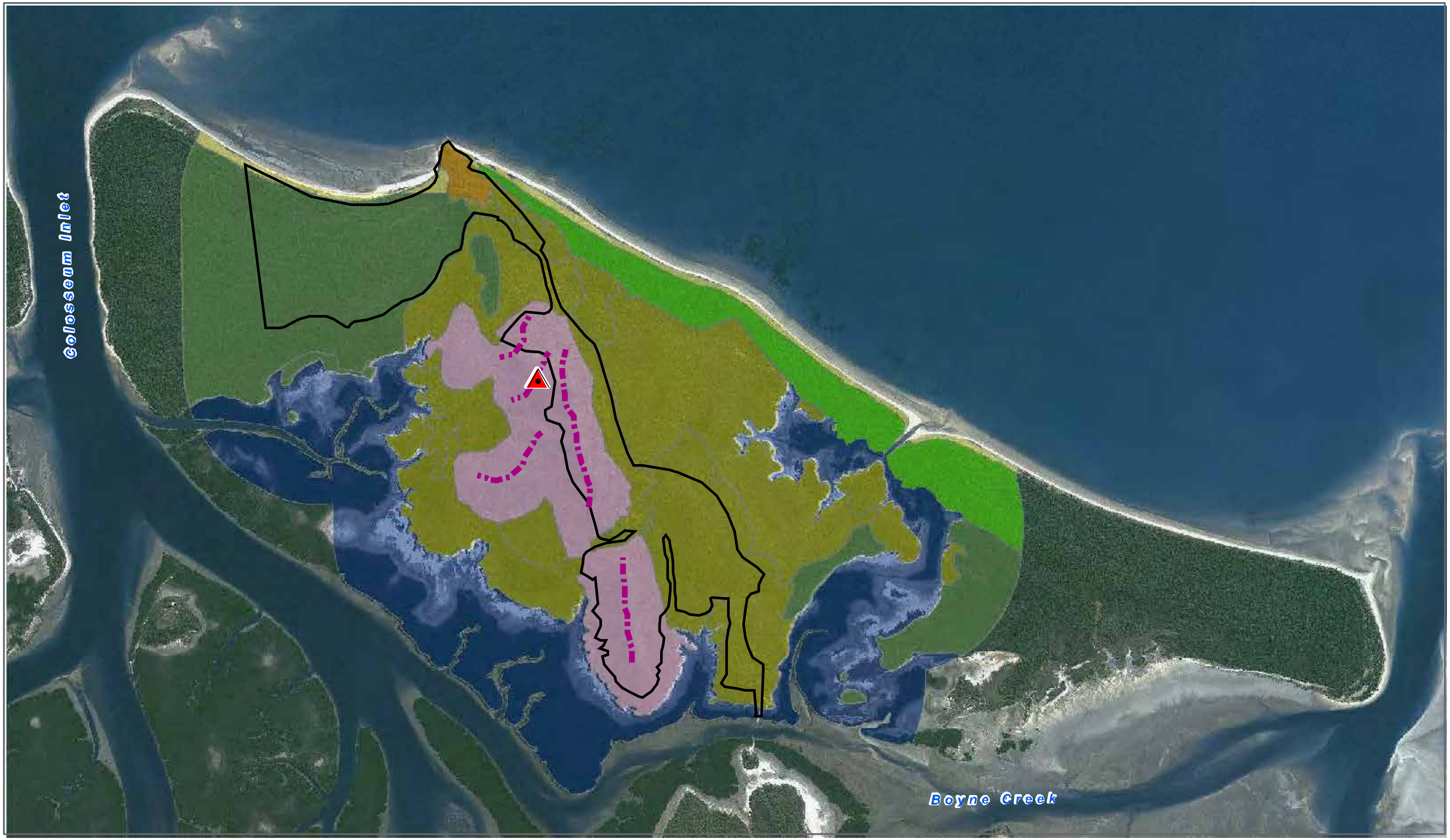
6.8.1.3 Landscape Character Units

Characteristic patterns and combinations of landscape elements which have broadly similar patterns of land cover, land use and land forms can be classified into landscape character units (LCUs) (Landscape Institute with the Institute of Environmental Management and Assessment 2002). The various LCUs are outlined in Table 6.46. Figure 6.58 illustrates the locations and extent of these landscape character units on the Island in relation to the development footprint.

Table 6.46 - Landscape Character Units of HHI

Landscape Character Units	Description of Character Elements	Typical example of Character Unit
LCU-1 Foredunes and Beaches	• The beaches are level to very gentle inclines subject to intermittent submersion from tidal flows • Foredunes consist of gentle sloping and undulating land to very steep embankments • Land cover is dominated by sand deposits containing low grade mineral sands • Along the front of the dunes low lying pioneer species such as coastal spinnifex and creepers dominate • Behind the pioneer species low shrubs and trees such as coastal she oaks at a height of approximately 5 m grade into littoral vine forest greater than 5 m	
LCU-2 Tidal Flats	• Level landform pattern with extremely low relief subject to intermittent submersion • Vegetation is distinct from the sandy regions with salt marshes, mangrove communities, sand and mud flats, and intermittent low density sea grass communities	
LCU – 3 Littoral Vine Forest	• Low lying relict beach ridges and strand plains • Vegetation communities include microphyll/notophyll vine forest • These are the only closed canopy forests on the island • The vine forest appears patchy in the undulating coastal beach ridges/strand plains with dry melaleuca woodlands present in the lower swales • Vegetation heights under 12 m with a dense and closed canopy at around 6 m	
LCU-4 Grassy Woodland on Undulating Plains	• Topography within the LCU is near level to very gently sloping plains and lowland drainage flats and colluvial plains • Open canopy cover dominated typically with mixed eucalypt woodland with grassy understorey and occasional herbs. Occasional melaleuca in lower–lying and depressional areas; casuarinas occur towards the seaward fringe • Below the east facing foot slopes of Hummock Hill the gently sloping outwash plains dominated by poplar box and blue gum.	

Landscape Character Units	Description of Character Elements	Typical example of Character Unit
	• Vegetation is considered "advanced re-growth" after the area was selectively cleared when the island was used for pastoral activities and logging • The evidence of past pastoral activities is scattered throughout the LCU typified by abandoned fences, drains and turkey nest dams • Tree heights are generally above 10 m in height	
LCU -5 Ridgeline Vegetation Communities	• Topography within the LCU contains broad low rounded ridge with marginal slopes in the range 10—20% and steep hilly lands with slopes in the range 20-35% • Partially cleared with mixed open canopied eucalypt woodland on the steeper and lower slope areas predominately ironbark species • A predominantly grassy understorey • Broken views are available from the ridgeline • Tree heights are generally 8 - 15 m in height	
LCU-6 Open Eucalypt Woodland	• Gentle to moderately steep moderate foot slopes on sand plain and relict beach ridges inclined typically <10% mostly in the range 2—5% • Mixed eucalypt woodland chiefly ironbark, bloodwood and Moreton Bay Ash • Tree heights are generally above 10 m in height	
LCU-7 Headland	• Rocky granite outcrop visually prominent component of the northern point of the island approximately 30 m high • Land cover is dominated by grasslands • The headland offers views to the south east along the beaches and foredunes of the island • Landscape exhibits modifications from previous settlements including abandoned homestead, cattle yards and sheds	



LEGEND

Hummock Hill 135-AHD
Main Ridgeline
Development Footprint

Landscape Character Units
LCU 1 - Foredunes and Beaches
LCU 2 - Tidal Wetlands
LCU 3 - Littoral Vine Forest
LCU 4 - Grassy Woodlands
LCU 5 - Ridgeline Communities
LCU 6 - Open Eucalypt Woodland
LCU 7 - Rocky Headland

Figure 6.58 - Landscape Character Units

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6.8.2 Visual Amenity

6.10.1.3 Identification of Viewer Groups and Viewpoint Significance

Appreciation of landscape (and seascape) scenery by various viewer groups and by the community generally is based largely on the landscape features and characteristics visible from public viewpoints (such as lookouts, parks and beaches), from tourist or recreation sites, or while travelling. The viewer groups and viewpoints identified for the project are:

- The Esplanade at Tannum Sands (R1)
- The Beach at Tannum Sands (R2)
- Bangalee (R3)
- Squatters Community (R4)
- Clarks Road (R5)
- Mundoolin Rocks (R6)
- Great Barrier Reef World Heritage Area (R7)
- Great Barrier Reef World Heritage Area (R8)
- Great Barrier Reef World Heritage Area (R9)
- Seal Rocks (R10)
- Gladstone Harbour (R11)
- Aerial View (R12).

The locations of the identified sensitive receptors are presented in Figure 6.59.

In general, various viewer groups (such as tourists, residents, fishing and boating enthusiasts) access different viewpoints and for different lengths of time, have different expectations regarding scenery and also differ in the numbers of people viewing the landscape from any viewpoint (Cardno 2013a). These factors allow viewpoints to be rated according to their significance, as shown in Table 6.47, as an input to mapping and rating the viewsheds of various viewpoints (Figure 6.60).

ID	Sensitive Receptor Location
R1	Tannum Sands Esplanade
R2	Tannum Sands Beach
R3	Bangalee
R4	Squatters Community
R5	Clarks Road
R6	Mundoolin Rocks
R7	GBRWHA
R8	GBRWHA
R9	GBRWHA
R10	Seal Rocks
R11	Gladstone Harbour Channe

LEGEND

- Towns
- Sensitive Receptors
- Development Footprint

Figure 6.59 - Identified Sensitive Receptors of Potential Visual Impacts

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Table 6.47 - Viewer Groups and Viewpoint Significance Levels

Viewer Groups	Viewpoints	Relative Annual Numbers	Likely Relative Scenic Expectations	Distance Range	Viewpoint Significance
Residents and visitors to Tannum Sands	R1, R2	High	High	>10 km (Background)	High
Small communities and residents of Bangalee, Squatters and Mundoolin Rocks	R3, R4 and R6	Low	High	1 km - 6 km (Foreground to Mid-ground)	Moderate
Recreational fishers, divers and other boat and beach users	R5, R10	Low	Medium	1 km - 13 km (Foreground to Background)	Moderate
GBRWHA/GBRMP Tourists	R7, R8 and R9	Medium	High	1 km - 13 km (Foreground to Background)	Moderate
Crew members of ships in the Gladstone Harbour channel	R11	Medium	Low	>13 km (Background)	Low
Viewers from the air	R12	High	Medium	2 km - 8 km (Mid-ground)	Moderate

Viewpoint locations in relation to HHI are illustrated in Figure 6.60 while Table 6.48 describes the views available from the receptors with photographs provided to illustrate.

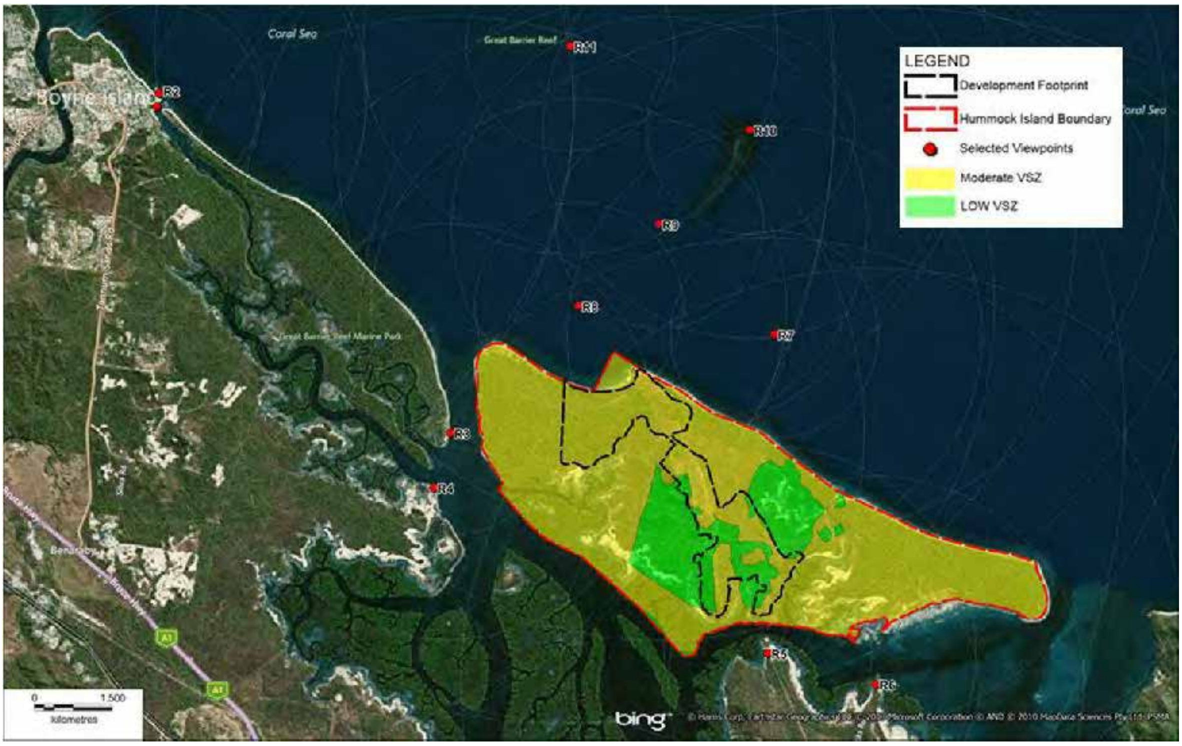


Figure 6.60 - Viewpoints and Composite Viewshed Significance Zones (Cardno 2013a)

Table 6.48 - Views of HHI from Identified Sensitive Receptors

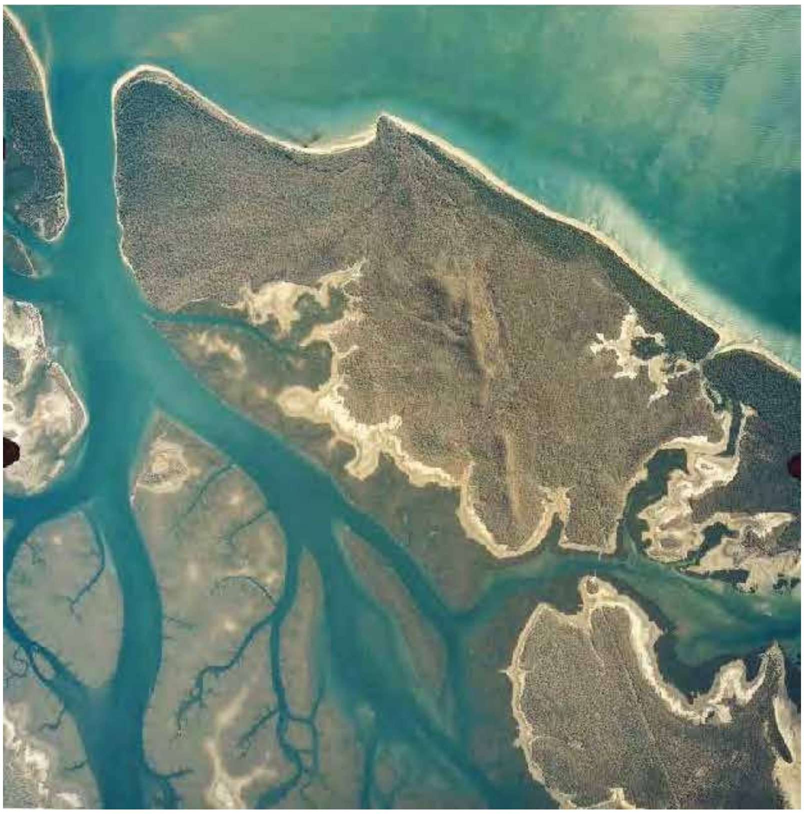
R1 Tannum Sands Esplanade >10 km to the Project	Description of Viewing Outlook
 View from Tannum Sands Esplanade	With extensive views to the south, HHI forms a relatively small proportion of the overall landscape from this location. The view can be described as containing predominately natural characteristics where the natural coastal vegetation and water elements dominate. The northern section of Wild Cattle Island dominates the mid-view with HHI in the background at greater than 10 km from the viewpoint.
R2 Tannum Sands Beach >10 km to the Project	**Description of Viewing Outlook**
 View from Tannum Sands Beach	The visual features looking from this location to the south are dominated by the wide views of the water and nearby coastal vegetation with little or no sign of man-made structures. HHI remains in the background from this viewpoint.

R3 Bangalee 2 km to Western Slopes and >5 km to Southern Ridge	Description of Viewing Outlook
 View from Bangalee (photo taken from water directly in front of Bangalee)	The views over Colosseum Inlet toward the Island are unobstructed with the foreshore vegetation highly visible. The elevated ridge and hillock on HHI are not visible in this view due to screening by the vegetation communities. Viewers from this location would see HHI in the foreground and mid-ground, however given the low viewer numbers the significance of this viewpoint is assessed as Moderate.
R4 Squatter's Community >3 km to the Slopes of Hummock Hill	**Description of Viewing Outlook**
 View from Squatters Community (photo taken from water directly in front of community)	The views from this community to HHI are unobstructed over the water. Hummock Hill and the central ridgeline are visible above the foreshore vegetation. Viewers from this location would see HHI in the mid-ground. Given the low viewer numbers the significance of this viewpoint is assessed as Moderate.

R5 Clarks Road Approximately 0.5 km from the Project	Description of Viewing Outlook
 View from end of Clarks Road at the causeway	The Island is clearly visible from this location due to the close proximity. The southern ridge and hill of the Island visible in the mid-ground. Boyne Creek and the southern coastline of HHI dominate the view. View from this location would be experienced by recreational users accessing the water and HHI via the causeway. Given the low viewer numbers the significance of this viewpoint is assessed as Moderate.
R6 Mundoolin Rocks 2.5 km to the South Eastern Slopes	**Description of Viewing Outlook**
 View from Mundoolin Rocks Settlement (photo taken from water directly in front of the settlement)	The viewing outlook is unobstructed to south eastern sections of the Island. The south eastern slopes of Hummock Hill and the entrance to Sandfly Creek are visible in the foreground and mid-ground. Only the northern landfall of the causeway across Boyne Creek is visible from this location. Given the low viewer numbers the significance of this viewpoint is assessed as Moderate.

R7 GBRWHA Approximately 1 km to Hummock Hill	Description of Viewing Outlook
 View from the north east looking west towards the northern headland	The north eastern slopes of Hummock Hill at 135 m AHD and the central ridgeline form the foreground and mid-ground from this viewpoint. The main beach and littoral vine scrub, along with the low ridge of the colluvial plain are visible from this location. The characteristics of the open woodland canopy is evident with vegetation on the slopes more sparse that the foreshore vegetation. Visitors to the GBRWHA in this location are anticipated to have High Relative Scenic Expectations. The significance of this viewpoint is therefore assessed as Moderate.
R8 GBRWHA Approximately 2 km to Headland (Southern)	**Description of Viewing Outlook**
 View from GBRWHA northern side Island	Hummock Hill forms the mid-ground view from this viewpoint. The headland and north beach are visible. Foreshore vegetation along north beach appears quite dense in comparison to the sloping sections of Hummock Hill where vegetation is less dense. Visitors to the GBRWHA in this location are anticipated to have High Relative Scenic Expectations. The significance of this viewpoint is therefore assessed as Moderate.

R9 GBRWHA 2 km to Headland (Northen)	Description of Viewing Outlook
 View to the south from GBRWHA northern side Island	Dawes Range (on the mainland) is visible to the west, Tannum Sands and Gladstone to the north and uninterrupted views to the horizon over the water to the east. The northern headland and main beach forms the mid-ground view from this location. Visitors to the GBRWHA in this location are anticipated to have High Relative Scenic Expectations. The significance of this viewpoint is therefore assessed as Moderate.
R10 Seal Rocks 6.6 km to Hummock Hill	**Description of Viewing Outlook**
 View from Seal Rocks	Hummock Hill and the North Beach coastline are visible in the background with the Dawes Range to the west of HHI also visible. Looking to the north from this viewpoint, the development of Boyne Island and Tannum Sands are visible. This visibility is increased at night with the urban lighting. To the east north east ships are visible queuing for passage into Gladstone Harbour. In contrast, the view to the south and HHI is largely undeveloped. There are low viewer numbers at the viewpoint, however, they have a moderate Relative Scenic Expectation. The significance of this viewpoint is therefore assessed as Moderate.

R11 Gladstone Harbour Shipping Channel 8.7 km to Hummock Hill	Description of Viewing Outlook
 View from Gladstone Harbour Shipping Channel	HHI forms a small component of the view from this location given the distance. While there are a substantial number of vessel movements through this channel, the nature of the viewers results in significance of this viewpoint being Low.
R12 Aerial View 1.5 km above Hummock Hill	**Description of Viewing Outlook**
 R12 Aerial View (Note: All of the Island is visible from the air)	The waterways and estuary form the dominant view from the air. The rural uses adjacent to the Bruce Highway are also visible when HHI comes into view. The southern expansion of Tannum Sands down the western side of Wild Cattle Creek is clearly viewed from this location. HHI forms a small proportion of the view available. The duration of the view of the Island is relative to the speed of the aircraft. The significance of this viewpoint is Moderate.

6.8.1.4 *Viewing Distance and Viewshed Significant Zones*

As seen from any viewpoint, the visible area (viewshed) comprises near and distant parts of the landscape with the size and visible detail depending on the viewing distance, viewing position and any screening. In addition, distant features occupy a very minor proportion of the viewshed and may be relatively unobtrusive, compared to nearby objects, features and developments. The viewing distances adopted for this study are foreground (0-2 km), mid-ground (2–8 km) and background (>8 km). Areas within the foreground or near mid-ground of high significance viewpoints are less tolerant of visual changes than areas in the background of moderate or low significance viewpoints (Cardno 2013a).

The Viewshed Significance Zones (VSZs) of all 11 land and water based viewpoints have been mapped and combined in a composite VSZ map for HHI. As shown in Figure 6.60, HHI has no areas of High VSZ with most of HHI being 'Moderate' VSZ, including most of the development footprint (Cardno 2013a). The central parts of HHI, including some of the development footprint, are mapped as Low VSZ. This is consistent with the generally low visibility of the island to tourists and highway travellers, its distance from towns and the relatively low numbers of boat-based viewers. However as indicated above, the whole of HHI (including the Low VSZ areas) is visible from commercial aircraft flying into and out of Gladstone (Cardno 2013a).

6.8.1.5 *Desired Visual Outcomes*

Desired Visual Outcomes have been identified to provide visual design objectives against which the project can be assessed. For HHI, the desired visual outcomes have been based on the GBRWHA aesthetic attributes represented on the island as well as the existing landscape character and scenery, within the viewsheds of the identified viewpoints (Cardno 2013a). The desired visual outcomes for areas of high and moderate viewshed significance are more protective of existing landscape values than those for areas of low significance. Desired Visual Outcomes have been defined for each of the VSZs and an assessment undertaken for HHI (Table 6.49).

Table 6.49 - Desired Visual Outcomes and Assessment for HHI

Desired Visual Outcomes	VSZ	Assessment
1. World Heritage Values relating to aesthetic Criterion (vii), and attributes which contribute to these, are not affected	All	This outcome will be achieved (see Chapter 7). The only World Heritage aesthetic attribute which is well represented on HHI (the intertidal mangroves) will not be affected by the development.
2. The existing natural setting of HHI remains visually dominant	All	This outcome will be achieved for viewer groups 1-5. HHI will remain predominantly natural. As seen from most external viewpoints (at viewing distances > 2 km), the development is largely screened by existing vegetation and has low visibility. The small proportion of visible built form will not change the dominant vegetated look of the Island. Built form will be mainly low rise (to 8.5 m height), and even where visible will be below tree canopy height, retaining the wooded skyline. Building design and materials will minimise the intrusiveness of built structures. As viewed from the air (viewer group 6), the development will change the existing character of HHI. Although most of the island will remain in natural condition, the developed areas and the golf course will be visually prominent, in contrast to the surrounding bush and coastline.
3. New built forms, vegetation clearance, operations, night time lighting and earthworks have limited visibility or are hidden from observers at high and moderate viewpoint significance (1 - 4 and 6)	Moderate	This outcome will be achieved for most of the development, mainly as a result of vegetation retention in the wide buffer setbacks from the coastline. Most PTP lighting will be below this tree canopy and screened from external land and seas based observers (viewer groups 1 – 4, and also 5). Hillside buildings and their lights will be visible from offshore viewpoints, but at a distance and seen by relatively few observers. However this relatively minor visual impact (in terms of viewer numbers and distance) is capable of further mitigation at detailed design stage by design, colour, building material and height controls on built form, controls on external lighting in elevated positions, and by landscape planting of street trees and other vegetation. With respect to viewer group 6 (aircraft passengers flying overhead), the PTP cleared areas, buildings, golf course and night-time lighting will be a visual contrast as discussed above for DVO 2.
4. New development does not detract from views of tourists and residents (1, 2 and 4)	Moderate	This outcome will be achieved, Views of mainland residents will include distant glimpses of a limited number of hillside buildings over and behind existing vegetation, and will see some distant lights at night, but this is not expected to detract from their existing coastal views. There are limited tourists in the area at present. Numbers of tourists will increase as a result of the project, but these visitors will not have scenic expectations of an undeveloped island. Some boat and boat ramp users (viewer group 3), plus motorists driving to HHI) will see the bridge and some built form on the hillside.

Desired Visual Outcomes	VSZ	Assessment
5. New built form, vegetation clearance, operations, night time lighting and earthworks are hidden from external views or visible to only a minor degree, remaining visually subordinate to the natural setting of HHI.	Low	This outcome will be achieved. Development in Low VSZ areas is well screened by the existing vegetation and landform.

6.8.2 Great Barrier Reef World Heritage Values

HHI is included within the southern section of the GBRWHA. The GBR is a World Heritage Area because it is of "outstanding universal value", and has been listed for its natural heritage values, including its scenic beauty. The GBRWHA meets Selection Criterion (vii) of the Operational Guidelines for the Implementation of the World Heritage Convention: "*to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance*".

A detailed assessment of the World Heritage Criterion (vii) Aesthetic attributes is contained within Chapter 7.2.2 and in the *Hummock Hill Island EIS Supplementary Visual Impact Report* (Cardno 2013a) contained in Appendix F.

6.9 Air Quality and Noise

6.9.1 Air Quality

Air quality in Queensland is administered under the *Environmental Protection (Air) Policy 2008* EPP(Air). The purpose of the EPP(Air) is to support the *Environmental Protection Act 1994* by:

- Identifying environmental values to be enhanced or protected
- Stating indicators and air quality objectives for enhancing or protecting the environmental values
- Providing a framework for making consistent, equitable and informed decisions about the air environment.

Environmental values of the air environment to be enhanced or protected under this policy are the qualities of the air environment that are conducive to suitability for the life, health and wellbeing of people.

HHI is currently undeveloped with no significant air pollution sources on the island. The main air emissions within the local environment are primarily natural sources, including particulates from ocean salt spray and wind transport of soil from exposed areas. A description of the meteorological influences on air quality and pollution dispersion within the region is provided in Section 6.2. Due to its coastal location, HHI is generally considered to have relatively good air dispersion conditions.

Industrial activities in Gladstone area, 30 km north-west of HHI, generate a range of air emissions from material handling, processing and fuel burning activities, most notably particulate matter, nitrogen oxides and sulfur dioxide, and have the potential to influence air quality at HHI.

The Clean and Healthy Air for Gladstone (DERM 2011) report ambient air quality in the Gladstone area meets current health-based standards or guidelines. The air is not pristine, nor can it be in such an environment. However no obvious health risks were identifiable in the ambient air assessment.

Despite monitoring results stating safe ambient levels in Gladstone, air quality remains a community concern. These concerns have prompted the Queensland Government to initiate a two year study, The Clean and Healthy Air for Gladstone Project. This project was established to gain a better understanding of air pollution in the Gladstone area.

Given these air pollution concentrations and the fact that HHI is generally upwind of Gladstone air emission sources, air quality at the Island is unlikely to pose significant amenity or health impacts to the proposed residential uses associated with the development. A “clean” air shed is likely to be an attractive option to potential visitors and residents.

Identified sensitive receivers are restricted to small communities such as Mundoolin Rocks, south of the Island and Bangalee on the south eastern tip of Wild Cattle Island and transient visitors within the local estuarine system.

6.9.2 Noise

Noise in Queensland is administered under the *Environmental Protection (Noise) Policy 2008*. The purpose of the *Environmental Protection (Noise) Policy 2008* is to support the *Environmental Protection Act 1994*:

- Identifying environmental values to be enhanced or protected
- Stating acoustic quality objectives for enhancing or protecting the environmental values
- Providing a framework for making consistent, equitable and informed decisions about the acoustic environment.

The environmental values to be enhanced or protected under *Environmental Protection (Noise) Policy 2008* are the qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems, the qualities of the acoustic environment that are conducive to human health and wellbeing and the qualities of the acoustic environment that are conducive to protecting the amenity of the community.

There are no specific noise objectives in the *Environmental Protection (Noise) Policy 2008* to protect the health and biodiversity of ecosystems. In areas of conservation significance, the acoustic quality objectives to protect the health and biodiversity of ecosystems will preserve the amenity of the existing area or place

The existing noise environment at the site is expected to be typical of a natural rural environment, dominated by: insects, birds and other wildlife; wind rustling leaves; and wave noise from the nearby ocean.

Transient noise from visiting boats and leisure craft would also contribute to the noise environment within the area surrounding the proposed development. Distant noise from occasional aircraft over flights on their approach to and departure from Gladstone may also occur on occasion.

Given the dominance of natural sources and the absence of industrial or transport related noise contributions to the existing noise environment (which are often associated with nuisance impacts) no baseline noise monitoring was undertaken for the project. Background noise levels were estimated from *AS-1055 - Description and Measurement of Environmental Noise* for areas with negligible transportation density to assist with developing noise level objectives for the project.

Sensitive sites to the development are likely to be the shorebird roosting and foraging areas on the southern fringes of the island.

6.10 Cultural Heritage

6.10.1 Indigenous Cultural Heritage

6.10.1.1 Methodology

Protection of cultural heritage places and values is an important criteria for PTP. The proponent has considered the findings of the cultural heritage surveys conducted with the Traditional Owners to ensure a minimal risk of disturbance.

In keeping with requirements of the part 7 of the *Aboriginal Cultural Heritage Act 2003*, the preparation of an EIS is a trigger for the requirement of a Cultural Heritage Management Plan (CHMP). The CHMP was formally notified to the Port Curtis Coral Coast (QC 01/29 [Q 6026/ 01]) native title claimant group through their applicants. One response was received from Mr Colin Johnson. Mr Johnson was then endorsed by Eaton Place Pty Ltd to be the Aboriginal Party to assist with the development of the CHMP. The CHMP was approved by the Qld DNRW on 17 January 2007.

Mr Johnson instructed that he wished to work through Gidarjil Aboriginal Corporation and requested that other representatives from the native title claimant group also be involved. In response to these instructions, Eaton Place Pty Ltd contacted Gidarjil and informed them of the details of the project. Gidarjil took responsibility for informing the representatives of the Aboriginal Party of the details of the project and for the allocation of representative field researchers for the project. The Aboriginal Party nominated ARCHAEO Cultural Heritage Services as technical advisor to the project and agreed that the survey could take place.

A survey of the Island was instigated by Eaton Place Pty Ltd in response to the requirements of the *Aboriginal Cultural Heritage Act 2003*. The survey was conducted over five days from 6 - 10 November 2006 and was restricted to the physical inspection of those sections of the project area that will be directly disturbed by the development.

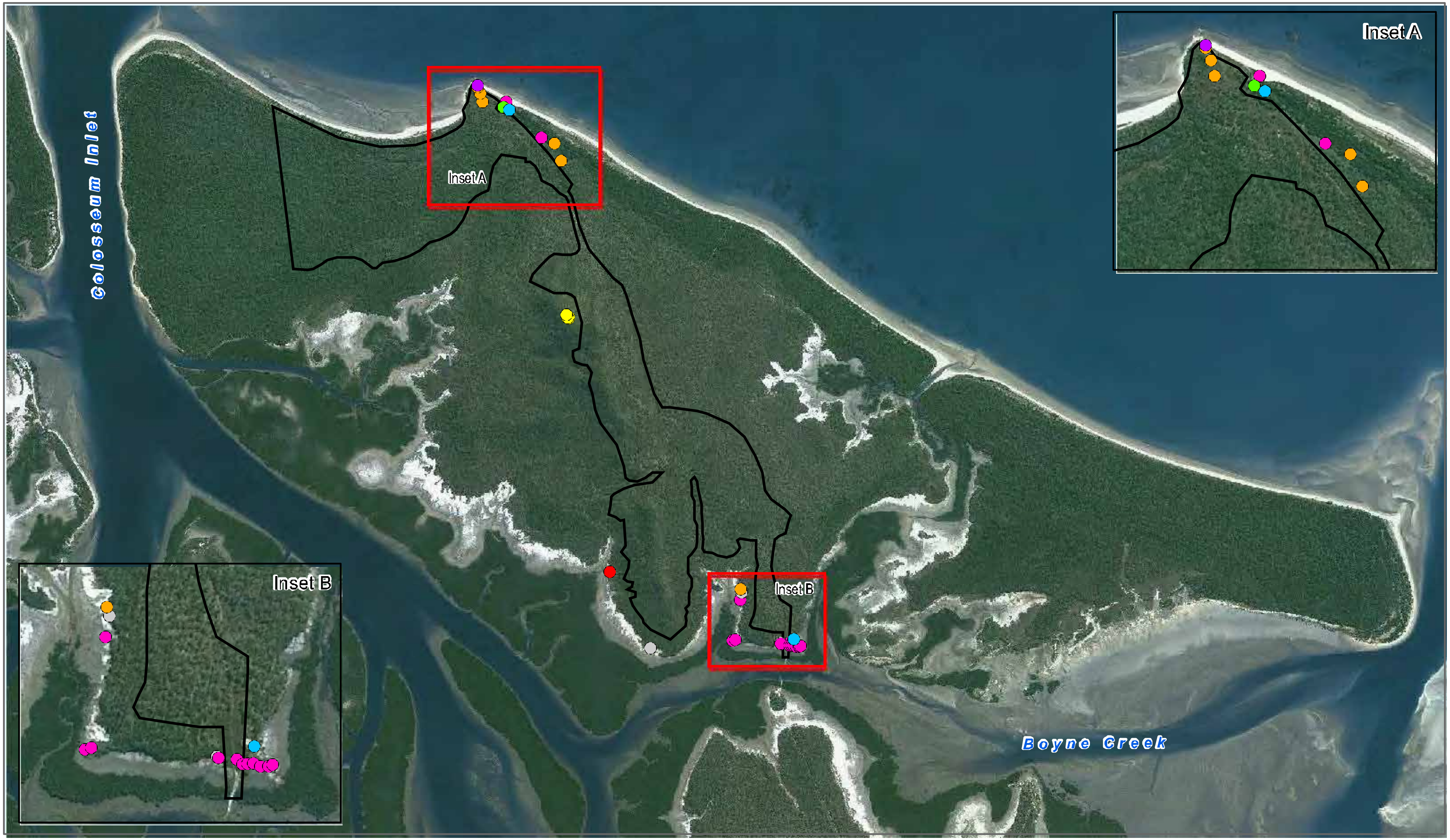
6.10.1.4 Site Searches

A search of the DNRW administered Register and the Database resulted in a number of registered sites being located on HHI, both inside and outside the development area. These sites are outlined in Table 6.50 and on Figure 6.61.

Note: Discrepancies often occur in relation to the co-ordinates of sites recorded on the register and database.

Table 6.50 - List of DNRW Registered Sites within the Project Area on HHI

Site ID	Site Type	Recorder	Location	Notes
JE:A04	Stone Arrangement	G. Alfredson	24°00'43" 151°28'30"	A stone arrangement on the summit of Hummock Hill. Alfredson (1993) identified this site 'as a probable surveyor's trig point' although subsequent research failed to locate supporting evidence Relocated - HH Site 9 - S12A
JE:A41	Shell Midden/Artefact Scatter	H. Johnson	23°59'54" 151°28'20"	Alfredson Site 1 Relocated - HH Site 7– S09
JE:A42	Shell Midden	H. Johnson	24°02'18" 151°29'29"	Alfredson Site 1 Relocated? - HH Site 13– S17?
JE:A43	Shell Midden/Artefact Scatter	H. Johnson	24°02'18" 151°29'22"	Alfredson Site 2 Relocated - HH Site 10– S13
JE:A62	Artefact Scatter	C. Burke	24°00'43" 151°28'44"	Unable to be relocated during present survey
JE:A65	Shell Midden	C. Burke	24°02'18" 151°29'36"	Shell mound with a depth of up to 40 cm. Burke (1993) noted that only a small portion of the site had not been damaged by development activities and water erosion. References: Burke (1993). Alfredson Site 2 Relocated - HH Site 13 - S18&19



LEGEND

- Quartz Flake
- Single Platform Core
- Artefact
- Ceremony Rocks
- Core Silcrete
- Grindstone
- Historic Rocks
- Midden
- Development Footprint

Figure 6.61 - Cultural Heritage Sites

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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6.10.1.5 Field Survey Results

Seventeen specific cultural heritage sites were located during the field survey as presented in Figure 6.62. These sites consisted of:

- 5 x isolated stone artefacts
- 1 x possible ceremonial area
- 3 x artefact scatters (under five artefacts)
- 1 x background degraded shell scatter with associated artefacts
- 4 x shell midden deposits in various levels of erosion and/or disturbance (some with associated stone artefacts including one containing 8 artefacts [HH Site 13 SO17])
- 2 x stone arrangements (one consisting of four individual arrangements – S12A-D)
- 1 x mound (possible midden mound).

TOFOs noted the significance of remnant vegetation across the entirety of the study area and subsequently raised direct concerns relating to the potential impact of the project on such areas. The importance of creek systems, drainage lines and seasonally inundated wetlands were also raised, particularly in relation to the probability that elevated areas located in the vicinity of these waterways would have represented ideal locations for activities such as camping and therefore possess a higher archaeological potential.

Survey emphasis was placed specifically on the following areas:

- Sand ridges, swales and the associated stream and riparian vine thicket located on the northern boundary of the project area east of the headland
- Beach ridges, swales and associated creeks and wetlands west and southwest of the headland
- The foreshore and associated eroded/remnant beach ridges and adjacent areas of elevated land on granodiorite deposits located on the southern, central section of HHI
- The summit of Hummock Hill
- Elevated areas surrounding two dammed creek systems still retaining fresh water (see Figure 6.62).

Figure 6.62 - Cultural Heritage Sites and Archaeological Potential (ARCHAEO 2006)

6.10.2 Non-Indigenous Cultural Heritage

6.10.2.1 Historical Background for the Study Area

Leasehold of Hummock Hill Island

The first known records relating to the tenure of HHI include an 1877 telegraph from Mr Thomas Farmer, requesting clarification of the nature of land tenure for 'Hummocky Island' to the Under Secretary for the Lands Department in Brisbane. At this time it seems that the official nature of land tenure for the Island is unclear.

Correspondence from the District Surveyor in Gladstone in October of 1877 reveals that there was "*currently no lease or ownership over Hummock Hill Island, however cattle from this run (Rodds Bay) do graze over it*" including, "*the running of brood mares*."

A five year lease for the whole Island was offered for the first time at public auction on the 19 February 1878. The lease was for 9 square miles and bids were reserved at 2 pound per square mile. John McLean Bruce was the successful bidder with a final bid of 54 Pounds. Bruce struggled to pay the rent and forfeited the lease in January 1880. The lease was offered once again at public auction on 18 March 1880 and Thomas Williman Wade secured a five year pastoral lease over the Island. Wade transferred his lease to Henry Missing of 'Goochy' via Maryborough on 17 January 1882. Missing secured a further 10 year lease for Island (9 square miles) in March 1883.

The pastoral lease for the Island was resumed and split into two 6 sq. mile runs in 1886 (refer to Figure 6.63. One of the new leases was registered to James Worthington in 1886. It is not clear whether Missing continues on the Island and it is possible that Worthington took over both 6 sq. mile leases from this time however there is no clear correspondence in the pastoral lease file related to Missing from this time.

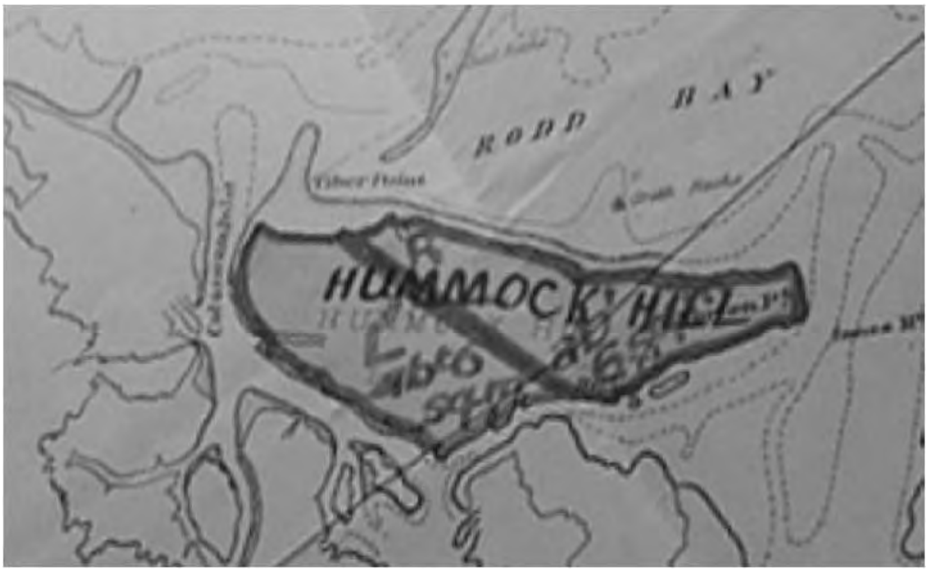

Figure 6.63 - 6 Square Mile Lease on HHI in 1886 (Pastoral Lease file 1219)

Worthington died in 1897 and his lease was resumed. It appeared that the Island was unoccupied from his death and according to a Lands Department letter from July 1898, "*Presently there are no inquiries for it*." This situation continued for a decade until a new 10 ½ square mile lease was offered for sale on 22 January 1908. A 14 year lease was acquired by Thomas Farmer of Diamantina via Gladstone on 29 April 1908. Farmer is believed to have lived on the Island until his death in 1916.

Leases become more frequent from this point, most likely the result of severe lantana infestation experienced on the Island. The lease transferred to Mortimer Moore Mackellar of Casuarina Island Bajool on 12 February 1917 and subsequently to Otto Christensen of nearby Iveragh on 20 August 1917. Christensen's lease was transferred to John James Athelstanes Murray on 15 November 1920. Murray extinguished his lease on the 6 January 1922, but acquired a new lease almost immediately. This is most likely a renegotiation of his lease conditions due to the hardships related to lantana infestation. Murray died in 1931/32 and his estate was passed to his son's Matthew John Murray and Valentine James Murray who continued the pastoral lease with beef cattle for several decades until Mr. Colin Ross Graving acquired the lease in 1961.

More recent leaseholders included Alexander and Ruth Neilson who took over the lease from Graving on 13 November 1970. The Neilson's were succeeded by Allan and Daphne Pedwell on 6 February 1974, Bunny Holdings Pty Ltd from 8 March 1982 and Walsteam Pty Ltd from 11 December 1985. Hummock Hill Island Pty Ltd was the new leaseholder for the Island, purchasing the lease from

Walstea1m in 1991. Conversion of the pastoral lease to special lease was undertaken by the Queensland Government in November 1991.

Day to Day Life on the Island

Early leaseholders appear to have used the Island for grazing of cattle, but do not appear to have lived there permanently. Correspondence from leaseholder Henry Missing during the 1880s is drafted on letterhead from a station 'Goochy' via Maryborough.

There is no mention of a residence on the Island in the 1891 valuation, however a similar valuation of HHI in 1917 identifies a substantial six room cottage, (32 x 27 foot) with verandas all around, detached kitchen and bathroom under. This design describes a dwelling most likely to be built during the 1880s or 1890s, suggesting the likelihood of Worthington as the leaseholder responsible for its construction.

This original homestead is believed to have been moved from HHI to Middle Island and possibly later to Gladstone in the 1930s or 1940s. The house site is believed to have been located within the vicinity of the date palm and mango trees surviving to the east of the existing homestead. A causeway was constructed at the narrowest point of the estuary that divides the Island from the mainland and is possibly mentioned as early as 1886. Site inspection revealed that improvements or alterations have most likely occurred to it over several decades.

The 1891 survey describes the 6 square mile lease as having *"3 square miles of sloping ridges lightly timbered with ironbark and thickly grassed, approximately 2 square miles of level sandy country, tea tree swamps and box and tea tree forest. The remainder mangrove swamps and mudflats"*. Lack of a reliable supply of water is a constant problem. The survey describes *"no natural occurring water, but water can be stored at various places at a very reasonable cost…and a small tank which holds water for about 3 months"*. The run is therefore *"only fit for fattening bullocks as cows and calves cannot be crossed in the event of the water failing as the water on the crossing is too deep"*.

A Men's hut and stalls for shearing, milking yards and calf pens, two dams, two wells and significant fences are also described in the 1917 valuation, suggesting a change in pastoral use of the Island to include sheep and dairy, possibly the result of a more reliable water supply and the possible introduction to the causeway at an earlier point.

Later leaseholders seem to focus to beef cattle once again on the Island. Figures from the 1920s and 1930s show that the Murray's kept an average of 450 head of cattle and 20 horses. This included pastoral activities on other property leases as well, of which approximately 200 head are shown to reside on the Island. The Murray's hired several Aboriginal people of Gurang decent as stockmen and domestic servants, including Mabel and Jim Williams, who lived on the Island with their family during this period.

The 1993 survey of the Island conducted by Mabel and Jim's son, Cedric Alfredson discusses possible remnants of a constructed flying fox at the homestead location, believed to have been used to carry milk to the foreshore for daily collection by boat.

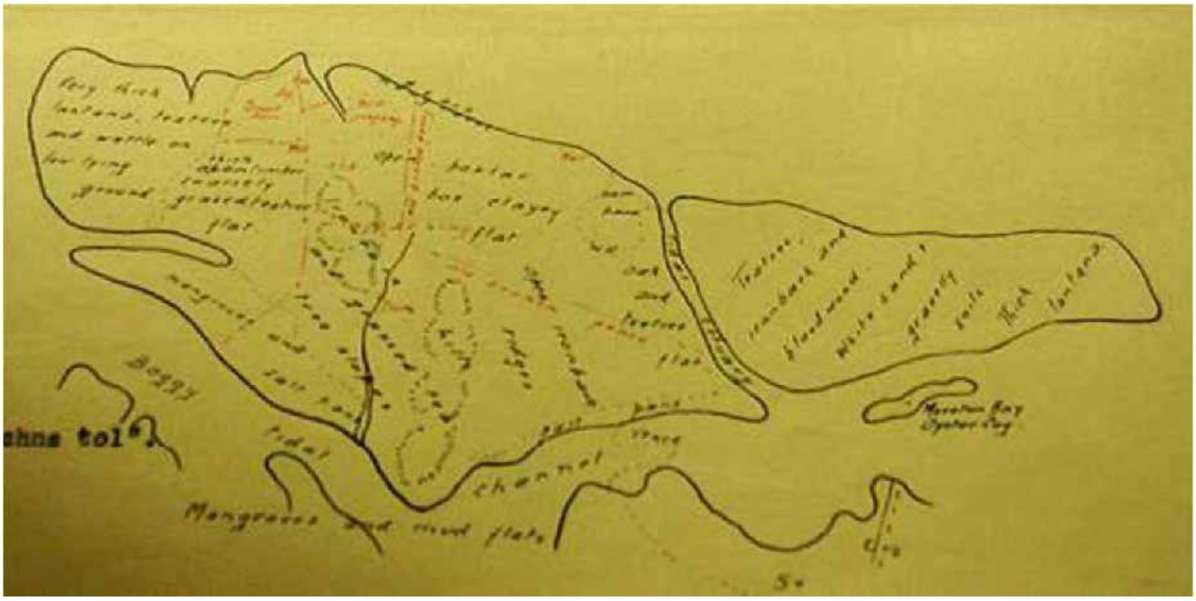

Figure 6.64 - Lantana infestation on HHI (showing also existing vegetation) 1937

Lantana Infestation

Probably the greatest effect on the Island and its landscape was lantana infestation. First reported in 1905, by 1917 lantana infestation threatened the viability of pastoral lease on HHI. Correspondence from the Rockhampton District Land Office Rockhampton in March, 1917 states that "*If left unchecked, the Island will become impenetrable in a few years*."

The Queensland Government released flies introduced from Honolulu onto the Island in 1917, in an attempt to eradicate the lantana. This trial was conducted in conjunction with additional conditions imposed on the leaseholders to clear large areas of land on the Island and keep them clear. Application to ring bark 2000 acres of gum and Moreton Bay ash at the north of the Island was administered in 1917. Later records reveal clearing of at least 600 acres of this application was completed within the study area in a short period soon after.

The eradication of lantana was rapid. A report from the Land Agent in December 1921 reveals the "*Lantana flies making good progress*" with large areas of land clear of all vegetation across the Island. It is assumed that lantana infestation improved from this time and included clearing of much of the remaining native vegetation from the Island. Field survey in 2007 (SKM 2007) revealed no infestation of lantana.

The Island in More Recent Times

Personal communications with former leaseholder Daphne Pedwell during the 2007 study confirmed the following aspects of her family's time on the Island in the early 1970s. Daphne provided the following photographs.

Figure 6.65 - Looking North to Hummock Hill – Approximately 1973

Figure 6.66 - Daphne Pedwell at Homestead Complex Gates – Approximately 1973

The Pedwell's ran approximately 500 cattle and 10 horses and also had on HHI, two trucks, a Land Rover, two tractors, a radio telephone, two of generators, a kerosene deep freeze, a gas stove, gas fridge and ¾ of a 44 gallon drum on the roof for heating water. The cattle were beef cattle which were mustered by Allan Pedwell and several friends once a year over 3 days. The cattle were crossed to and from HHI via the causeway at low tide. The Pedwell's marked the center edge of the causeway with two metal posts, so as not to risk going over the edge when crossing by vehicle.

Daphne recalls that water supply consisted of seven dams and the dam behind the homestead that was spring fed. There were also two windmills on the Island which were regularly used to pump for water. Discussions with Daphne confirm that the water often ran dry during this time.

At the homestead site, Daphne and her family lived what was known as the purple house which was there when they arrived (Figure 6.67). Nearby was a small green shack and a large tin shed, which housed the generator. Daphne recalls a cement foundation with four wooden stumps existing near the green house. The purple house burnt down following the Pedwell's departure from HHI. Daphne's daughter used to bring supplies to the island once a week from Gladstone, where she worked as a police officer.

Daphne recalls that the majority of the Island was cleared at the time, with the exception of pandanas trees and mangroves surrounding the foreshore areas. The Pedwells fished of the rocks on the Island and often took a 'tinny' across to Seal Rocks for shell collecting and oysters. Daphne also remembers barramundi, cod, sharks, dugongs and turtles which laid eggs on beach. The Pedwell's built a protected bay pool enclosure in the ocean near the homestead with wooden posts and wire mesh driven into the ocean at low tide.

Figure 6.67 - The Pedwell Residence – Approximately 1973

Figure 6.68 - Looking North toward the Homestead - Approximately 1973

Daphne also described an old man, nicknamed 'Robinson Crusoe', living at the eastern end of HHI. He was there when the Pedwell's arrived and remained after they left. He did not wear clothes and built himself a decent size dwelling, consisting of three large rooms and a couple of water tanks. HHI was found to be uninhabited during the field survey in 2007.

Figure .69 – Beach Enclosure Constructed by the Pedwells - Approximately 1973

Figure 6.70 - Looking East from Pedwell Residence - Approximately 1973

Residential Development

Bunny Industries first explored the possibility of residential development on HHI and did some exploration for water, and constructed the airstrip in the final six months of the Pedwell's lease in 1974. Plans for residential development have continued from that time (Figure 6.71) through to the current proposal by Eaton Place Pty Ltd.

Bunny moves on Hummock

A deal that will change Hummock Hill Island, in Rodds Bay, from grazing land and a fishing spot into a possible tourist resort, or residential development should be signed by the end of September, say developers, Bunny Industries Ltd.

Company spokesman, Hugh Walker, has said that although leasing processes are slow, Bunny Industries are taking the project seriously. "We already have on site engineers and consultants examining all aspects of water supply, sewerage, drainage, and road construction," he said.

Company clients have also been flying in to inspect the island, but Mr Walker says that it will be at least 12 months after the signing before construction starts.

"The general idea at present is to apply for both the resort and residential projects," he said. "it could be that both will go ahead."

Bunny Indistrial Ltd is a Queensland-based firm who moved to the state 10 years ago. "We are developing 'Pacific Haven,' at Hervey Bay," Mr Walker said. "That comprises 500 blocks adjacent to the Burrum River."

Mr Walker went on to say that there are many conditions which must be satisfied before the lease can be changed from the hands of Mr Pedwell, a grazier, into the care of Bunny Industries major shareholder and managing director, Mr G.H. McGuiness.

"It's all on the drawing boards", Mr Walker said, "but until certain conditions are met, more definite plans are not possible."

Figure 6.71 - Local Newspaper Article (Publisher Unknown – Approximately 1974)

6.10.2.2 Relevant Recorded Heritage Sites

On-line searches of the National and Commonwealth Heritage Registers, Register of the National Estate and the Queensland Heritage Register web sites were conducted in 2007 to identify places and sites of cultural heritage significance that may be impacted upon by the proposed development.

The National and Commonwealth Register and the Register of the National Estate is compiled by the Australian Heritage Council and is an inventory of Australia's natural and cultural heritage places that are worth conserving for the future. The Queensland Heritage Register has the aim of protecting historic cultural heritage for future generations. All places, trees, natural formations and buildings of historic (non-Indigenous) cultural heritage significance listed on the register are protected under the *Queensland Heritage Act 1992*.

These searches revealed no sites of historic significance have been recorded within the study area.

6.10.2.3 Identified Sites and Places Relevant to the Project

The following sites and places were identified during the field survey component of this study:

- Site 1 – Homestead Complex, Cattle Dip and Yards

  Location: Northern, central headland overlooking ocean. Northern extent of granodiorite ridge running roughly north south through the Island

- Site 2 – Historic Trig Point

  Location: Summit of Hummock Hill

- Site 3 – Historical Survey Tree (blazed tree)

  Location: A blazed survey tree was located adjacent to the main access track from the causeway to the main homestead site at its junction with two other tracks
- Site 4 – Causeway
- Site 5 – Airfield

  Location: Running approximately east west for 200 m from the centre point
- Site 6 – Various Dams
- Site 7 – Unknown Stone Arrangement

  Location: Elevated headland overlooking ocean to north and west in the vicinity of beach shack (original homestead area).

Table 6.51 identifies assesses the non-indigenous cultural heritage values of HHI. This is based on the *European Cultural Heritage Survey Report* prepared by ARCHAEO (2007).

Table 6.51 - Summary of Non-Indigenous Cultural Heritage Significance for HHI

Value	Rating	Justification	Suggested Legislative Status
Aesthetic	Moderate	Existing in what has remained a remote and picturesque coastal Island, HHI presents aesthetic qualities related to a relatively natural and somewhat secluded Island environment.	• Satisfies criteria for listing on the Local Heritage Register (currently unlisted); • Does not satisfy criteria for listing on the State or National Heritage Register (currently unlisted).
Historic	Moderate	Representing the pastoral lease and settlement activities on the Island since the 1870s, including the many challenges and challenges and activities associated with remote Island life and pastoral pursuits from this time. The site was an important part of the trials for the introduced Honolulu fly in the fight to eradicate lantana.	• Satisfies criteria for listing on the Local Heritage Register (currently unlisted); • Does not satisfy criteria for listing on the State or National Heritage Register (currently unlisted).
Scientific	Little	With the exception of the causeway and potentially aspects of flying fox (not located in this study), the Island is considered to demonstrate little scientific value.	• Does not satisfy criteria for listing on the Local, State or National Heritage Register (currently unlisted).
Social	Little - Moderate	From its first lease holding in 1877, HHI has no doubt had a direct effect on the social environment of the small number of lessees, their families and associated workers on the Island. Participation by the local community has been less involved.	• May satisfy criteria for listing on the Local Heritage Register (currently unlisted); • Does not satisfy criteria for listing on the State or National Heritage Register (currently unlisted).

6.10.3 Cultural Heritage Conclusions

Areas of indigenous cultural heritage and non-indigenous heritage have been identified within the development footprint. Construction activities for the northern abutment of the bridge, headland holiday homes and town centre coincide with area of high indigenous cultural heritage significance.

A CHMP has been accepted by Qld DNRW in January 2007. Construction works will be conducted in accordance with the requirements of the CHMP.

SECTION 7
Occurrence of MNES

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Contents

7. Occurrence of MNES

7.1 Introduction

This section describes the occurrence of relevant MNES within and adjacent to the special lease area, based on the controlling provisions specified for the action, being:

- World Heritage properties
- National Heritage places
- Listed threatened species and communities
- Listed migratory species
- Great Barrier Reef Marine Park.

Information presented in this section is taken from a range of data sources including:

- A search of the EPBC Act protected matters database, undertaken on 12 November 2012 (see Appendix C1)
- Results of desktop studies and field surveys undertaken since 1993 and presented in SKM (2007a) (see also Section 6.6 and 6.7)
- MNES specific reports prepared for the 2007 EIS (SKM 2007a) and Supplementary EIS (SKM 2009)
- A report on impacts of the HHID on World Heritage Values (SKM 2010)
- Reports of field surveys for migratory shorebirds undertaken for Gladstone Ports Corporation (GHD 2011a, b, c, d, Sandpiper Ecological Surveys 2012a, Sandpiper Ecological Surveys 2012b, Wildlife Unlimited 2012) (available at http://www.westernbasinportdevelopment.com.au/environmental_reports/section/environmental)
- Reports of field surveys for marine megafauna undertaken for GPC (GPC June 2011 and November 2011). (available at http://www.westernbasinportdevelopment.com.au/environmental_reports/section/environmental)
- Reports of the Port Curtis Integrated Monitoring Program (Vision Environment 2011, Storey *et al.* 2007) (available at http://www.pcimp.com.au/)
- Australian Government Species Profile and Threats Database. (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl)
- Research reports on aesthetic aspects and geological and geomorphological values that contribute to the outstanding universal value (OUV) of the GBRWHA (Context 2013 and Whiteway *et al.* 2013).

For each of the identified MNES, an assessment was also made of the value or sensitivity of the matter as represented on and around HHI. This assessment provides the basis for later evaluation of significance of impacts. Further information on the methodology used for assignment of values and sensitivities is provided in Section 1.

An overview of general physical and ecological features of the study area is provided in Section 6.

7.2 World Heritage Properties

7.2.1 Overview

The EPBC Act protected matters search report (12 November 2012, see Appendix C1), identified that the project takes place within the GBRWHA. The inshore boundary of the GBRWHA is the low water mark of the mainland Queensland coast and hence, the whole of HHI and surrounding waters are located within the GBRWHA. A retrospective statement of the OUV of the GBRWHA was made to UNESCO in 2912 (UNESCO June 2012a) and is attached in Appendix C2.

There are no other world heritage properties near to, or in any way connected to HHI.

World heritage listing indicates a site of OUV when considered against criterion established under the World Heritage Convention (UNESCO 1972). Some of the key features that contribute to the OUV of the GBRWHA include:

- The GBR is the world's most extensive coral reef ecosystem
- The reef extends nearly 2,000 km from north to south and the latitudinal extent of the reef means that it crosses a number of climatic zones which has led to significant ecological diversity
- The longitudinal extent of the reef is also large, with a width up to 250 km offshore, encapsulating the entire cross section of the continental shelf from low water mark on the Queensland coastline to oceanic waters over 2,000 m deep. This also contributes significantly to the ecological and geological/geomorphological diversity of the GBRWHA
- As a consequence of its extent, range and complexity of habitats available, the GBRWHA is considered to have the highest biodiversity of any world heritage area. There are a range of endemic species present in the GBRWHA and the WHA also provides habitat to a range of listed threatened species
- In addition to the overall geological, geomorphological and ecological diversity of the GBRWHA, the WHA includes a large number of individual sites and features that display unique or very high values in terms of natural beauty, geological and geomorphological formations and plant and animal habitats or associations. (UNESCO June 2012a, see also Appendix C2)

While the coral reef structures and associated ecosystems are the best known features of the GBRWHA, the WHA encompasses a wide range of other features and habitats that:

- Provide a buffer to the GBR and also support overall ecological services that are required to maintain the health of the coral reef ecosystem

- Are important to many of the iconic species of the GBR at some point in these species' life cycles
- In themselves, feature unique or very high value features that contribute to the overall OUV of the WHA.

HHI is one of over 600 islands located within the GBRWHA, all of which make a contribution to the overall natural diversity of the WHA (Lucas et al 1997). Some key values that the islands of the WHA contribute to the OUV of the GBRWHA include

- Geomorphological features
- Flora and fauna
- Aesthetic values
- Record of significant natural processes (MICDA/MINCA 2004).

An assessment of the extent to which HHI and surrounding waters contribute to the OUV of the GBRWHA has been undertaken and is presented in Sections 7.2.2 to 7.2.5. The approach used is consistent with World Heritage value assessment approaches used for Magnetic Island (SEWPaC 2010, Kenchington and Hegerl 2005) and for the Hinchinbrook area (Valentine 1994). The assessment also draws on an earlier assessment of values at HHI by SKM (2010). Adopting the criteria established by Kenchington and Hegerl (2005), the relative significance of the contribution of various attributes to the OUV of the GBRWHA has been assigned as follows:

- Unique values, only represented on or around HHI and hence providing a highly important contribution to the OUV of the GBRWHA (significance: unique expression, importance – highest importance)
- Regionally important values where HHI and surrounding waters contains a highly significant expression of the value, or a significant proportion of expressions of the value within the WHA and hence, make a moderately important contribution to the OUV of the GBRWHA (significance: regionally important expression, importance - moderate importance)
- Values for which HHI is a minor component of the total expression of the value within the WHA and hence, make a minor contribution to the OUV of the GBRWHA (significance: minor expression, importance - lower importance)
- Values which are not represented at HHI or in surrounding waters and hence make no discernible contribution to the OUV of the GBRWHA (significance: not represented).

The approach to significance assessment is explained further in Section 1.7.4. Importance values are described and defined further in Table 1.2.

In addition to considering the extent to which HHI and surrounding waters contain features that contribute to the OUV of the GBRWHA, it is also necessary to consider the aggregate contribution that HHI and surrounding waters make to the overall integrity of the entire GBRWHA and the overall representation of the OUV of the WHA. This aspect also recognises the views of traditional owners that that culture, heritage and the natural environment cannot be readily separated (MICDA/MINCA 2004). This assessment is provided in Section 7.2.6.

An initial evaluation of impacts of the PTP on the OUV of the GBRWHA is provided in Section 8, with a more detailed evaluation of potentially significant impacts provided in Section 11.

7.2.2 Criterion vii – Superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

Criterion vii refers to world heritage sites that "*contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance*". The statement of OUV notes that *the GBR is of superlative natural beauty above and below the water, and provides some of the most spectacular scenery on earth. It is one of a few living structures visible from space, appearing as a complex string of reefal structures along Australia's northeast coast* (UNESCO June 2012a, see also Appendix C2).

A study has been undertaken on determining the aesthetic values of the GBRWHA (Context, 2013). Appendix 4 provides a list of special places that was compiled from previous studies and consultation with GBRMPA staff. In the Mackay/Capricorn region, the following special places were identified:

- Capricorn Bunker group was identified for manta rays, pisonia forests, turtles, birds, beaches, sense of solitude, serenity and peace, value for research in terms of evolution of reefs and turtle nesting
- Curtis Island was identified for its intertidal areas and integrity of channels and waterways in tidal mudflats
- Endeavour Reef (off Seventeen Seventy) identified as the location where Captain Cook's ship the Endeavour ran aground
- Keppel Islands for the diversity of reefs and island landscapes, white sand beaches and views from the mainland as well as a high degree of naturalness and the ruggedness of the terrain
- Shoalwater Bay, for its remote islands and isolation and presence of turtle and dugong as well as the high diversity of landforms ranging from mountains through to mangroves, beaches and saltpan.
- Swains Reef for wilderness values, the view from the air, underwater views and features such as deep black holes and honeycomb reefs.

These sites are all distant from HHI, with the nearest being Curtis Island, 40km to the north and the Capricorn Bunker group, being 50-150km east.

The components of the GBRWHA that particularly contribute to criterion vii are shown in Table 7.1, together with an assessment of the representation of the OUV on or adjacent to HHI and the contribution that HHI and surrounding waters makes to the OUV of the GBRWHA. Location specific information used to compile the assessment was sourced from data sources discussed in

Section 7.1. A more detailed assessment of expression of aesthetic attributes in the local and regional study area is provided in **Appendix F**.

Table 7.1 – Criterion vii

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
From the air, the vast mosaic patterns of reefs, islands and coral cays produce an unparalleled aerial panorama of seascapes comprising diverse shapes and sizes.	From the air, HHI does not present an unparalleled aerial panorama (see also **Appendix F**). Aerial views of HHI also take in the red mud dam from the Boyne Island smelter 15 km to the north-west and Gladstone Harbour 30 km to the north-west as well as ships utilising the shipping channel which is located 6km north of HHI. When viewed from land or sea, HHI blends with the adjacent mainland and does not have any distinguishing features that make it stand out. The nearest major coral reef system which is visible from the air to HHI are the Capricorn and Bunker Group which lie 50-150 km east and north-east of HHI. HHI does not feature any fringing coral reefs. Rocky reefs closer to HHI have some coral cover but are not visible from the air. On this basis, HHI is considered to make a low contribution to this aspect of the OUV of the GBRWHA. **Significance: Minor expression, Minor contribution**
The Whitsunday Islands provide a magnificent vista of green vegetated islands and spectacular sandy beaches spread over azure waters. This contrasts with the vast mangrove forests in Hinchinbrook Channel, and the rugged vegetated mountains and lush rainforest gullies that are periodically cloud-covered on Hinchinbrook Island.	HHI is approximately 450 km south of the Whitsunday Islands and over 800 km south of the Hinchinbrook Channel and in a different region to these features. However, these locations are presented as examples that contribute highly to the OUV of the GBRWHA and the potential for HHI to make a similar contribution must therefore be examined. HHI is generally flat with a central ridgeline that reaches only 125 m above sea level. HHI is separated from the mainland by a narrow tidal creek and HHI appears as part of the adjacent mainland with similar topography, geology and vegetation. HHI does not feature the steep topography and “rugged vegetated mountains” that is characteristic of many of the continental islands further north. Nevertheless, HHI forms part of the wide diversity of island types within the GBRWHA. The northern side of HHI features narrow to moderate width sandy beaches. As HHI is located in subtropical waters, the distinct “azure” water colour is not typical but the beaches do provide a distinctive edge around the northern and western sides of HHI. Some moderately extensive mangrove stands up to 900 m wide exist along the southern shore of HHI, and these are bisected by tidal channels. Similar stands of mangroves exist on intertidal mudflats and along the mainland shore of Boyne Creek, Colosseum Inlet and Seven Mile Creek. These are backed by low coastal plains, rather than the steep hills that are a feature of Hinchinbrook Channel. Terrestrial vegetation of HHI and the adjacent mainland is an open woodland, rather than “lush rainforest”. Mangrove forests and other coastal vistas surrounding HHI would make a local contribution to scenic amenity, but do not constitute a magnificent vista and are not unique or unusual in any way. **Significance: Minor expression, minor contribution**

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
On many of the cays there are spectacular and globally important breeding colonies of seabirds and marine turtles, and Raine Island is the world's largest green turtle breeding area.	The nearest coral cays are those of the Capricorn and Bunker Group, lying 50-150 km from HHI. While the beaches of HHI do provide for some intermittent, low density flatback turtle nesting, the level of nesting activity is not such that there is spectacular aggregation of turtles, with surveys indicating less than 25 nests per year, in years when nesting occurs (see also Section 7.4.4). By contrast, green turtle nesting rates at Raine Island are estimated at 4000 to 15,000 breeding females per night during the summer months (NPRSR 2006). At Mon Repos beach, which is outside the GBRWHA but has become a significant tourism attraction on the basis of turtle nesting numbers and is thus representative of what might be considered spectacular, 20 or more female turtles may come ashore each night in the breeding season (http://www.ehp.qld.gov.au/wildlife/watching/turtles/). There are no breeding colonies of seabirds at or near HHI but intertidal and supratidal flats on the South-east part of HHI and on the adjacent mainland do provide roosting and foraging habitat for large numbers of migratory shore-birds (see also Section 0). The density is relatively low, at about 0.9 shorebirds per hectare (see also Section 0) and hence does not provide a "superlative natural phenomenon" compared to locations such as Raine Island, Michaelmas Cay, the cays of the Swain reefs and the islands of the Capricorn Bunker Group (GBRMPA 2009). By contrast, at Raine Island, with a land area of around 21 hectares, there are breeding colonies of 16 bird species, with seven species represented by over 1,000 breeding pairs (NPRSR 2006). There are no other large, spectacular or unusual aggregations of animals occurring on or near HHI that would contribute to this aspect of the OUV of the GBRWHA. **Significance: Minor expression, minor contribution**
On some continental islands, large aggregations of over-wintering butterflies periodically occur.	Aggregations of butterflies have not been observed on HHI. As such, HHI is not considered to contribute to this aspect of the OUV and the value of HHI in this regard is low. Butterfly aggregations are known to occur around Townsville, on Magnetic Island and the Hinchinbrook area (Dobbs 2011). There are no other spectacular aggregations of animals that are comparable to the butterfly aggregations on or around HHI. **Significance: Not represented, no contribution**
Beneath the ocean surface, there is an abundance and diversity of shapes, sizes and colours; for example, spectacular coral assemblages of hard and soft corals, and thousands of species of reef fish provide a myriad of brilliant colours, shapes and sizes. The internationally renowned Cod Hole near Lizard Island is one of many significant tourist attractions. Other superlative natural phenomena include the annual coral spawning, migrating whales, nesting	The nearest coral-based reefs to HHI are the Capricorn and Bunker Group which lie 50-150 km east and north-east of HHI. HHI does not feature any fringing coral reefs. A submerged rocky reef lying 200-900 m north of HHI has around 30-40% coral cover (SKM 2010). Dames and Moore also noted that the subtidal surfaces of Seal Rocks, 5 km to the north of HHI, hosted "isolated soft and hard coral colonies" and that "the diversity and extent of coral coverage is particularly high" but did not provide any details of surveys undertaken to establish this. As mentioned above, a small number of turtles nest on beaches of HHI, with surveys indicating less than 25 nests. The migration route for humpback whales lies offshore and migrating whales may only occasionally be visible from HHI, as well as from many other mainland and island locations in the region. Whale watching tours operate from Hervey Bay, 200 km to the south and, to a lesser extent, Seventeen Seventy, 60 km south. There do not appear to be any whale watching tours operating

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
turtles, and significant spawning aggregations of many fish species.	from Gladstone. Dugong are also present in waters around HHI (see also Section 7.5.3.2). There are no tourist attractions relating to spectacular underwater formations in proximity to HHI. HHI and surrounding waters does not contain any spectacular examples of natural phenomenon and hence does not make any notable contribution to the OUV of the GBRWHA in this regard. Turtles and dugongs are present in waters around HHI and visible to viewers in boats. While not present in numbers that may be considered "spectacular aggregations" these are iconic species of the GBRWHA and hence, the waters around HHI make a minor contribution to the OUV of the GBRWHA in relation to spectacular features of the marine environment. As discussed above, turtle nesting is also minor and not known to occur at numbers that might attract particular attention of tourists or scientific researchers. **Significance: Minor expression, minor contribution**

(1) UNESCO June 2012a, see also Appendix C2

Overall, in relation to the criterion "***contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance***", HHI and surrounding waters make a minor contribution to the OUV of the GBRWHA as the island and surrounding waters feature minor expressions of some aesthetic values based on the presence of low profile coastal panoramas, mangrove lined channels and the presence of some iconic species of the GBRWHA, albeit at low to moderate numbers. Aesthetic values of HHI are affected by presence of shipping and major industrial and port development to the north. There are no superlative phenomena or spectacular features on or around HHI.

HHI is therefore of **lower importance** for this criterion and makes a minor contribution to the OUV of the GBRWHA.

7.2.3 Criterion viii - Outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features

Criterion viii refers to sites that provide an "outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features" (UNESCO July 2012). The statement of OUV prepared by the Australian government notes that "the GBR, extending 2,000 kilometres along Queensland's coast, is a globally outstanding example of an ecosystem that has evolved over millennia. The area has been exposed and flooded by at least four glacial and interglacial cycles, and over the past 15,000 years reefs have grown on the continental shelf" (UNESCO June 2012a, see also Appendix C2).

A study of geological and geomorphological features of OUV in the Great Barrier Reef World Heritage Area identifies "representative" and "best" examples of the range of geological and geomorphological features that characterise the GBRWHA and hence contribute to the OUV of the

GBRWHA (Whiteway et al, 2013). The following sites are identified in the GBRWHA south of Rockhampton:

- Fringing reefs - Great Keppel Island Group (representative example)
- Shelf reefs – One Tree Island Reef (best example) and Fairfax Islands Reef (representative example)
- Carbonate Reef islands – Lady Musgrave Island and Fairfax Islands (representative examples)
- Gravel and shingle ridges – Lady Elliot Island (best example) and Fairfax Island (representative example).
- Mangroves and mangrove islands – Curtis Island – The Narrows (representative example)
- Palaeochannels – Fitzroy River (best example)
- Dune systems – Curtis Island - Buckhead Beach (representative example)
- Submarine canyons and turbidite deposits – Southern Frazer Island Zone (Whiteway et al, 2013).

The nearest of these features to HHI is Curtis Island, the southern edge of which is about 40km north of HHI. However, neither this, nor any of the other sites are connected to HHI in a manner by impacts might be induced. Note that none of the continental islands or seagrass beds south of Rockhampton were identified in the study as either representative or best examples of these features in the GBRWHA.

The components of the GBRWHA which relate to this criterion are shown in Table 7.2, together with an assessment of the representation of the OUV on or adjacent to HHI and the contribution that HHI and surrounding waters makes to the OUV.

Table 7.2 – Criterion viii

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
During glacial periods, sea levels dropped, exposing the reefs as flat-topped hills of eroded limestone. Large rivers meandered between these hills and the coastline extended further east.	HHI is located within the southern extent of the GBRWHA. The island is not associated with the coral reef formations of the GBR ecosystem. While HHI would have undergone geomorphological transformations during glacial and interglacial cycles, the geological formations of HHI do not provide any particular insights into these processes (SKM 2007 (section 05, Section 07, Appendix A7.5), SKM 2010). The underlying geology is Permian to Triassic granodiorites overlain by more recently deposited Holocene sediments, mostly of marine origin on the ocean side of the island, with estuarine sediments likely to be terrigenous. The Holocene dunes on the seaward side of HHI are a common feature along the coastline north and south of HHI, with the nearest such features inside the WHA being Wild Cattle Island and Curtis Island to the north (SKM 2007, Appendix A 7.5B). As HHI is separated from the mainland by a relatively shallow tidal channel, HHI would have been connected to the mainland prior to and during the last glacial period, probably becoming isolated about 6,000 years ago (http://www.cmar.csiro.au/sealevel/sl_hist_intro.html, accessed 16/02/2013). HHI sits across the mouth of a small estuarine system that does not have any major river systems draining to it. The upstream catchment for

Outstanding Universal Value (1)	Extent to which HHI and Surrounding Waters Contribute to the OUV
	Colosseum Inlet is quite small, at 475 km^2. HHI is almost bisected by a tidal creek (Sandfly Creek). It does not appear that major river systems played a significant part in the formation of HHI and surrounding estuaries and coastal features, rather, geomorphology appears to be influenced by volcanic activity and later depositional coastal processes and subsequent inward (aeolian or wind driven) migration of sand dunes occurring in the Holocene period, around 6,500 years ago (Cardno Lawson Treloar 2007, Stephens 2007 (Appendix A7.5 of SKM 2007)). Dobbs (2011) identifies the Whitsunday Islands, Corio Bay and Shoalwater Bay as outstanding examples of this value. Whiteway et al identified Fitzroy River palaeochannel as one of the best examples of a palaeochannel, showing river courses at lower water levels (Whiteway et al 2013). HHI is considered to make a minor contribution to the OUV of the GBRWHA in respect of evidence of geological and geomorphological processes during glacial periods. It is similar to a number of other sites, and has not been identified as a good or representative example of this aspect of the OUV of the GBRWHA. **Significance: Minor expression, minor contribution**
During interglacial periods, rising sea levels caused the formation of continental islands, coral cays and new phases of coral growth. This environmental history can be seen in cores of old massive corals.	HHI is one of over 600 continental islands in the GBRWHA but does not have any unique features in relation to past history of sea level rise or provide any particular insight into geological and geomorphological processes. HHI is not identified in Whiteway et al(2013) as a representative or best example of continental islands in the GBRWHA. The geology of HHI indicates that it is not associated with corals, with the underlying geological formation being granodiorite. The island features a granodiorite ridge flanked by deposited sediments, however this is not an unusual feature, with Great Keppel Island, Facing Island and several other continental islands in the Southern GBRWHA showing similar features. Other large continental islands in close proximity include Curtis Island (approximately 46,600 ha) and Facing Island (approximately 2,500 ha). This compares to the land area of HHI of 3,071 ha. The best examples of continental islands identified by Whiteway et al are Flinders Island Group, Hinchinbrook Island, Magnetic Island, Whitsunday Islands, South Percy Island, South Repulse Island and Wild Duck Island. Overall, HHI makes a minor contribution to this aspect of the OUV of the GBRWHA, as it is an example of a continental island cut off from the mainland by rising sea levels, but has not been identified as being a representative or best example of this, and does not have any unusual or unique features. **Significance: Minor expression, minor contribution**
Today the GBR forms the world's largest coral reef ecosystem, ranging from inshore fringing reefs to mid-shelf reefs, and exposed outer reefs, including examples of all stages of reef development.	HHI does not feature any fringing coral reefs. A low profile rocky reef 200-900 m north of HHI has some coral cover but is not itself a coral reef (SKM 2010). Seal rocks is a rocky reef located about 5 km north of HHI with some coral cover. The nearest coral reefs are the Capricorn and Bunker Group located 50-150 km north-east and east of HHI. HHI does not contribute to this aspect of the OUV of the GBRWHA as there are no coral reefs at or near HHI. **Significance: Not present**

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
The processes of geological and geomorphological evolution are well represented, linking continental islands, coral cays and reefs. The varied seascapes and landscapes that occur today have been moulded by changing climates and sea levels, and the erosive power of wind and water, over long time periods.	HHI does not provide any remarkable evidence of geological and geomorphological evolution. The underlying geology is Permian to Triassic granodiorite overlain by more recently deposited Holocene sediments, mostly of marine origin on the ocean side of the island, with estuarine sediments likely to be terrigenous. The geology and geomorphology is typical of the south and central Queensland coastal zone, is not unique or unusual and is well represented within the WHA including at Wild Cattle Island, Facing Island and Curtis Island, including areas on these islands that are protected as National Parks under the Queensland *Nature Conservation Act 1992*. Similar features are also found on the nearby coastline outside of the WHA but protected as national parks and conservation areas under the Queensland *Nature Conservation Act 1992*. HHI is not linked to coral reef formation and does not feature any fringing coral reefs, nor are there any coral reefs within 50 km. A rocky reef to the north of HHI features some coral cover. Hummock Hill Island does feature a range of nearshore ecosystems in the form of sand dunes, intertidal mud flats and tidal creeks. These are relatively dynamic systems and are not unique or unusual in terms of geological and geomorphological features (Cardno Lawson Treloar 2007, Stephens 2007 in Appendix A7.5 in SKM 2007). An assessment of beach and sand dune formations indicates that these systems are stable or accreting and not particularly susceptible to erosion processes. The geomorphological features of HHI are not unusual and are well represented on the other islands in the area, including protected areas on Curtis Island and Wild Cattle Island National Park. HHI is considered to make a local contribution to geological and geomorphological values, and hence the value is of this contribution is considered minor. Islands and estuaries featuring important expressions of geological and geomorphological processes include Corio and Shoalwater Bays, Hinchinbrook Island and Passage, Whitsunday Islands, the Palm Island Group and Curtis Island (south) (Dodds, 2011). **Significance: Minor expression, minor contribution**
One-third of the GBR lies beyond the seaward edge of the shallower reefs; this area comprises continental slope and deep oceanic waters and abyssal plains.	HHI is not located in this area and is not connected to the outer reef area or continental slope. **Significance: Not present, no contribution**

(1) UNESCO June 2012a, see also Appendix C2

In relation to the criterion "*outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features*" there is a minor expression of several features identified as contributing to the OUV of the GBRWHA present at HHI and in surrounding estuarine waters:

- Minor expression of coastal geological and geomorphological changes and estuary formation
- Minor expression as an example of a continental island
- Minor expression of geological and geomorphological processes in formation of coastal beaches and sand dunes, intertidal mud flats and tidal creeks.

HHI does not feature any unique or unusual landscape or geomorphological features at either a regional or WHA-wide scale. It is therefore considered to make only a minor contribution to the OUV of the GBRWHA with respect to geological and geomorphological processes.

Features on the mainland coast, which lie outside the GBRWHA boundary also contribute to these values. Expressions of these values are present and protected at the nearby Eurimbula National Park.

HHI is of **lower importance** for this criterion and makes on a minor contribution to the OUV of the GBRWHA in this regard.

7.2.4 Criterion ix – Outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals

Criterion ix requires that a site is an "outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals" (UNESCO July 2012, see also Appendix C2).

The components of the GBRWHA that particularly contribute to this component of the OUV are shown in Table 7.3, together with an assessment of the representation of the OUV on or adjacent to HHI and the contribution that HHI and surrounding waters makes to the OUV.

Table 7.3 – Criterion ix

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
The globally significant diversity of reef and island morphologies reflects ongoing geomorphic, oceanographic and environmental processes. The complex cross-shelf, longshore and vertical connectivity is influenced by dynamic oceanic currents and ongoing ecological processes such as upwellings, larval dispersal and migration.	HHI is located very close to the mainland and from a geomorphological and ecological point of view, is closely aligned with the mainland. While HHI and the surrounding estuary provide an example of coastal geomorphic processes creating habitat for plants and animals, the area is not outstanding or unique, with similar systems both within and adjacent to the GBRWHA. The area is not particularly influenced by oceanic currents or related ecological processes. There are no known upwellings in the vicinity of HHI, with the main upwellings being the Coral Sea and outer reef areas (Dobbs, 2011, Wachenfield et al (eds) 1997). Coral larval dispersal and migration is not a feature of the locality surrounding HHI as there are no significant coral reefs within 50 km and HHI does not lie in any potential dispersal pathways. **Significance: Minor expression, minor contribution**
Ongoing erosion and accretion of coral reefs, sand banks and coral cays combine with similar processes along the coast and around continental islands.	Holocene age sand dunes along the north coast of HHI were formed by accretion of sand from wave action and aeolian (wind-blown) processes. Some ongoing accretion is likely to be occurring from longshore transportation of materials (SKM 2007). Sediment mobilised in runoff from the adjacent mainland is deposited in tidal waters around HHI, however deposition rates are proportionately lower when compared to larger systems such as the Fitzroy River estuary

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
	and the Narrows (Curtis Island) due to the small size of the contributing catchment and tidal velocity in Seven Mile Creek, Boyne Creek and Colosseum Inlet. Sand bars and mud flats in Seven Mile Creek and Boyne Creek and the entrance to Colosseum Inlet undergo ongoing changes due to tidal movements. Significant sand bank features contributing to this aspect of the OUV are identified at locations very distant from HHI, including Hedge, Grubb and Corbett Reefs (Dobbs 2011). As such, HHI makes a local contribution to OUV through provision of examples of coastal processes around a continental island, particularly through accretion and erosion of sand banks and intertidal mudflats, but does not contain any unique or unusual features in this regard. **Significance: Minor expression, minor contribution**
Extensive beds of Halimeda algae represent active calcification and accretion over thousands of years.	There are no Halimeda beds in proximity of HHI (Thomas et al 2009, Rasheed et al 2003). The extensive Halimeda beds referred to in this component of the OUV are located in the north of the WHA, including Bioregion NI and NF (GBRMPA 2009). **Significance: Not present, no contribution**
Biologically the unique diversity of the GBR reflects the maturity of an ecosystem that has evolved over millennia; evidence exists for the evolution of hard corals and other fauna. Globally significant marine faunal groups include over 4,000 species of molluscs, over 1,500 species of fish, plus a great diversity of sponges, anemones, marine worms, crustaceans, and many others.	HHI and surrounding waters do not provide any evidence of the complex and mature coral reef ecosystem referred to in this component of the OUV. The waters around HHI are part of a dynamic coastal and estuarine system and geomorphological changes in this type of ecosystem tend to override evolutionary changes in relation to habitat provision. While the waters around HHI are utilised by a range of marine fauna including EPBC Act listed threatened species and feature mangrove, mudflat and seagrass habitats that are utilised by these species, there is no particular evidence of evolution of marine flora or fauna. These coastal systems are in a good state of preservation (Lucas et al 1997). The land area of HHI is closely associated with the mainland and not remote enough that species and communities have evolved differently to those on the mainland and nearby islands. HHI and surrounding waters do not contribute to scientific understanding of evolutionary processes or provide any unique or significant expressions of these processes. As such, HHI and surrounding waters do not contribute to that aspect of the OUV described by this component of the statement of OUV. **Significance: Not present, no contribution**
The establishment of vegetation on the cays and continental islands exemplifies the important role of birds, such as the Pied Imperial Pigeon, in processes such as seed dispersal and plant colonisation.	HHI is located very close to the mainland, separated by a narrow, shallow channel. Aerial seed dispersal is likely to be through both birds and wind mobilisation. At lower sea levels during glacial periods, HHI would have been connected to the mainland and plants would have dispersed by other means as well. HHI is likely to have been separated from the mainland since sea levels stabilised 6,000 years ago ((http://www.cmar.csiro.au/sealevel/sl_hist_intro.html, accessed 16/02/2013). There are no notable differences between vegetation on HHI and that of the mainland and other nearby islands within the WHA that would indicate any unusual processes of seed dispersal (Batianoff and Dillewaard 1997, SKM 2007). Proximity to the mainland is the main

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
	influence on vegetation types and, if any unusual methods of seed dispersal were occurring, these would be masked by influences from the mainland. As such, HHI and surrounding waters do not contribute to that aspect of the OUV described by this component of the statement of OUV. **Significance: Not present, no contribution**
Human interaction with the natural environment is illustrated by strong ongoing links between Aboriginal and Torres Strait Islanders and their sea-country, and includes numerous shell deposits (middens) and fish traps, plus the application of story places and marine totems.	HHI sits in the traditional lands of the Port Curtis Coral Coast native title claimant group. Given the lack of permanent freshwater, HHI appears to have been used only intermittently by Aboriginal groups. Nevertheless, the island was used by Aboriginal groups over the years and evidence of Aboriginal use of HHI remains in the form of shell middens and artefact scatters which also provide some evidence of usage of natural environmental resources (SKM 2007, Appendix A7.10). Field surveys indicated that coastal areas, sand dunes and areas around seasonally inundated wetlands were likely to be important foci of usage by Aboriginal people. Story places and totems were not identified in field surveys or consultation with Aboriginal people. Aboriginal people were also reported to have been employed in grazing activities on HHI. There is no ongoing use of HHI by the Port Curtis Coral Coast group. A cultural heritage management plan has been prepared in consultation with relevant Aboriginal parties being part of the Port Curtis Coral Coast native title claimant group and was approved by the Queensland Government in January 2007 in accordance with the requirements of the Queensland *Aboriginal Cultural Heritage Act 2003*. As HHI also has a history of use for logging and grazing, there are also some non-indigenous cultural heritage features remaining, although none are considered to be more than moderately significant at a local level (SKM 2007, Appendix A7.10). **Significance: Minor expression, minor contribution**

(1) UNESCO June 2012a, see also Appendix C2

In relation to the criterion "*outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals*", minor expressions of some components that contribute to the OUV are considered present as follows:

- Minor expression of the relationship between coastal geomorphic processes and environmental processes
- Minor expression of erosion and accretion processes in relation to sand banks and beaches
- Minor expression of relationship of local Aboriginal groups to the natural environment as evidenced through shell middens and artefact scatters in locations such as sand dunes and ephemeral wetlands. Minor evidence of post-settlement use as a grazing property.

On this basis, HHI is of **lower importance** for this criterion and makes only a minor contribution to the OUV of the GBRWHA.

7.2.5 *Criterion x – Contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation*

Criterion x requires that a site "contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation" (UNESCO July 2012, see also Appendix C2).

The statement of OUV notes that "the enormous size and diversity of the GBR means it is one of the richest and most complex natural ecosystems on earth, and one of the most significant for biodiversity conservation" (UNESCO June 2012a, see also Appendix C2).

While rocky reefs within 5 km of HHI have some coral cover, the nearest fringing reef is at Facing Island, more than 20 km from HHI and the nearest reef systems are located more than 50 km from HHI, in the Capricorn Bunker group. The contribution of HHI to the diversity and health of the ecosystem is at least partly through being part of the larger buffer area around the reef. However the OUV of the GBRWHA also encompasses other ecosystems and features. The components of the GBRWHA which particularly contribute to this criterion are shown in Table 7.4, together with an assessment of the representation of features or values recognised as part of the OUV of the GBRWHA on or adjacent to HHI and the contribution that HHI and surrounding waters makes to the OUV.

Table 7.4 – Criterion x

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
The amazing diversity supports tens of thousands of marine and terrestrial species, many of which are of global conservation significance.	The waters around HHI do not feature particularly high diversity, and surveys by GPC indicate that marine megafauna occurring around HHI is typical of the distribution within the wider Rodds Bay and Port Curtis/Gladstone Harbour area (GPC 2011). The waters are zoned general use under the GBR zoning system, indicating that the waters do not feature any particular scientific or conservation significance, beyond that ascribed to all waters of the Marine Park. The intertidal waters between HHI and the mainland have been declared a Fish Habitat Area under the Queensland *Fisheries Act 1994*, one of 70 such areas along the Queensland coast, encompassing a total area of 1.13 million hectares. Flatback turtle (vulnerable), loggerhead turtle (endangered) and green turtle (vulnerable) have all been positively identified in the waters around HHI, with the flatback and green turtle being relatively common (GPC 2011, SKM 2007). Flatback turtle have been observed to nest on HHI on the beach to the east of the headland (see also Section 7.4.4.3). Nesting density appears to be low and intermittent (SKM 2007, Hodge et al 2007). Hodge et al observed two fresh tracks and five old tracks in a three day survey in December 2006. HHI has not been identified in any literature on turtle nesting as even a minor nesting site (for example, Limpus 2007, Limpus 2008, Environment Australia 2003). Leatherback turtle (endangered) and hawksbill turtle (vulnerable) may utilise the area, although these species tend to be more pelagic and do not nest in the area. Humpback whales migrate past HHI, but this is not known as a location where humpback whales come close inshore, nor is it known as a resting or calving location. The threatened marine fauna known to utilise waters around HHI are generally known from a wide range of locations along the GBRWHA coastline and offshore islands and there is no evidence that the waters around HHI support isolated populations that might be genetically distinct from other populations. HHI is not located on the edge of these species' known distribution. HHI is within the Capricorn floristic region of the WHA. No plants of conservation significance have been identified on HHI (SKM 2007). One critically endangered ecological community is present, being Littoral Rainforest and Coastal Vine Thickets of Eastern Australia. Two vegetation communities that occur on HHI are not present on any other islands within the WHA, namely *Eucalyptus melanophloia* woodland (classified as RE 12.12.8) and *Eucalyptus tereticornis* and *E. crebra* dominated forests (RE 12.12.12) (SKM 2007). One listed vulnerable fauna species has been observed feeding in woodland areas on HHI, being the grey-headed flying fox. The vulnerable black-breasted button quail is also suspected to be present in the coastal vine thicket. Other threatened species for which suitable habitat is present, even though the species have not been observed, are water mouse, red goshawk, Australian painted snipe, yakka skink and brigalow scaly-foot (see also Section 7.4.3). There are no known endemic species on HHI (Turner and Batianoff 2007, SKM 2007). Compared to other continental islands, the number of threatened terrestrial flora and fauna species known or considered likely to occur on HHI is low (MICDA/MINCA 2004, APLNG 2010, DIP 2009, Turner and Batianoff 2007). As such, HHI and surrounding waters make a minor contribution to the

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
	OUV of the GBRWHA in relation to biodiversity, providing habitat for a range of species that occur across wide ranges in the GBRWHA, and also containing vegetation communities not well represented elsewhere (see also discussion below on floristic diversity). **Significance: Minor Expression, minor contribution** (in relation to species diversity – see below however for discussion regarding regionally important expression of ecological communities)
As the world's most complex expanse of coral reefs, the reefs contain some 400 species of corals in 60 genera. There are also large ecologically important inter-reefal areas.	There are no coral reefs directly associated with HHI. A rocky reef north of HHI has 30-40% coral cover (SKM 2007). The waters around HHI are not inter-reefal areas as these waters do not provide connectivity between reef systems. **Significance: Not present, no contribution**
The shallower marine areas support half the world's diversity of mangroves and many seagrass species.	The southern side of HHI contains stands of mangroves up to 900 m wide. SKM reports a distinct banding pattern on HHI and the mainland with a fringe (sometimes absent) of Avicennia at the seaward margin, a main zone of Rhizophera and a narrower Ceriops zone backed by supratidal coastal salt flats. In some areas there is also a discontinuous Ceriops fringe between the salt flats and terrestrial vegetation (SKM 2007). The Colosseum estuary contains 1900 ha of mangroves including 430ha on HHI. Species present are *Rhizophera stylosa*, *Avicennia marina* var *australasica*, *Ceriops tagal* var *australis*, *Aegiceras corniculatum*, *Lumnitzera racemosa* and *Excoecaria agallocha* (SKM 2007). Shallow coastal waters around HHI support intertidal and subtidal seagrass beds with key species being *Zostera capricorni*, *Halophila ovalis* and *Halodule uninervis* (wide). Seagrass surveys identified around 240 ha of seagrasses in the upper reaches of Colosseum inlet in 2002 and around 127 ha in 2009, 26 ha in Boyne Creek in 2002 and 1.5 ha in 2009 and 520 ha in Seven Mile Creek to the east of HHI in 2002 and 210 ha in 2009. A large patch of nearly 500 ha (2003) and 430 ha (2009) is also located off the north-east shore of HHI (Rasheed et al 2003, Thomas et al 2009). There is no data available for seagrass cover after the severe rain events in the summer of 2010/2011. Compared to other intertidal and estuarine locations within the GBRWHA, the tidal and intertidal waters surrounding HHI have a similar diversity of marine plants. There are no particularly unusual associations of plants. In this regard, HHI and surrounding area make a moderate contribution to the OUV of the GBRWHA, featuring some regionally important habitats and good, but not unique examples of fringing mangroves and large, persistent seagrass beds. **Significance: Regionally important expression, moderate contribution.**
The waters also provide major feeding grounds for one of the world's largest populations of the threatened dugong.	Dugongs are known to occur in waters around HHI and suitable seagrass feeding areas are present. A dugong density model established by Grech and Marsh (2007) has been applied to the Gladstone region, including Rodd's Bay Area (GHD 2009, GPC 2009) and indicates that waters around Hummock Hill Island are of low to medium density for dugong at low tide and on high tide were recognised as supporting a dugong density of low to high. Aerial surveys were undertaken for GPC in March and June 2011 covering waters from the mouth of the Fitzroy River to Rodds Peninsula. In March

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
	2011, the only dugong sighted in the survey was north of Rodds Peninsula. In June 2011 one dugong was sighted near the HHI causeway and another dugong about 5 km north of the mouth of Colosseum Inlet at high tide. In the same June survey, eight dugong were sighted within Port Curtis (GPC 2011). In the summer of 2010/2011, there were severe rainfall events, runoff from which may have affected seagrass health, and this in turn has raised concerns about potential declines in dugong numbers in the GBRMP (see for example http://www-public.jcu.edu.au/news/current/JCU_110255 accessed 14/03/2013). Population estimates for the Rodds Bay DPA indicate that this area may support 5-10% of the dugong population in the GBRMP south of Hinchinbrook Island (see also Section 7.5.3). HHI is within the larger Rodds Bay Dugong Protection Area which extends from Rodds Peninsula, south of HHI to Curtis Island to the north. Overall, it is likely that the area around Hummock Hill Island is of low to moderate importance to dugong, but given its location in the Rodds Bay DPA, waters surrounding HHI are considered to have moderate value in terms of contribution to the OUV of the WHA. The most significant areas for dugong in the GBRWHA are identified as the northern region, Hinchinbrook Island, Cleveland Bay and Shoalwater Bay (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 5/03/2013). **Significance: Regionally important expression, moderate contribution**
At least 30 species of whales and dolphins occur here, and it is a significant area for humpback whale calving.	The indo-Pacific humpback dolphin is known to occur in waters around HHI and also occurs commonly in Port Curtis to the north (GPC 2009, GPC 2011). Australian snub-fin dolphin has not been seen south of Port Alma for almost five years and has never been observed around HHI (GPC 2009, GPC 2011). Other dolphin and whale species have not been observed in waters around HHI and are not predicted to occur, based on habitat suitability. Migrating whales pass well offshore of HHI and HHI is not considered to provide resting or calving areas. Key locations for humpback whale include resting areas at Whitsundays, Hervey Bay, Moreton Bay, the Swain Reefs complex, Bell Cay, and the Palm Island Group (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=38 accessed 05/03/2013). The area is of low value in this regard and makes only a minor contribution to this aspect of the OUV of the GBRWHA as one species of dolphin is known to utilise waters around HHI. **Significance: Minor expression, minor contribution**
Six of the world's seven species of marine turtle occur in the GBR. As well as the world's largest green turtle breeding site at Raine Island, the GBR also includes many regionally important marine turtle rookeries.	Green turtle are known to forage on seagrass beds in Boyne Creek and Seven Mile Creek and on the ocean side of Hummock Hill Island (Rasheed et al, 2003, GPC 2011). This species is quite common in the Rodds Bay/Port Curtis area (GPC 2009, GPC 2011). EIS studies, literature reviews and consultation with relevant government agencies did not identify any known nesting activity of green turtles on Hummock Hill Island. Flatback turtles have been observed using the north-eastern facing beach on Hummock Hill Island for nesting in small numbers, with seven tracks of various ages identified during a three day survey in 2006. Queensland Parks and Wildlife Service concluded that this beach was not an important nesting area (Hodge et al, 2006). There are important nesting sites in the area, particularly the eastern coast of Curtis Island

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
	(GPC 2009). Loggerhead and hawksbill turtles have been observed in the area but in low numbers (GPC 2009). These species have not been observed using HHI beaches for nesting. More information on important areas for turtles is provided in Section 7.4.4.3, as is discussion on potential recent increases in turtle strandings in the Port Curtis area. While the nesting activity is not considered particularly important for the maintenance of flatback turtle populations in the region or across the GBRWHA, the area is conservatively assessed as making a moderate contribution to the OUV of the GBRWHA in this regard as nesting beaches at other locations have come under increased pressure. **Significance: Regionally important expression, moderate contribution**
Some 242 species of birds have been recorded in the GBR. Twenty-two seabird species breed on cays and some continental islands, and some of these breeding sites are globally significant; other seabird species also utilize the area.	Bird surveys have been carried out on HHI in 1993, 1995, 2005 and 2007. A total of 125 bird species have been recorded from these surveys. This number is comparable to results of surveys in nearby areas such as Tannum Sands (Austecology 2012), although the Tannum Sands bird counts are based on a lower overall level of survey effort. Around 180 species of birds have been observed on Magnetic Island, which is about twice the size of HHI. Two surveys undertaken for the GKI Revitalisation project identified 67 bird species on Great Keppel Island, which is about 50% of the size of HHI and much further offshore compared to HHI (Chenoweth EPLA August 2011). GPC has undertaken eight surveys of migratory shorebirds from North Curtis Island and the Fitzroy estuary to Rodds Peninsula, including sites on HHI and the adjacent mainland. The results of the eight surveys have been analysed in Appendix E and this analysis indicates that the entire area provides internationally and nationally important feeding and roosting habitat for migratory and non-migratory shorebirds, including sites in intertidal mudflats and salt pans on the south-eastern corner of HHI (see also Section 0). On this basis, intertidal flats of Seven Mile Creek, Boyne Creek and Colosseum Inlet are part of a nationally and internationally important area for migratory shorebirds and make a major contribution to the OUV of the GBRWHA, particularly when considered in conjunction with similarly important sites in Port Curtis/Gladstone Harbour, the Narrows and north Curtis Island/Fitzroy River estuary. Note however that there is no evidence of seabird breeding colonies on or around HHI and the migratory shorebirds identified in the Seven Mile Creek/Boyne Creek/Colosseum Inlet/Rodds Bay area are non-breeding populations. **Significance: Minor expression (diversity of birds), minor contribution** **Internationally important expression (eastern curlew), major contribution** **Nationally important expression (other shorebirds), major contribution**
The continental islands support thousands of plant species, while the coral cays also have their own distinct flora and fauna.	Surveys of HHI have not identified any rare or threatened plant species (SKM 2007). Several vulnerable plants, including Wedge-leaf tuckeroo and *Germainia capitata* have potential to occur, but have not been found in surveys to date (see also Section 7.4.3.15). Diversity of plants on HHI, particularly at ground level, is relatively low, probably reflecting historic grazing and burning practices. Some weed

Outstanding Universal Value [1]	Extent to which HHI and Surrounding Waters Contribute to the OUV
	invasion has occurred. Hummock Hill Island is located in the Capricorn floristic region. The Capricorn region has the lowest biodiversity of the five floristic regions of the GBR (Batianoff and Dillewaard 1996). HHI is located close to the mainland and distinct flora and fauna have not evolved on the island. Vegetation of HHI is not particularly distinct in a local or regional context, however HHI does support one critically endangered ecological community, *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*. This ecological community is also present along much of the east coast of Curtis Island within the GBRWHA, including in some areas protected under the Queensland NC Act. Two REs (as defined in the Queensland regional ecosystem database) that occur on HHI are not present on any other islands within the WHA, namely *Eucalyptus melanophloia* woodland (12.12.8) and *Eucalyptus tereticornis* and *E. crebra* dominated forests (12.12.12). While similar species and communities are present on Curtis Island, these are in a different bioregion, when defined under Queensland legislation. Component species, and similar species associations are present on nearby continental islands, however the underlying geology is different and hence, these species and associations are located in a different bioregion. qwe **Significance: Regionally important expression, moderate contribution**

(1) UNESCO June 2012a, see also Appendix C2

In relation to the criterion "contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation", HHI and surrounding waters make a minor or moderate contribution to the OUV of the GBRWHA due to a number of features as follows:

- Minor expression of biodiversity, supporting a wide range of plants and animals typical of the Capricorn/Mackay region, including some threatened species and a threatened ecological community
- Regionally important expression of shallow intertidal and subtidal mangrove, seagrass and mud flat habitats
- Regionally important expression in relation to dugong habitat, with the wider Rodds Bay DPA supporting 5-10% of the southern GBRMP population of Dugong
- Minor expression as habitat for the Indo-Pacific humpback dolphin
- Regionally important expression as habitat for green, flatback and loggerhead turtles, with minor nesting by flatback turtles occurring some years
- Internationally (eastern curlew) and nationally (all other species) important expression of values relating to roosting and feeding sites for migratory shorebirds
- Regionally important expression of floristic diversity, with two vegetation communities that, while present on the adjacent mainland, are not well represented elsewhere in the GBRWHA
- Contains a critically endangered threatened ecological community.

On this basis, HHI is of **moderate importance in terms of its contribution to** this criterion when considered overall and makes a moderate contribution to the OUV of the GBRWHA. Migratory shorebird habitat and critically endangered regional ecosystem are considered of **highest importance** as individual features and make a major contribution to the OUV of the GBRWHA, particularly when considered in conjunction with similarly important sites in Port Curtis/Gladstone Harbour, the Narrows and north Curtis Island/Fitzroy River estuary.

7.2.6 Integrity

7.2.6.1 Overview

The operational guidelines also note that for a property to be deemed to be of outstanding universal value, it must meet the conditions of authenticity (for properties nominated under the anthropogenic criteria 1 to xi) or integrity (for all properties) (UNESCO July 2012, paragraph 78).

Integrity is defined in the operational guidelines as a *measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes* (UNESCO July 2012, paragraph 88).

The operational guidelines then note that: *examining the conditions of integrity therefore requires assessing the extent to which the property:*

a) includes all elements necessary to express its outstanding universal value

b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance

c) suffers from adverse effects of development and/or neglect (UNESCO July 2012, paragraph 88).

In the statement of OUV, the concept of integrity as it relates to the GBRWHA is examined (UNESCO June 2012a, see also Appendix C2). This section reviews these aspects in relation to the importance of HHI and surrounding areas in maintaining the integrity of the GBRWHA.

7.2.6.2 Includes All Elements Necessary to Express its Outstanding Universal Value

In the GBRWHA, many of the elements and components identified as contributing to the OUV occur over a wide geographic range. The element underpinning the OUV of the GBRWHA is the conglomerate of reefs known as the Great Barrier Reef which extends north to south for nearly 2000 kilometres from latitude 10°40'55"S to 24°29'54"S. In places, coral reef complexes are over 100km wide while the width from the coastline to the outer edge of the reef is 250km or more. The superlative aerial vistas referred to in the statement of OUV extend over tens or, in the case of the reefs themselves, hundreds of kilometres. Some of the most highly valued vistas above the water are combinations of contrasting landscapes extending from steep, forested islands to open waters extending over tens of kilometres.

In addition, some of the marine and bird species considered iconic to the GBRWHA cover wide ranges within and outside the GBRWHA and some also require different habitats at different stages of their lifecycle. By encompassing non-reef habitats in the GBRWHA, habitats important to the biodiversity of the GBRWHA are included.

The need to encompass all of these elements has led to the boundary of the GBRWHA extending well beyond the reef ecosystems themselves to include areas that, while not of themselves containing the superlative phenomenon and unique features reflected in the statement of OUV, are important in maintaining the OUV of the GBRWHA (Lucas *et al.* 1997).

From this point of view, and based on the analysis presented in Sections 7.2.2 to 7.2.5, most components of HHI and surrounding waters make no contribution or a minor contribution to the OUV of the GBRWHA. There are some components of HHI and surrounding waters that make more highly or moderately important contributions to the OUV of the GBRWHA as follows:

- Migratory shorebird roosting and foraging habitat on and adjacent to HHI is part of an internationally (eastern curlew) and nationally (other species) important conglomerate of sites. Key sites on HHI in this regard are to the south-east of the island. This aspect therefore represents a highly important element in the overall expression of OUV and makes a major contribution to the OUV of the GBRWHA (see also Section 7.2.5).
- HHI features two patches of an EPBC Act critically endangered threatened ecological community and also two vegetation communities that are not well represented elsewhere in the GBRWHA. As floristic diversity across a wide latitudinal range is recognised as one aspect of the OUV of the GBRWHA, HHI makes a moderately to highly important contribution in this regard (see also Section 7.2.5).
- Waters provide habitat for dugong (EPBC Act listed migratory species) and some EPBC Act listed vulnerable and migratory species of marine turtles also utilise waters around HHI at certain stages of their lifecycle. One endangered marine turtle has also been observed. While the waters around HHI are not recognised as core or important habitat for these animals, the waters are considered of moderate importance in relation to preservation of these elements specifically mentioned in the statement of OUV of the GBRWHA.
- A range of fish species utilise estuarine waters such as those present inshore of HHI at certain stages of the lifecycle.

Refer to Section 1.7.4 for further definition of what constitutes a lower, moderate or higher value in relation to GBRWHA and a minor, moderate or major contribution to the OUV of the GBRWHA.

7.2.6.3 Is of Adequate Size to Ensure the Complete Representation of the Features and Processes Which Convey the Property's Significance

The focus of the GBRWHA is on the coral reef ecosystem and associated scientific and aesthetic values that such a vast and diverse ecosystem provides (UNESCO June 2012a). The statement of OUV clarifies that the inclusion of a much broader area within the WHA is based on ensuring "the integrity of the coral reef ecosystems in all their diversity" (UNESCO June 2012a, see also Appendix C2). As such, while HHI and the surrounding area does not feature coral reef environments, its inclusion in the GBRWHA can be seen as important in providing a buffer area of sufficient size to protect the GBR ecosystem.

The features of HHI and its surrounding waters are not specifically referenced in the listing of values that convey the OUV, and are not considered to be highly representative of features and processes which convey the overall significance of the property. HHI does however feature important habitats for migratory shorebirds, moderately important habitats for marine turtles and dugongs and vegetation communities that contribute to floristic diversity of the GBRWHA which can be considered representative of these values.

7.2.6.4 Suffers from Adverse Effects of Development and/or Neglect

The statement of OUV also recognises that there are a number of legacy issues in relation to current and previously proposed developments that pre-date declaration of the GBRWHA and that a range of important human uses continue to take place in the WHA. Given that the GBRWHA covers one third of Queensland's coastline, it would be unreasonable to prohibit coastally dependent activities from occurring within the WHA. In recognition of this, the statement of OUV notes that "*The World Heritage property is and has always been managed as a multiple-use area*" (UNESCO June 2012a, Appendix C2).

However, these activities, together with activities on the mainland in catchments that drain to the GBRWHA place some pressure on the intactness of the coral reef ecosystem and associated values, particularly in relation to water quality and loss of coastal habitats. The GBR outlook report (GBRMPA 2009) also identified climate change as a critical threat to the coral reef ecosystem.

HHI is located immediately south-east of an area that has undergone significant development. Gladstone Harbour, 25 km to the north-west, is Australia's largest coal export port and is also the site of four major LNG processing plants, preparing LNG for overseas export markets. The shipping channel for Gladstone Harbour passes less than 10 km to the north of HHI. A major alumina refinery is located 15 km to the north-west and the community of Tannum Sands is located 12 km to the north-west. Due to the low topographic relief between HHI and Gladstone, structures from these developments are visible from HHI and lights and light glow from these developments are visible from various locations on and around HHI at night.

The extent to which the marine and estuarine habitats of Port Curtis may have been affected by past and recent development is not yet clear. Ongoing monitoring has been undertaken in recent years and the Port Curtis Integrated Monitoring Program (PCIMP) has not identified significant degradation between 2007 and 2010 and reports that the condition of impact sites remains good, and similar to reference sites (Vision Environment 2011). Waters of Colosseum Inlet, Boyne Creek and Seven Mile Creek may be remote enough from this development that impacts have not occurred. More recent monitoring results from the PCIMP program are not available.

Waters around HHI are also affected by catchment runoff from the mainland catchments of Colosseum Inlet, Boyne Creek and Seven Mile Creek which have been cleared and have undergone a low to moderate level of urban development and widespread agricultural development. Effects of catchment runoff have been identified in the GBRMP Outlook Report as moderate to major risks to the GBR (GBRMPA 2009). The Great Barrier Reef Report Card series indicates that marine water quality in the Burnett Mary Region was good to very good in 2009, but had degraded significantly in 2010, partly due to above median rainfall in this year and remained poor in 2011, again partly due to extremely high rainfall in this year (State of Queensland 2011, State of Queensland 2013a, State of Queensland 2013b).

However, results of the PCIMP program indicate that the reference sites in waters around HHI have a high level of compliance with most of the performance indicators (Vision Environment 2011). Hence the current level of threat from catchment development and runoff is not likely to cause obscurement of values of the GBRWHA in the locality of HHI.

HHI itself has been previously modified by logging and grazing, with most impacts occurring within the special lease area. During this time, weeds and feral animals became established on HHI. Since grazing ceased around 20 years ago, there has been recovery of forest and woodland ecosystems in the disturbance area, however some evidence of the previous land use remains in terms of remnant structures as well as modification to vegetation. As there has not been any active management of HHI since it was used for grazing, weed invasion is affecting some ecosystems, including the critically endangered ecosystem, *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* (SKM 2007, Darren Maxwell, pers com 2010). However, it is not considered likely that these current threats have caused or would cause values of the GBRWHA to be obscured.

7.2.7 Protection and Management

Another important condition in relation to a world heritage property is that the property has “an adequate protection and management system to ensure its safeguarding” (UNESCO July 2012 paragraph 78).

The e statement of OUV notes the complexity of managing such a large area, in multiple jurisdictions and with multiple uses occurring.

Much of the GBRWHA is managed as part of the GBRMP. For HHI, the waters from low water mark along the northern side of the island are part of the federally managed GBRMP while enclosed waters between HHI and the mainland are part of the GBRCMP which is managed by the State of Queensland. Waters between high and low water mark along the northern coastline of HHI are also part of the Coast Marine Park (See Figure 6.35).

Seventy islands within the WHA have been declared as national parks, with some managed in conjunction with the marine park and others under Queensland legislation. HHI itself is not one of these. The statement of OUV clarifies that “the Queensland Government is responsible for natural resource management and land use planning for the islands, coast and hinterland adjacent to the GBR” but that any development on islands within the GBRWHA is also subject to assessment and approval under the EPBC Act.

The HHID received approval from the Queensland government in February 2011, through the release of a Coordinator-General's report under the SDPWOA. The assessment process underlying this approval included consideration of the consistency of the development with Queensland land use planning and natural resource management legislation and policies. This is discussed further in Section 3.

7.3 Natural Heritage Places

The GBRWHA was added to the National Heritage list on 21 May 2007 by virtue of being a declared world heritage area. While there are no site specific criteria in relation to the national heritage listing, a place listed on the national heritage register must fulfil one or more of the national heritage criteria (Australian Heritage Council 2009). National heritage criteria relevant to the GBR are briefly discussed in Table 7.5. These criteria are encapsulated by the statement of OUV (Section 7.2.1, see also Appendix C2).

As part of the GBRWHA, HHI contributes holistically to the national heritage listing in the same way that it does to the WHA and this contribution can be understood by analysis of the presence of features that contribute to the OUV of the GBRWHA on and around HHI as presented in Sections 7.2.2 to 7.2.5.

Table 7.5 – National Heritage Criteria

National Heritage Criteria	Representation by GBRWHA
The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history	The GBR is an iconic feature of Australia and is highly valued by Australians.
The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history	The GBR contains a range of uncommon, rare or endangered features including geological, geomorphological and ecological features, and rare and threatened species.
The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history	Geological, geomorphological and ecological features contribute to understanding of evolutionary processes and natural history.
The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: • A class of Australia's natural or cultural places; or • A class of Australia's natural or cultural environments	The GBR is highly representative of coral reef and related coastal and marine ecosystems, and is considered one of the best examples in the world.
The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group	One of the key features of the GBR that are valued by Australians is the high visual amenity of many areas within the marine park and WHA.
The place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period	Not relevant
The place has outstanding heritage value to the	Indigenous people have strong associations with the

National Heritage Criteria	Representation by GBRWHA
nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons	GBR, in terms of food and other resources and spiritual and cultural associations. Spiritual and cultural associations include associations with particular places as well as animals.
The place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history	Not relevant
The place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.	Indigenous people have strong associations with the GBR, in terms of food and other resources and spiritual and cultural associations. Spiritual and cultural associations include associations with particular places as well as animals.

There are no other national heritage places within or in proximity to the project.

Evaluation of impacts of the PTP on national heritage values overlaps with the assessment of impacts on world heritage values and is provided in Section 8, with a more detailed evaluation of potentially significant impacts provided in Section 11.

7.4 Listed Threatened Species and Communities

7.4.1 Overview

Ecological surveys have been conducted on and around HHI since the 1980s. Section 6.7.1.2 provides a summary of overall terrestrial survey effort and the general findings of surveys are presented in Section 6.7. Results of marine-based surveys are provided in Section 6.6. This section focuses on those ecological communities and individual species listed under the EPBC Act that are known or likely to occur on and around HHI, based on survey results and the results of a search of the DotE protected matters database (see Appendix C1).

Evaluation of impacts of PTP on listed threatened species and ecological communities is undertaken in Section 8, and where potentially significant impacts are identified, further evaluation is provided in Section 9. Where the likelihood of occurrence assessment presented in this section indicates low likelihood of occurrence, or that the species is not present, no further assessment has been undertaken.

7.4.2 Ecological Communities

7.4.2.1 Distribution and Key Characteristics

HHI features vegetation that meets the criteria for a critically endangered ecological community, *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*. This ecological community meets the following criteria for listing of an ecological community:

- Criterion 2 - Small geographic distribution coupled with demonstrable threat
- Criterion 4 - Reduction in community integrity (TSSC 2008a).

This ecosystem occurs within about 2 km of the coast or coastal estuaries from Princess Charlotte Bay in the Cape York Peninsula Bioregion, Queensland, to the Gippsland Lakes in the South East Corner Bioregion, Victoria (TSSC 2008a). The ecosystem occurs on a range of geological strata over a large latitudinal extent through multiple climatic zones, with one of the key distinguishing features being a salt tolerant canopy. Using the Queensland regional ecosystem classification system, regional ecosystem 12.2.2 (Microphyll/notophyll vine forest on beach ridges) corresponds to the critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia.*

On HHI, the vine thicket community occurs in a mosaic with *Corymbia spp., Eucalyptus spp., Acacia spp.* open forest to low closed forest. The extent of this vegetation community is shown on Figure 7.1. In the patch to the west, microphyll/notophyll vine forest on beach ridges, corresponding to Queensland regional ecosystem classification 12.2.2 is the dominant community. *Corymbia spp., Eucalyptus spp., Acacia spp.* open forest to low closed forest, corresponding to Queensland regional ecosystem 12.2.11 is the dominant community in the patch running parallel to the northern beach, east of the headland with microphyll/notophyll vine forest on beach ridges occurring as a sub-dominant community.

Listing advice prepared for DotE and the EPBC Act policy statement on this community did not identify any particular cultural significance of the community (DEWHA 2009c, TSSC 2008a). Like all coastal ecosystems, the ecological community plays an important function in stabilisation of the coastal zone.

It should be noted that mapping prepared by the then DEWHA as part of the listing process does not show the communities on HHI (DEWHA 2009c), possibly because these are largely present as subdominant or mosaic patches within a more broadly classified vegetation community. The ecological community was also not identified in the Protected Matters Search Report (Appendix C1). However, field surveys undertaken by CQU (2006) and SKM (2007) confirm the presence of this ecological community and correlation with Queensland RE mapping also indicates presence.

LEGEND

- Development Footprint
- Littoral Rain Forest and Dominant Coastal Vine Thickets
- Littoral Rain Forest and Sub-dominant Coastal Vine Thickets

Figure 7.1 Occurrence of Littoral Rainforest and Coastal Vine Thickets of Eastern Australia on HHI

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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7.4.2.2 Extent

Pre-clearing extent and current extent of this ecological community has been estimated for Queensland based on the Queensland RE classifications and is shown in Table 7.6 (TSSC 2008a). The remnant extent of this ecological community in the SEQ Bioregion is 1,977 ha in 2003, from an estimated pre-clearing extent of 2,993 ha (TSSC 2008a). The total area of vegetation communities encapsulating this threatened ecological community on HHI is about 190 hectares in two main patches on the northern (exposed) coast as shown on Figure 7.1. These areas occur as a mosaic rather than a homogenous patch, but still contain species and features characteristic of this TEC.

While it does not appear that the patches on HHI have been included in this inventory, the total area of patches on HHI represent about 10% of the total bio-regional extent and are highly significant, in spite of the patches occurring as a mosaic and of degradation from weed invasion and .

Table 7.6 - Decline in Extent of the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia in Queensland (TSSC 2008a)

Bioregion	Pre-Clear Extent (ha)	Remnant Extent 1997 (ha)	Remnant Extent 2003 (ha)	Decline Pre-Clear to 2003
Cape York Peninsula	9,952	9,946	9,924	0.3 %
Wet Tropics	22,717	20,012	20,009	12 %
Central Queensland	2,826	2,513	2,497	12 %
South-East Queensland	2,993	1,995	1,977	34 %
All Queensland REs	38,488	34,466	34,407	11 %

The size of the two patches on HHI is also significant, given that an estimated 77% of known patches in Queensland are less than 10ha in size (TSSC 2008a). Fragmentation and small patch size is one of the main reasons for the ecological community being listed under the EPBC Act.

Nearby patches of Littoral Rainforest and Coastal Vine Thickets of Eastern Australia occur at Curtis Island, Boyne Island, Rodds Peninsula and Bustard Head (TSSC 2008a). There is potential for bird dispersal of seeds between HHI and patches of coastal vine thicket on nearby islands and on the mainland, and, to a lesser extent, wind dispersal.

7.4.2.3 Condition and Threats

The vegetation community on HHI is in moderate condition, with some significant rubber vine invasion (SKM 2007, D Maxwell pers com 2010). In 1994, Dames and Moore observed that "*the littoral vine habitat is considered to be of conservation value for wildlife only at a local level. This is due to its limited size and poorly developed structure. Few specialist birds were observed in this area.*" (Dames and Moore 1995).

The most significant threat to the *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* ecological community has been clearing for coastal development. This has not occurred on HHI as previous land uses were pastoral and logging. Fragmentation, including through roads and beach access trails is also of concern, and only limited fragmentation for rough tracks and a single beach shack has occurred on HHI. While fire resistant, inappropriate burning of the ecological community is also a threat. It is not known to what extent fire may have affected the patches on HHI over time, however, it is likely that the frequency of fire increased.

Weed invasion has occurred within the vine thickets on HHI, primarily through rubber vine (SKM 2007, D Maxwell 2010 pers com).

There is evidence from old fencing that the vine thicket was at least partially fenced off during pastoral activities. Deer, which have also been identified as a threat to this ecological community, are not present on HHI.

Clearing has occurred adjacent to the patch of vine thicket east of the headland, thus exposing several hundred metres of the patch to edge effects. This is also the narrowest area of the patch.

Generally however, the two patches are currently considered to be in good condition and the size of the patches increases the ecological value. As this is an example of a critically endangered regional ecosystem, the community is considered to be of **highest importance** against the criteria established in Section 1.7.4.2.

7.4.3 Terrestrial Threatened Species

7.4.3.1 Water Mouse

The water mouse, *Xeromys myoides*, is listed as vulnerable under the EPBC Act, and also under the Queensland *Nature Conservation Act 1992*. The water mouse uses coastal saltmarsh, mangrove and adjacent freshwater wetland habitats and is known from coastal areas in the Northern Territory, Queensland and New Guinea (DERM 2010).

Mapping accompanying DotE's significant impact guidelines for the vulnerable water mouse (DEWHA 2009b), indicates occurrence of this species on the eastern end of HHI. An extract of this mapping is shown in Figure 7.2 and the full map is available at http://www.environment.gov.au/epbc/publications/xeromys-myoides.html. Intertidal and supratidal mangroves and saltmarshes on the southern shore of HHI and the adjacent mainland shoreline also provide potentially suitable habitat for water mouse. The location of these habitat features is shown on Figure 7.3. Eurimbula National Park to the south-east of HHI has been identified as an important population of water mouse (DERM 2010) and there are also records from the mainland coast of Seven Mile Creek immediately south-east of HHI (DEWHA 2009b).

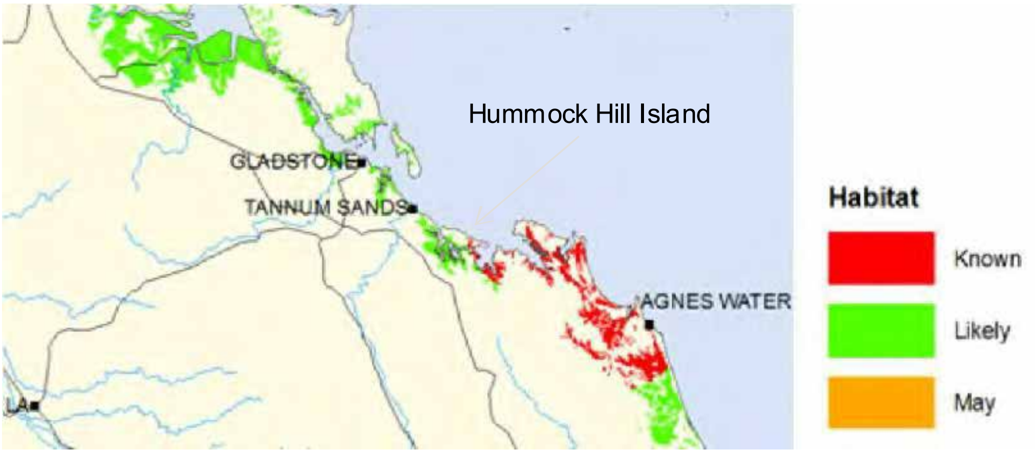

Figure 7.2 – Water Mouse Habitat - Extract from Central South Queensland Map 2
http://www.environment.gov.au/epbc/publications/xeromys-myoides.html

Extensive surveys across all potential water mouse habitat on HHI have not been undertaken as development has never been proposed in or immediately adjacent to most habitat. A trapping program was undertaken in the vicinity of the bridge and boat ramp to ascertain whether this area was utilised by water mouse; however no animals were captured and no signs of presence were observed (SKM 2007).

Regardless, given the previous record from the Wildnet database, presence of suitable habitat and other known populations in the area, and low success rate of trapping programs, for the purposes of this assessment, the water mouse is considered highly likely to be present on HHI, although it does not appear that an important population is present.

The threatened species recovery plan for water mouse notes that insufficient information is available to determine whether there is exchange of genetic material between isolated populations (DERM 2010). Water mouse is reasonably mobile, with home ranges estimated at around 0.7 ha (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66, accessed 27/01/2013). Dispersal movements are not well known, however given proximity of HHI to the mainland, it is possible that animals may move between habitats on HHI and the adjacent mainland coast.

Habitat loss and habitat degradation or alteration, are identified in the species recovery plan as key threats to the survival of water mouse. Processes that alter habitat include changes in hydrology from altered surface drainage in adjacent areas inland of habitat. As water mouse feeds on invertebrates gleaned from mudflats, impacts on water and sediment quality may reduce food availability and hence threaten water mouse populations. Threatening processes in this regard include oxidation of potential acid sulphate soils due to disturbance, as well as contaminated stormwater runoff and discharges from wastewater treatment plants. These threatening processes are generally absent from HHI, with only minor direct habitat loss to date in the vicinity of the existing causeway and only minor alteration of freshwater runoff due to construction of several small farm dams on creeks draining to the south-west of the Island.

LEGEND

Development Footprint

Inferred Habitat Area

Figure 7.3 - Inferred Suitable Water Mouse Habitat

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Predation is also identified as a threatening process and this threat is present on HHI as there are feral cats and dogs.

The Australian Government species profile and threats database does not identify any particular cultural, social or economic values associated with water mouse (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66, accessed 27/01/2013).

On the basis of habitat suitability and at least one recorded sighting on the east of HHI the water mouse has been assumed to be present for the purposes of optimisation of the development footprint and ongoing management of environmental values. However, in accordance with the criteria established in Section 1.7.4, HHI is of lower or possibly moderate importance in relation to water mouse. The area of water mouse habitat in proximity to the development area is considered of lower importance as water mouse were not identified in a survey undertaken at this location.

7.4.3.2 Black-breasted Button Quail

The black-breasted button quail, *Turnix melanogaster*, is listed as vulnerable under the EPBC Act, and also under the Queensland *Nature Conservation Act 1992*. The black-breasted button quail occurs in semi-evergreen vine thicket and coastal thicket (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=923, accessed 28/10/2012). Location of suitable habitat coincides with the location of the endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and is shown on Figure 7.1.

Black-breasted button quail scats and “platelets” characteristic of several button quail species including the black-breasted button quail have been observed in the *Coastal Vine Thicket* east of the headland in a 2006 survey (SKM 2007). The 1993 survey noted a sighting of a quail but did not identify the species of quail. Black-breasted button quail are cryptic and shy, and hence difficult to observe in field surveys.

Therefore, while there has not been a direct sighting of the black-breasted button quail on HHI, suitable habitat is present on HHI in the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community and there is evidence that the button-quail species are present in this habitat.

The black-breasted button quail is reasonably tolerant to dry conditions and therefore lack of permanent water on HHI would not preclude presence of this species. It feeds on ground dwelling invertebrates and seeds and characteristically forages in leaf litter 3-10 cm deep using its tail to clear a “platelet” (Mathieson and Smith 2009).

Figure 7.4 – Black Breasted Button Quail (NSW NPWS Undated)

The bird is relatively sedentary and flies only for very short distances. Therefore if black-breasted button quail are present on HHI, it is unlikely that birds would move between HHI and the mainland. Black–breasted button quail have occasionally been seen in more open woodland areas, and hence, it is possible that the birds might move between patches of vine thicket on the western end of HHI and east of the headland (Mathieson and Smith 2009). Females are territorial while breeding, otherwise birds may occur singly or in small groups. Females may mate with several males in a breeding season and lay clutches of three to four eggs. The male incubates and tends the young.

Black-breasted button quail nest, roost and feed on the ground, which increases vulnerability to predation and disturbance.

As no actual birds have been identified, the population size cannot be estimated. Given that there is no direct connectivity with the mainland, potential for genetic isolation exists, however most known populations of black-breasted button quail occur in isolated circumstances so a population on HHI would not be unusual in this regard (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=923, accessed 26/01/2013). The Recovery Plan notes sightings of black-breasted button quail on the mainland around 50 km to the north-west of HHI and around Baffle Creek over 70 km to the south-east. The nearest noted population is at Kalpower (including Bulburin National Park), about 80 km south-west of HHI. Black-breasted button quail on HHI would be very unlikely to interact with these populations even if habitat connectivity existed.

Current threats to black-breasted button quail include predation from feral cats and dogs as well as habitat loss and fragmentation and fire. Wild dogs have been seen on HHI as recently as 2012 (J Kelly pers com) and previous surveys also identified the presence of feral cats and dogs (SKM 2007). Historic aerial photography indicates that clearing and logging activities did not appear to take place in the coastal vine thicket but the observations of Dames and Moore (1994) indicate that grazing disturbance and possibly fire disturbance had occurred.

The SPRAT database notes that there is no evidence of a further decline in black-breasted button quail numbers in the last decade which is attributed to stricter controls on clearing of habitat (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=923, accessed 26/01/2013).

The Australian Government species profile and threats database does not identify any particular cultural, social or economic values associated with black breasted button quail (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=923, accessed 26/01/2013).

On the basis of habitat suitability and observations of signs that may indicate black-breasted button quail, the species has been assumed to be present for the purposes of optimisation of design of the project and ongoing management of environmental values.

7.4.3.3 Grey-headed Flying-fox

The grey-headed flying fox, *Pteropus poliocephalus*, is vulnerable under the EPBC Act but is considered least concern under the Queensland *Nature Conservation Act 1992* indicating that the species is relatively abundant in Queensland. Listing under the EPBC Act is based on a decline in numbers rather than a decline in range (TSSC advice 2001, http://www.environment.gov.au/biodiversity/threatened/species/p-poliocephalus.html accessed 27/01/2013).

The current northern extent of grey-headed flying fox appears to be around Bundaberg and Hervey Bay, with the species extending south to Melbourne and also recently detected in South Australia. However, the northern extent of the range may have once extended to Rockhampton, with camp sites recorded at Rockhampton in 1929 (TSSC advice 2001, http://www.environment.gov.au/biodiversity/threatened/species/p-poliocephalus.html accessed 27/01/2013).

Flying foxes were observed foraging on HHI during a survey in 1993 but the individual species were not identified (AGC Woodward-Clyde 1993). Queensland's wildnet database also records a sighting on HHI and SKM noted that grey headed flying fox had been observed foraging on HHI (SKM 2007). Roosts or camps have not been seen. The SPRAT database indicates that in 2004/05 the nearest major population (more than 10,000 individuals) was at Hervey Bay, nearly 200 km south-east of HHI (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 accessed 27/01/2013). There are no known camps closer to HHI.

Flying fox camps and habitat are shown on Figure 7.5. This includes camps of other flying fox species, most notably the black flying fox (*Pteropus alecto*).

Camps and roosts are typically near lakes, rivers or the coast and may occur in rainforest patches, stands of melaleuca, mangroves and riparian vegetation (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 accessed 27/01/2013. Camps in urban areas use modified vegetation indicating flexibility in roosting habitat.

Grey-headed flying foxes are believed to typically forage over areas up to 15 km from their roost/camp sites, but may travel up to 50 km if foraging resources are poor, and have also been recorded making longer seasonal journeys between camps.

The grey-headed flying fox feeds on nectar and pollen from eucalypts, melaleucas and banksias. It will also forage on introduced species and will forage in urban areas, with known large populations in major metropolitan areas.

As grey-headed flying foxes migrate between camps, the entire population is considered to be a single breeding population (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 accessed 27/01/2013).

The Australian Government species profile and threats database does not identify any particular cultural, social or economic values associated with grey headed flying fox (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 accessed 27/01/2013).

Based on the available information, HHI is considered to provide foraging habitat, albeit beyond the edge of the current range of grey-headed flying fox. HHI does not support a population of grey-headed flying fox and its distance from the currently accepted northern range extent indicates that it would only be used intermittently for foraging. However, should the northern range of the grey-headed flying fox be restored to its original extent (Rockhampton), HHI would be within this range. The importance of HHI to grey-headed flying fox is assessed as lower importance.

LEGEND

- Towns
- Flying Fox Roosting Sites (Inc. Black-headed Flying Fox)
- Main Roads
- Roads
- Development Footprint
- Offset Areas - see also Figure 3.1

Regional Ecosystem

- Remnant Vegetation Communities
- Non-remnant Vegetation Communities (limitied foraging)

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Figure 7.5 - Flying Fox Habitat and Camps

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7.4.3.4 Squatter Pigeon

The protected matters search tool indicated that HHI is within the range of the vulnerable squatter pigeon, *Geophaps scripta scripta*. Squatter pigeon is listed as vulnerable under the EPBC Act. Squatter pigeon utilises a wide range of grassland and open woodland habitats, including habitats modified by grazing. The species has a tendency to occur around cattle yards, access tracks and other disturbed areas (Higgins and Davies 1996, Garnett *et al*. 2011)).

In five fauna surveys undertaken on HHI since 1993, squatter pigeon has not been identified on HHI. As squatter pigeon inhabits grassy areas in relatively open woodlands, as well as modified grassland habitat, it is relatively easy to detect and if present, it is likely that it would have been readily observed during the number of field surveys that have taken place since 1993. The most suitable habitat exists on the flatter land between the causeway and headland to the east of the main ridgeline, and as the main access track between the causeway and headland traverses this area, survey teams would have ample opportunity to opportunistically sight this species while travelling around HHI, in addition to potential sightings in targeted surveys.

Foraging habitat is usually considered as habitat within three kilometres of permanent water while breeding habitat is typically on stony rises in sandy or gravelly soil types, within 1 km of a suitable, permanent waterbody (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64440, accessed 21/8/2013). While HHI has suitable grassland and open woodland habitats, permanent water has not been historically available on HHI.

It is considered unlikely that squatter pigeon have dispersed to HHI since permanent water became available with the commencement of grazing habitat. There is no record of the species within 25 km of HHI in the Queensland Government Wildlife Online database. Targeted surveys at Tannum Waters also failed to identify squatter pigeon (Austecology 2012). Further, the squatter pigeon is relatively sedentary species, only dispersing over distances of more than several kilometres when accessing water resources in drought conditions, and generally only making short flights to escape threat. For this reason, HHI is also not considered to provide dispersal habitat for squatter pigeon.

Given that it has not been observed during surveys, in spite of being easy to detect, the lack of permanent freshwater on HHI and the lack of records within 25km, it is not considered likely that squatter pigeon is present on HHI. Impacts on this species are not considered further in this assessment.

7.4.3.5 Red Goshawk

The protected matters search tool indicated the potential presence of red goshawk, *Erythrotriorchis radiatus*, which is listed as vulnerable under the EPBC Act. The red goshawk is reported as being sparsely distributed across coastal and near coastal areas from the Kimberley Ranges to Northern New South Wales.

Red goshawk has not been sighted on HHI. The bird is generally inconspicuous and secretive and individuals have a wide home range and occur at low densities, making it difficult to confirm absence even where surveys have been undertaken (DEWHA 2010). Mapping provided in the recovery plan indicates a sighting in the Gladstone area (DERM 2012). Wildlife online records show that there have not been any sightings within 25km of HHI, however there have been sightings in the Gladstone Regional Council area. It is known from the Kroombit Tops area, about 50km south-west of HHI and Eurimbula National Park, approximately 30km south of HHI (Austecology 2012).

Red goshawk forages across a range of several hundred kilometres but is rarely seen away from large areas of intact woodland and focusses on riparian areas (SKM 2009). Red Goshawk preys almost exclusively on birds and its hunting style leads to a preference for open woodland where it can manoeuver easily. Preferred areas feature permanent water and fertile soils supporting relatively rich bird populations, conditions which are not typically met on HHI (DERM 2012).

Red goshawk usually nests within 1 km of permanent freshwater, and typically adjacent to the watercourse and therefore is unlikely to nest on HHI (DERM 2012).

The current distribution of red goshawk occurs across five key areas, Top End, Tiwi Islands, Cape York, Central coastal Queensland and Southern coastal Queensland/Northern New South Wales. Available information on morphology of birds from each population indicates that these groups are not genetically distinct (DERM 2012). Movement patterns are not well known but it is likely that breeding pairs tend to remain in the same area for extended periods of time (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=942, 29/01/2013).

On the basis of foraging preferences, open woodlands on HHI may provide occasional foraging resources for red goshawk but are not likely to be core habitat, or nesting habitat.

7.4.3.6 Australian Painted Snipe

Australian painted snipe, *Rostratula australis*, was identified in the protected matters search tool as potentially present at HHI on the basis of potentially suitable habitat being likely to occur in the area. The EPBC Act conservation status of the Australian painted snipe was lifted from vulnerable to endangered in April 2013. It is also listed as migratory.

The Australian painted snipe typically inhabits large shallow wetlands, ephemeral and permanent, usually freshwater but occasionally brackish. It will also occasionally use inundated grasslands, saltmarsh, dams, rice crops, sewage farms and bore drains (Marchant & Higgins 1993). Preferred foraging habitat has shallow wetland fringes with relatively short sedge/grass cover and muddy edges (http://www.environment.gov.au/biodiversity/threatened/species/r-australis.html, accessed 29/01/2012).

Australian painted snipe feed on invertebrates taken from the water's edge and mudflats and nests in reed-like vegetation near the water's edge (Australian Government 2003). Breeding may be in response to favourable conditions in terms of wetland inundation. Hence, a key habitat aspect is ready access to the waterbody from the shoreline and steep sided waterbodies and waterbodies with trees or dense vegetation to the water's edge are not utilised by Australian painted snipe.

The Murray-Darling Basin is a stronghold for the bird and it is not generally considered a coastal species. Australian Painted Snipe have been reported and photographed by birdwatchers at wetlands in and around Brisbane and other urban areas such as Bundaberg and Rockhampton botanic gardens, indicating a tolerance for modified environments and some human activity.

Small ephemeral dune swale wetlands and dams created for the previous grazing activity on HHI are considered too small and narrow, and are steep sided with trees to the water's edge which does not allow foraging access for Australian painted snipe (see Figure 7.6). There is a larger dam on the southern side of HHI (see Figure 2.3 for location and photo in Figure 7.7) which although smaller than those wetlands typically utilised by Australian painted snipe, has some suitable habitat features. Australian painted snipe might be a rare and transient visitor to this dam. The dam would not provide breeding habitat.

Figure 7.6 – Smaller dams and wetlands with trees to the edge of water would not provide suitable habitat for Australian painted snipe

Figure 7.7 – Farm dam to south of HHI. Australian painted snipe may be a rare and transient visitor to this dam in wet years

Water management ponds that are to be created at the proposed golf course would provide suitable foraging habitat for Australian painted snipe provided that there were sections where the walls were not too steep, and vegetation was more open. Australian painted snipe have been observed using artificial waterbodies and in close proximity to human activity, and are not likely to be disturbed unless approached within about 20m.

Australian painted snipe has not been observed in surveys undertaken at HHI, nor are there any Wildlife Online records from the Gladstone Regional Council area, or within 25km of HHI. Suitable habitat is limited to a single farm dam, however Australian painted snipe is assessed as potentially being only a rare and transient visitor to this dam. As this dam dries out in drought conditions, it does not provide refuge habitat in droughts. On this basis, HHI is not likely to provide important or core habitat for the Australian painted snipe, and this bird would be expected only on a very intermittent basis. As the farm dam is not affected by the proposed PTP, and additional habitat in the form of lagoons at the golf course will be provided as part of PTP, impacts on Australian painted snipe are not considered further.

7.4.3.7 Brigalow Belt Reptiles

Overview

While HHI is not strictly located in the brigalow belt, it is identified as adjacent to areas on the mainland where brigalow belt reptiles may occur (SEWPaC 2011, http://www.environment.gov.au/epbc/publications/pubs/draft-brigalow-belt-map01-allreptiles.pdf, accessed 12/08/2013). Species specific modelled distribution maps have been prepared for the Brigalow Belt Reptile draft referral guidelines (SEWPC 2011). These indicate that, while HHI is not identified in the modelled range of any of the Brigalow Belt reptiles, four of the Brigalow belt reptile species "may occur" on the adjacent mainland, being yakka skink, brigalow scaly-foot, collared delma and Dunmall's snake. Wildlife online has records of Yakka Skink and Dunmall's snake in the Gladstone Regional Council area, but there are no records of yakka skink, Dunmall's snake or collared delma within 25km of HHI. Brigalow scaly-foot is known from a colony on Boyne Island, 15-20km north of HHI.

Fauna surveys undertaken on HHI to date have not met the EPBC Act survey guidelines for brigalow belt reptiles, and some potentially suitable foraging and breeding habitat is present. While it is unlikely that these species would have colonised HHI from the mainland, this cannot be ruled out and mitigation measures including pre-clearing surveys are proposed as discussed in Section 9.2.2 as a contingency in case these species are present. As HHI is not connected to the mainland, it does not provide dispersal habitat for these ground dwelling species.

Threatening processes relevant to brigalow belt reptiles considered here include:

- Loss of habitat due to habitat clearing and thinning
- Removal of microhabitat (woody debris and rocks)
- Inappropriate fire regimes
- Inappropriate roadside management
- Overgrazing
- Predation (Richardson, R, 2008).

Yakka Skink

Yakka skink, *Egernia rugosa*, is listed as vulnerable under the EPBC Act. Although most closely associated with the Brigalow Belt Bioregion, yakka skink have been sighted outside this area, including sightings near Miriam Vale and Bundaberg (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1420 accessed 29/01/2013). Modelled distribution for yakka skink does not show the species as known or likely to occur on HHI, but the adjacent mainland is modelled as an area where the species "may occur" http://www.environment.gov.au/epbc/publications/pubs/draft-brigalow-belt-map03-erugosa.pdf accessed 30/01/2013).

Although not identified in the distribution model, poplar box and iron bark woodland areas in Queensland Regional Ecosystem Land Zone 3 on HHI may provide suitable habitat, particularly on slopes as the species is generally known from more rugged terrain (SEWPaC 2011). Location of Queensland Regional Ecosystem Land Zone 3 is shown on Figure 6.55. Associated vegetation communities are as follows:

- *Eucalyptus tereticornis* woodland to open forest (155 hectares) (Queensland regional ecosystem classification 12.3.3).
- *Melaleuca quinquenervia*, *Eucalyptus tereticornis*, *Lophostemon suaveolens* woodland (61 hectares) (Queensland regional ecosystem classification 12.3.6)
- *Eucalyptus populnea* dominated forests on alluvial plains (Queensland regional ecosystem classification 12.3.10).

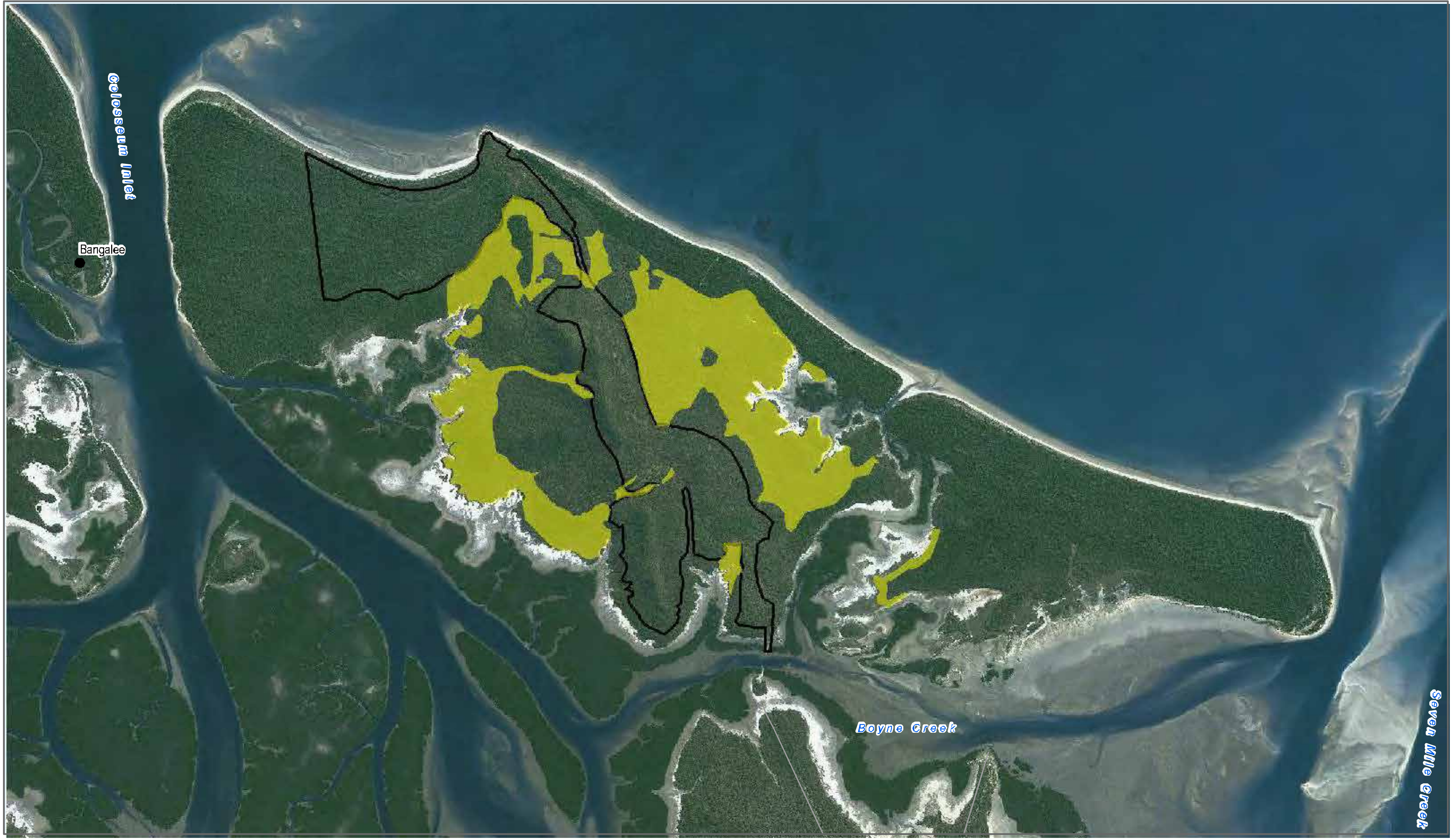
Two hectares of the *M quinquenervia* woodland on landzone 3 (Queensland regional ecosystem classification 12.3.3), being 1% of its extent on HHI, is within the development footprint as this is an endangered regional ecosystem, and the development footprint has been designed to avoid endangered regional ecosystems. 1 *E populnea* dominated forests (Queensland regional ecosystem classification 12.3.10) is also an endangered regional ecosystem and only 1.1 ha, being 0.7% of the extent on HHHI will be disturbed.

None of the *E. tereticornis* woodland on landzone 3 (Queensland Regional ecosystem classification 12.3.6) will be disturbed. Figure 7.8 shows suitable habitat for the yakka skink, based on occurrence of Queensland regional ecosystem classification landzone 3. Microhabitat requirements may not be present across the entire area shown.

Micro habitat requirements for colonies of yakka skink include rocks, hollow logs and dense ground vegetation and it may construct burrows. Slopes along the central ridgeline of HHI have rocky outcrops and may offer suitable micro-habitat. These areas were also less disturbed by logging and grazing activities, however, are still subject to predation from feral animals present on HHI and would have been affected by increased frequency of fire during grazing times.

Surveys undertaken on HHI have included active searches for ground dwelling fauna, particularly reptiles, and have not identified yakka skink. However, it is recognised that the species is cryptic and has a small home range, and hence, can be missed, even in targeted and systematic surveys. Fauna surveys have generally identified a low diversity of ground dwelling fauna (SKM 2007).

Yakka skink feed on plant materials, fruits and insects, not usually moving too far from shelter to feed.



LEGEND

- Towns
- Main Roads
- Roads
- Development Footprint
- Inferred Habitat Areas

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

0 0.5 1 1.5 2 km

1:50,000 on A4

Figure 7.8 - Inferred Suitable Habitat – Yakka Skink and Collared Delma

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I:\QENV2\Projects\QE99099\Spatial\ArcGIS\Figures\01_Final_Figures\Chapter_07\Figure7.8_Inferred_Habitat_YakkaSkink_CollaredDelma.mxd Date: 18/11/2013

Information on genetic diversity of yakka skink is not known, but current distribution is noted to be highly fragmented and this may affect genetic diversity. (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1420 accessed 29/01/2013). If a colony of yakka skink does exist on HHI, it is unlikely that it would have interacted with mainland colonies.

On the basis of presence of suitable habitat, it is possible that yakka skink could be present on HHI, in the rugged rocky slopes of the ridgeline and targeted surveys have not been conducted to inform an assessment of likelihood of occurrence. However, given that there are no known populations within 25km of HHI, that HHI is outside the modelled distribution range for Yakka Skink, low levels of ground dwelling fauna on HHI and previous disturbance, it is considered unlikely that the PTP footprint provides important habitat for yakka skink.

Brigalow Scaly-foot

Brigalow scaly-foot, *Paradelma orientalis*, was removed from listing under the EPBC Act in May 2013, but was listed as vulnerable at the time that the PTP was referred in 2012 and is therefore included in the guidelines as a species that must be considered in the EIS. Like the yakka skink, it is most closely associated with the Brigalow Belt Bioregion, however there is a known population on Boyne Island, 15-20 km north-west of HHI (http://www.environment.gov.au/biodiversity/threatened/species/pubs/59134-conservation-advice.pdf accessed 30/01/2013). Modelled distribution for brigalow scaly-foot does not show the species as known or likely to occur on HHI, but the adjacent mainland is shown as an area where the species "may occur" and Boyne Island as an area where it is known to occur (http://www.environment.gov.au/epbc/publications/pubs/draft-brigalow-belt-map03-erugosa.pdf accessed 30/01/2013).

Brigalow scaly-foot is found in a range of habitats including remnant brigalow woodland and eucalypt woodland with an understory of brigalow (Cogger et al 1993). It may also be found in vine thickets and other habitats with shelter provided by rocks, tussock grasses or thick leaf litter (http://www.environment.gov.au/biodiversity/threatened/species/pubs/59134-conservation-advice.pdf accessed 30/01/2013). On Boyne Island, a colony is located in woodland with sparse understorey and dense layer of leaf litter (Cogger et al 1993).

Although not identified in the species distribution model, habitat on HHI may be suitable for brigalow scaly-foot and the species is known from Queensland Regional Ecosystem land zone 3 (alluvium (river and creek flats)) which occurs on HHI as shown in Figure 7.8 and includes the following vegetation communities.

- *Eucalyptus tereticornis* woodland to open forest, including some areas at the base of the western facing side of the ridgeline (155 hectares) (Queensland regional ecosystem classification 12.3.3).
- *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland (61 hectares) (Queensland regional ecosystem classification 12.3.6).
- *Eucalyptus populnea* dominated forests on alluvial plains (Queensland regional ecosystem classification 12.3.10).

Two hectares of the *M quinquenervia* woodland on landzone 3 (Queensland regional ecosystem classification 12.3.3), being 1% of its extent on HHI, is within the development footprint as this is an endangered regional ecosystem, and the development footprint has been designed to avoid endangered regional ecosystems. 1 *E populnea* dominated forests (Queensland regional ecosystem classification 12.3.10) is also an endangered regional ecosystem and only 1.1 ha, being 0.7% of the extent on HHHI will be disturbed.

None of the *E. tereticornis* woodland on landzone 3 (Queensland Regional ecosystem classification 12.3.6) will be disturbed.

Surveys undertaken on HHI have included active searches for ground dwelling fauna, particularly reptiles, and have not identified brigalow scaly-foot. However, it is recognised that the species is cryptic and can be missed, even in targeted and systematic surveys, and that EPBC Act guidelines on survey for brigalow belt reptiles have not been strictly followed. Fauna surveys have generally identified a low diversity of ground dwelling fauna and this is consistent with previous patterns of disturbance as well as lack of freshwater resources (SKM 2007). Open woodland areas on HHI have been particularly subject to disturbance by grazing and logging.

On the basis of presence of suitable habitat, it is possible that brigalow scaly-foot could be present on HHI, particularly in areas of Queensland regional ecosystem land zone 3. Given lack of survey findings, generally low levels of ground dwelling fauna and previous disturbance, it is considered unlikely that the development footprint provides important habitat for brigalow scaly-foot.

Collared Delma

Collared delma (*Delma torquata*) is listed as vulnerable under the EPBC Act and is a small reptile endemic to Queensland. HHI is outside the modelled range of collared delma, however but the adjacent mainland is shown as an area where the species “may occur” (http://www.environment.gov.au/epbc/publications/pubs/draft-brigalow-belt-map07-dtorquata.pdf, accessed 12/08/2013).

The SPRAT database reports that seven significant and seven minor populations have been described in the Brisbane area, and six significant and nine minor populations have been described outside of Brisbane. Outside the western suburbs of Brisbane, collared delma has been recorded at the following sites:

- the Bunya Mountains (approximately 200 km north-west of Brisbane)
- Blackdown Tablelands National Park (approximately 200 km west of Rockhampton)
- Expedition National Park (Central Queensland)
- Western Creek, near Millmerran (approximately 200 km south-west of Brisbane)
- Toowoomba Range (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1656, accessed 01/08/2013).

The Queensland Wildlife Online database does not have any recorded sightings within 25km of HHI, nor are there any recorded sightings in the Gladstone Regional Council area.

Suitable habitats as exposed rocky outcrops on ridges and slopes with a canopy of Narrow-leaved Ironbark (*Eucalyptus crebra*), Silver-leaved Ironbark (*E. melanophloia*), Moreton Bay Ash (*E. tessellaris*), Gum Top Box (*E. moluccana*), Tallowwood (*E. microcorys*) and, in the Bunya Mountains, Queensland Blue Gum (*E. tereticornis*). The SPRAT database also identifies that preferred slope aspects are south-west to north-west facing, while the development footprint for HHI is on the eastern side of the ridgeline.

All records are in the Queensland classified bioregion 11 with specific Queensland regional ecosystem land zones including land zone 3, which occurs on HHI, albeit in association with bioregion 12, rather than bioregion 11.

HHI is in bioregion 12, but does include some landzone 3 regional ecosystems being:

- *Eucalyptus tereticornis* woodland to open forest, including some areas at the base of the western facing side of the ridgeline (155 hectares) (Queensland regional ecosystem classification 12.3.3).
- *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland (61 hectares) (Queensland regional ecosystem classification 12.3.6).

Figure 7.8 shows suitable habitat for the collared delma, based on occurrence of Queensland regional ecosystem classification landzone 3 (bioregion 12). Microhabitat requirements may not be present across the entire area shown.

Only two hectares of the *M quinquenervia* woodland on landzone 3 (Queensland regional ecosystem classification 12.3.3), being 1% of its extent on HHI, is within the development footprint as this is an endangered regional ecosystem, and the development footprint has been designed to avoid endangered regional ecosystems. None of the *E. tereticornis* woodland on landzone 3 (Queensland Regional ecosystem classification 12.3.6) will be disturbed and there will be no disturbance on the west facing slope of the ridgeline.

Collared delma also has microhabitat requirements of rocks, logs, bark and leaf litter. These are present in some areas of HHI, mostly on the steep ridgeline that bisects the island.

On available distribution information, lack of records at a regional level and habitat preferences, it is considered unlikely that collared delma is present on HHI, not least as all sightings are within bioregion 11. Notwithstanding this, any potentially suitable habitat is outside the development footprint and will therefore be incorporated into the managed conservation area (see also Section 8.3.8). Mitigation measures have been proposed for some other brigalow belt reptiles and, in the unlikely event that collared delma is present, would also identify and protect this species.

Dunmall's Snake

Dunmall's snake *(Furina dunmalli)* is listed as vulnerable under the EPBC Act and identified as a brigalow belt reptile. There are no Wildlife Online records within 25km of HHI, however there are records from within the Gladstone Regional Council area.

HHI is outside the modelled distribution range for this species, however there are known records from near Gladstone area and the immediately adjacent mainland is identified as an area where the species "may occur" (http://www.environment.gov.au/epbc/publications/pubs/draft-brigalow-belt-map10-fdunmalli.pdf, accessed 12/08/2013).

Records are largely from sites between 200m and 500m above sea level, which would preclude HHI as the highest point above sea level is around 110m. Otherwise, habitat requirements appear quite broad, including forests and woodlands on black alluvial cracking clay and clay loams, particularly with acacia species and on woodlands on sandstone derived soils. Microhabitat requirements are for shelter such as fallen timber and ground litter and possible cracks in soils. (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59254, accessed 12/08/2013). Suitable soil types are absent from HHI although other microhabitat requirements are available.

Food sources are small skinks and geckos.

On available distribution information, lack of records at a regional level and habitat preferences, it is considered unlikely that Dunmall's snake is present on HHI, not least as sightings appear to be from locations at 200-500m above sea level and there are no cracking clay soil types on HHI. Notwithstanding this, mitigation measures have been proposed for brigalow belt reptiles in recognition of lack of survey effort and, in the unlikely event that Dunmall's snake is present, these measures would lead to the identification and protection of this species.

7.4.3.8 White-bellied Storm-Petrel

The white-bellied storm-petrel (*Fregella grallaria grallaria*) is listed as vulnerable under the EPBC Act. It is a pelagic bird and suitable habitat lies far offshore, although it has been observed over near-shore waters off the mainland coast, possibly blown ashore in severe weather events. In the non-breeding season, white-bellied storm-petrel forages over near shore waters along the continental shelf (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64438, accessed 1/8/2013). The SPRAT database identifies the non-breeding grounds of white-bellied storm-petrel as in the Tasman Sea, Coral Sea and central Pacific Ocean.

The only known breeding sites in Australian territory are several islands in the Lord Howe group, over 1100 kilometres south-east of HHI and 600 kilometres from the Australian mainland. The population became vulnerable due to elimination of a breeding colony on Lord Howe Island due to feral cats, which have now been eradicated and possibly black rats. The population was considered stable in 2000 (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64438, accessed 1/8/2013).

The white-bellied storm-petrel may be present as an occasional vagrant over inshore waters in Central Queensland but the waters surrounding HHI cannot be considered to be likely or important habitat. No further consideration is given to impacts on this species.

7.4.3.9 Southern Giant-Petrel

The southern giant-petrel (*Macronectes giganteus)* is listed as endangered and migratory under the EPBC Act. Occurrence is widespread throughout the Southern Ocean and breeding colonies are known within Australian territory on Macquarie Island, Heard Island and McDonald Island in the Southern Ocean, and Giganteus Island, Hawker Island, and Frazier Island in the Australian Antarctic Territories (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1060, accessed 01/08/2013). The nearest of these islands, Macquarie Island, is over 3,000 km from HHI.

The southern giant-petrel remains in Antarctic and sub-Antarctic waters in summer, but in winter disperses as far north as the Tropic of Capricorn, and hence may be present in Central Queensland waters, although waters of south-eastern Australia have been identified as potentially more important. Severe weather events may also blow birds inshore.

Foraging generally takes place over open water, but southern giant-petrel will forage over land with prey including penguins and rabbits. It is known to follow ships and commercial fishing vessels and scavenging on baited hooks has led to the birds being hooked and drowned and ingesting fishhooks. Other threatening processes include ingestion of plastic, entanglement in marine debris, oil spills, accumulation of chemical contaminants, disruption to breeding colonies and predation in breeding colonies.

While the southern giant-petrel might occasionally be present in the Central Queensland area, presence would be as an uncommon vagrant and it is not considered that waters around HHI, or HHI itself provide any important habitat. On this basis, this species is not considered further in this assessment. However, an assessment of the potential for PTP to contribute to threatening processes of ingestion of plastic and entanglement with marine debris is provided in Section 8.7.4. An assessment of the potential for minor leaks and spills of hydrocarbons is provided in Section 8.5.11.

7.4.3.10 Kermadec Petrel

The vulnerable Kermadec petrel (*Pterodroma neglecta neglecta*) is a largely pelagic species inhabiting the central Pacific ocean from about 20°S to 35°S, reported as only occasionally reaching the Australian east coast http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64450 accessed 01/08/2013). In Australian waters, it breeds on islands in the Lord Howe and Norfolk Group. Lord Howe Island is 1,100 kilometres south-east of HHI and Norfolk Island is 1,700 kilometres east-south-east of HHI.

The Kermadec petrel forages over open ocean on squid, fish, crustaceans and, during the breeding season, forages aerially on insects at and near breeding islands.

Although the species may be an occasional vagrant in near-coastal waters, HHI and surrounding waters cannot be considered to provide any habitat for this species. This species is therefore not considered further in this assessment.

7.4.3.11 Black-throated Finch (southern)

The EPBC Act listed endangered black-throated finch (*Poephila cincta cincta)* was identified as potentially occurring by the protected matters database search although it has not been sighted in previous surveys of HHI and the closest recent record of the species is located 150km north-west of the HHI.

Populations are known from Townsville and Ingham and environmental impact assessment studies for coal mines are identifying significant numbers in the Galilee Basin in Central Queensland (for example, Adani 2012, Waratah Coal 2011, Hancock Coal 2010). HHI is considered well south of the current range of the species (DEWHA 2009h).

Under EPBC Act Policy Statement 3.13 (DEWHA 2009h), important habitat for Black-throated Finch comprises suitable habitat within a 5km radius of a recent record of the species. Important areas for the black-throated finch have been mapped by the Australian Government in its significant impact guidelines for the black-throated finch (DEWHA 2009h). An excerpt of this map is provided in Figure 7.9 and shows two important areas west of Rockhampton, based on pre-1995 sightings. Note that the map does not extend any further south as no important areas have been identified south of Rockhampton, except for one area near Stanthorpe on the Queensland/NSW border.

Mapping of records presented in the Black-Throated Finch Recovery Plan (Black-Throated Finch Recovery Team 2007) shows a concentration of pre-1995 sightings in the area west of Rockhampton but does not show any sightings in the vicinity of HHI. The Recovery Plan notes that “virtually all sightings south of the tropics are from riverine habitat” which is not present on HHI. The recovery plan also lists regional ecosystems in which black-throated finch has been recorded since 1994. None of these regional ecosystems occur on HHI.

The black-throated finch feeds primarily on grass seeds, with species varying throughout its range. It inhabits grassy woodland dominated by eucalypts, paperbarks or acacias where there is accessibility to seeding grasses (http://www.ehp.qld.gov.au/wildlife/animals-az/blackthroated_finch_southern_subspecies.html, accessed (01/08/2013). However, similar habitat is widespread across Queensland and hence, the definition of important habitat is filtered on the basis of proximity to species records (DEWHA 2009h).

Figure 7.9 – Black-throated Finch Important Areas - Excerpt from DEWHA 2009

A characteristic of the species is the need to drink water regularly and hence it is rarely found away from a water source, with sightings including at stock watering points and farm dams (Adani Group 2012). Hence, black-throated finch is unlikely to have been present on HHI prior to commencement of grazing, as there were no permanent waterbodies until farm dams were constructed in the early 20th Century. The birds are thought to be fairly sedentary, with limited home range, and given the lack of records within 150km of HHI, it is unlikely that colonisation of HHI would have occurred after farm dams were created.

As the black-throated finch is an endangered species and a recovery plan has been prepared, it is considered that information available on important areas and habitat preferences is reliable. This information provides no reason to believe that black-throated finch would occur on HHI, particularly given lack of sightings within 150km of HHI, lack of permanent freshwater and lack of riparian habitat. On this basis, this species is not considered present and is not assessed further.

7.4.3.12 Large-eared Pied Bat

The vulnerable large-eared pied bat *Chalinolobus dwyeri* was identified in the protected matters search database as being potentially present. There are no wildlife online records for Gladstone Regional Council, or within 25km of HHI. SKM undertook 10 anabat recording nights at HHI in 2006 and did not record large-eared pied bat.

While distribution is broadly mapped as extending from Shoalwater Bay in Queensland to Ulladulla in New South Wales on the basis of recorded sightings, the range may be more restricted then this (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=183 accessed 14/08/2013). In Queensland, populations are known from:

- Carnarvon Gorge national park, 290km west of HHI
- Blackdown Tableland national park and state forest, about 240km west of HHI
- Gambubal state forest, Main Range national park, Mount Barney and Lamington national park near the Queensland/NSW border

- Road reserves around the Wivenhoe Dam over 370km south of HHI,
- Lake Moogerah area, over 400km south of HHI
- Private land adjacent to Mt Mistake, over 600km west of HHI.

All of these locations are distant from HHI and HHI is not within the foraging range of any of these populations.

Suitable roosting habitat of caves, mines, rock overhangs and crevices is not present on HHI.

On the basis of lack of records within several hundred kilometres of HHI, anabat survey results and lack of roosting habitat, it is not likely that large-eared pied bat is present at HHI. This species is not considered further.

7.4.3.13 Northern Quoll

The northern quoll *Dasyurus hallucatus* is endangered under the EPBC Act and was identified in the protected matters database as being potentially present. HHI is within the distribution range mapped by DotE (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=331 accessed 14/08/2013) however the Wildlife Online database does not have any confirmed records of northern quoll in Gladstone Regional Council or within 25km of HHI. The National Recovery Plan shows capture records in the vicinity of Rockhampton and inland of Gladstone in the period 1970-1999 but does not indicate capture records south of Townsville since 1999.

Habitat requirements are generally centred on rocky areas suitable for denning with adjacent vegetated habitats for foraging and dispersal (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=331, accessed 14/08/2013). The ridgeline that bisects HHI includes areas of rocky habitat, however, rocks are largely scattered in the landscape rather than in outcrops and hence do not provide caves or similar shelters suitable for denning. Permanent water may also be a habitat requirement (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=331 accessed 14/08/2013).

Northern quoll feeds on larger crawling insects such as spiders and beetles as well as some fruits, smaller vertebrates, bird eggs and nectar. Northern quoll has also been observed foraging on road kill and from garbage.

While threatening processes such as habitat loss, habitat modification and predation are all identified as contributing to decline of northern quoll, a key threat emerging as very significant for northern quoll is the ingestion of cane toads which release poison which generally kills northern quoll. Cane toads are present on HHI.

Lack of records in the region, and lack of suitable denning habitat on HHI would indicate that HHI does not provide important habitat for northern quoll. HHI is not important for dispersal as it is an island, with no connection to the mainland. Northern quoll is therefore not considered further in this assessment.

7.4.3.14 Koala

Koala (combined populations of Queensland, New South Wales and Australian Capital Territory) *Phascolarctos cinereus* was listed as vulnerable under the EPBC Act in 2012 after advice that the sub-population of Koala in Queensland, New South Wales and Australian Capital Territory had declined (TSSC 2012). This followed an earlier assessment in 2010 that the population was stable at a national level.

Koala are known from the Gladstone Regional Council area and wildlife online records show one confirmed sighting within 25km of HHI and 40 confirmed sightings in Gladstone Regional Council. Austecology (2012) recorded a single koala at Tannum Waters, 10-15km north-west of HHI and also recorded evidence of low density koala presence in the form of scats and scratches on tree trunks. Mapping of koala sightings and fatalities in central Queensland in 2009-2011 did not show any sightings in the Rockhampton and Gladstone area. This may be attributed to localised extinction rather than lack of suitable habitat (Tucker and Clifton in Flint and Melzer 2012).

There are no confirmed records within 1 km of HHI, and fauna surveys conducted since 1993 have not identified koala on HHI, nor has evidence of koala scratches on trees been observed (SKM 2007). In the 2007 flora and fauna survey, a series of koala search plots were established (SKM 2007, see also Section 6.7.1.2). These plots generally coincided with quaternary vegetation plots and involved searches for animals, scats and scratches over a 50 m transect, completed by two observers. A total of 26 Koala search plots were completed. SKM also undertook night time call playback at six sites over five nights for a range of animals including koala and this did not evoke any response from koala.

Koala are poor swimmers and are generally only present as natural populations on islands that are connected or partially connected to the mainland at low tide (Australian Koala Foundation, https://www.savethekoala.com/sites/default/files/docs/conserve/islandfacts.pdf accessed 12/08/2013, Phillip Island Nature Park http://www.penguins.org.au/ accessed 12/08/2013). In Central Queensland, koalas occur naturally on Rabbit Island and nearby Newry Island and have been introduced to St Bees Island and Brampton Island (Flint and Melzer, 2012). Rabbit Island is connected to the mainland by mudflats that are exposed at low tide and Newry Island is separated from Rabbit Island by a channel 250m wide. Flint and Melzer also note a “recently extinct” koala population on Great Keppel Island but do not provide any detail on the timing of extinction and whether koalas were introduced. Koalas are present on Curtis Island, however at low tide, mudflats between Curtis Island and the mainland can be traversed and this may explain why Curtis Island has been colonised by koala, while HHI does not appear to have been colonised.

While Koalas obtain 90% of their water requirements from leaves, in drought conditions, access to permanent surface water resources is required as moisture content of leaves is reduced (SEWPaC June 2012). While farm dams were constructed on HHI early in the 20th Century, in drought conditions, there is little or no permanent water on HHI.

Essential habitat for koala in Queensland is identified through presence of regional ecosystems. In Bioregion 12, DEHP has identified regional ecosystems 12.3.3, 12.3.4, 12.3.6, 12.3.7, 12.3.10, 12.3.11, 12.5.2, 12.5.3, 12.8.14, 12.9-10.4, 12.9-10.7, 12.9-10.17, 12.11.5, 12.11.18, and 12.12.12 as containing suitable habitat for koala.

As shown in Table 7.7, there is a total of 758 hectares of suitable koala habitat on HHI and the proposed PTP will result in clearing of 41.9ha (5.5%) of this. The remainder of suitable koala habitat will be included in the managed conservation area (see also Section 8.3.8). Some mature trees will be retained within the development footprint and these will be managed for habitat values as described in Section 8.3.9. Koala is known to occur in urban areas where suitable habitat trees are present, however is more vulnerable to predation and vehicle strike in these areas.

Table 7.7 – Vegetation Clearing by Regional Ecosystem Type

Vegetation Type	Corresponding Regional Ecosystem	Area on HHI (ha)	Area Impacted (ha)	% of Total Extent on HHI
Eucalyptus tereticornis woodland to open forest	12.3.3	154.80	2.0	1.1
Eucalyptus tereticornis and *E. crebra* dominated forests	12.12.12	382.0	153.2	40.1
Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland	12.3.6	60.9	0.00	0.0%
Eucalyptus populnea woodland	12.3.10	160.10	1.1	0.7%
TOTAL native vegetation clearing		757.8	41.9	5.5%

While suitable habitat is present on HHI, koala are not considered likely to be present as:

- Fauna surveys undertaken since 1993 have not sighted koala, nor have scats or tree scratches been identified
- There are only limited confirmed sightings on the adjacent mainland with one sighting recorded by Wildlife Online within a 25km radius of HHI, and Austecology reporting a single koala and evidence of sparse occupancy at Tannum Waters 10-15km north-west of HHI
- There is lack of connectivity with the mainland. Koalas are poor swimmers and do not naturally occur on islands separated from the mainland by water.
- Historically, there are no drought-proof water resources on HHI.

Koalas are not considered further in this assessment, although it also is noted that, in relation to impacts on koala habitat:

- Of nearly 760 ha of suitable habitat on HHI, only 42 ha, or 5.5% will be cleared
- Within the PTP footprint, 50% of habitat trees will be retained and this area will be managed for its habitat values through a Wildlife and Habitat Management Plan as described in Section 8.3.9. Koala are known to utilise suitable trees in urban areas
- Predator control programs will be introduced as part of the proposal to manage HHI as a conservation area (see Sections 8.3.8 and 8.3.9)
- Road design will incorporate fauna crossings (see Section 8.6.3).

7.4.3.15 Protected Plants

The protected matters search tool identified the potential for the following threatened plants to be present, based on bioclimatic modelling:

- *Cupaniopsis shirleyana* (wedge-leaf tuckeroo) (vulnerable)
- *Germainia capitata* (vulnerable)
- *Phaius australis* (lesser swamp-orchid) (endangered)
- *Streblus pendulinus* (Siah's backbone, Sia's backbone, Isaac wood) (endangered)
- *Taemiophyllum muelleri* (minute orchid, ribbon-root orchid), (vulnerable)
- *Cycas megacarpa* (endangered)
- *Cycas ophiolitica* (endangered).

Botanical surveys have been carried out within the development footprint and across the special lease area and no protected plants have been identified in surveys to date. A further assessment of the likelihood of occurrence of threatened plants is provided in Table 7.8. In this assessment, the likelihood that a species is present was categorised according to the following definitions:

- Known - species positively recorded in surveys by qualified ecologists during past 30 years;
- Likely - based on the presence of suitable habitat and proximate records;
- Possible - suitable habitat present for the species, but no recent records from the Study Area or proximate areas;
- Unlikely - based on a lack of suitable habitat and/or lack of proximate records; and
- Absence Known or Suspected.

An index of confidence is applied to the assessment being:

- High – personal observations or records from other reputable sources (for example, 90% certainty);
- Medium – information from sources of reasonable/mixed reliability (location accuracy / taxa identification) (for example, 70% certainty); and
- Low – information from sources of unknown reliability (for example, 50% certainty).

Table 7.8 – Likelihood of Occurrence – Listed Flora Species

Species	EPBC Act Status	Habitat	Species Distribution	Likely Presence within Development Footprint	Likely Presence outside of Development Footprint
Wedge-leaf Tuckeroo *Cupaniopsis shirleyana*	V	Wedge-leaf Tuckeroo occurs in a number of small populations throughout its range, in dry rainforest and scrubby urbanised areas on moderate to very steep slopes, screeslope gullies and rocky stream channels at elevations of 60-550 m above sea level (TSSC 2008b)	Wedge-leaf Tuckeroo is known from south-eastern Queensland over a range of approximately 450 km, between Brisbane and Curtis Island (TSSC, 2008b).	**Absence known or suspected (medium)** Botanical surveys have been carried out within the development footprint and across the special lease area. This species was not identified during the surveys. No habitat suitable for this species is present within the development footprint.	**Possible (medium)** The vegetation type 'Microphyll/notophyll vine forest on beach ridges' occurs on Hummock Hill Island. While the Wedge-leaf Tuckeroo prefers rocky environments, the vine forest community on sand may represent suboptimal habitat.
Germainia capitata	V	*Germainia capitata* grows in open *Eucalyptus spp.* and *Melaleuca spp.* woodland where it is often found in patches or clumps on sandy soils, often in seasonally inundated areas. North of Bundaberg, one population occurs in Eurimbula National Park (over 20km south-east of HHI) and most of the other populations occur in areas of remnant vegetation as defined under the Vegetation Management Act 1999 (Queensland) (TSSC 2008c). The plant has not been identified in surveys to date.	*Germainia capitata* occurs in Australia at two disjunct localities north of Bundaberg and Torres Strait. North of Bundaberg, this species occurs near the Town of 1770 and Agnes Water (TSSC 2008b). This species also extends to Papua New Guinea, Malaya, Thailand, Vietnam, and China (TSSC 2008c).	**Possible (medium)** Due to the restricted distribution of *Germainia capitata*, it is unlikely that it occurs on Hummock Hill Island. The nearest known occurrence is Eurimbula National Park, 35km to the south east of Hummock Hill Island and is separated by Mountain Ranges and Ocean. To date, this species has not been recorded from Hummock Hill Island or areas proximate to the Island. While this species is unlikely to occur within the development footprint owing to its disjunct occurrence and because it has not been located to date, suitable habitat nonetheless occurs.	**Possible (medium)** To date, this species has not been recorded from Hummock Hill Island or areas proximate to the Island. While this species is unlikely to occur on HHI, owing to its disjunct occurrence and because it has not been located to date, suitable habitat nonetheless occurs.

Species	EPBC Act Status	Habitat	Species Distribution	Likely Presence within Development Footprint	Likely Presence outside of Development Footprint
Lesser Swamp Orchid *Phaius australis*	E	Commonly associated with coastal wet heath/sedgeland wetlands, swampy grassland or swampy forest and often where Broad-leaved Paperbark or Swamp Mahogany are found. Typically, the Lesser Swamp-orchid is restricted to the swamp-forest margins, where it occurs in swamp sclerophyll forest (Broad-leaved Paperbark/Swamp Mahogany/Swamp Box (*Lophostemon suaveolens*)), swampy rainforest (often with sclerophyll emergents), or fringing open forest. It is often associated with rainforest elements such as Bangalow Palm (*Archontophoenix cunninghamiana*) or Cabbage Tree Palm (*Livistona australis*), (SEWPaC 2013a).	The Lesser Swamp-orchid is endemic to Australia and occurs in southern Queensland and northern NSW, (SEWPaC 2013a).	**Absence known or suspected (medium)** Botanical surveys have been carried out within the development footprint and across the special lease area and this species was not identified. No habitat suitable for this species is present within the development footprint.	**Unlikely (medium)** The vegetation type '*Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland' occurs on Hummock Hill Island and represents marginal habitat. Generally this community is drier than the swampy environments where *Phaius australis* is commonly found.
Siah's Backbone *Streblus pendulinus*	E	On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest (SEWPaC, 2013b).	Siah's Backbone occurs from Cape York Peninsula to Milton, south-east New South Wales, as well as Norfolk Island (SEWPaC 2013b).	**Absence known or suspected (medium)** Botanical surveys have been carried out within the development footprint and across the special lease area and this species was not identified. No habitat suitable for this species is present within the development footprint.	**Possible (medium)** The vegetation type 'Microphyll/notophyll vine forest on beach ridges' occurs on Hummock Hill Island.
Minute Orchid, Ribbon-root Orchid Taeniophyllum muelleri	V	Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges, from sea level to 250 m alt (Plant Net, 2013).	North from the Bellinger R.(Plant Net, 2013)	**Absence known or suspected (medium)** Botanical surveys have been carried out within the development footprint and across the special lease area and	**Possible (medium)** The vegetation type 'Microphyll/notophyll vine forest on beach ridges' occurs on Hummock Hill Island and

Species	EPBC Act Status	Habitat	Species Distribution	Likely Presence within Development Footprint	Likely Presence outside of Development Footprint
				this species was not identified. No habitat suitable for this species is present within the development footprint.	*Taeniophyllum muelleri* may be present on rainforest trees in this habitat.
Cycas megacarpa	E	*Cycas megacarpa* is found in woodland, open woodland and open forests, often in conjunction with a grassy understory. This species is found in habitat dominated by *Eucalyptus crebra* and *Corymbia citriodora* as well as *Corymbia erythrophloia*, *Eucalyptus melanophloia* and *Lophostemon confertus*. There are also reports that it can be found in or on the edge of rainforest habitat. *Cycas megacarpa* may be present in the following Queensland Regional Ecosystems that occur on HHI – 12.1.3, 12.3.3, 12.12.7, 12.12.8 and 12.12.12. This species often grows on undulating to hilly terrain at an altitude of 40–680 m. The soil is typically a well draining rocky or shallow clay, clay/loam, derived from acid volcanic, ironstone or mudstone (SEWPaC 2013c). These soil types are present on HHI, although elevation for much of the island is below 40m.	*Cycas megacarpa* is endemic to south-east Queensland. It is found from as far south as Woolooga to Bouldercombe in the north (SEWPaC, 2013c). Many populations of *Cycas megacarpa* are very small and greatly fragmented, with only a handful of adult plants (SEWPaC 2013c). Cycad species are known to have little genetic flow between fragmented populations and Cycads are not known to disperse far from the parent plant (SEWPaC, 2013c).	**Unlikely (medium)** While suitable habitat exists for *Cycas megacarpa* this species is prominent, distinctive and easy to detect during field surveys. Hence, lack of detection provides a reasonable indication of lack of presence.	**Possible (medium)** Botanical surveys have been carried out within the development footprint and across the special lease area and this prominent species was not identified. However, *Cycas megacarpa* may be present in the following Regional Ecosystems that occur within the development footprint – 12.1.3, 12.3.3, 12.12.7, 12.12.8 and 12.12.12.

Species	EPBC Act Status	Habitat	Species Distribution	Likely Presence within Development Footprint	Likely Presence outside of Development Footprint
Cycas ophiolitica	E	*Cycas ophiolitica* grows on hills and slopes in sparse, grassy open forest at altitude ranges from 80–400 m above sea level. Much of HHI is below 80m. Although this species reaches its best development on red clay soils near Marlborough, it is more frequently found on shallow, stony, infertile soils, which are developed on sandstone and serpentinite, and is associated with species such as *Corymbia dallachiana, C. erythrophloia, C. xanthope* and *Eucalyptus fibrosa* (SEWPaC, 2013d). *Cycas ophiolitica* has also been found on mudstone in association with *Corymbia dallachiana, C. erythrophloia* and *Eucalyptus crebra*, and on alluvial loams with *Corymbia intermedia, Eucalyptus drepanophylla* and *E. tereticornis* (SEWPaC 2013d). These soil types are generally not present on HHI.	*Cycas ophiolitica* is endemic to Queensland, occurring from Marlborough to Rockhampton in central-eastern Queensland (SEWPaC, 2103d). HHI is therefore not in the known distribution range.	**Unlikely (medium)** While suitable habitat exists for *Cycas ophiolitica* the species is prominent, distinctive and easy to detect during field surveys. Hence, lack of detection provides a reasonable indication of lack of presence. HHI is also well outside the known range.	**Possible (medium)** Botanical surveys have been carried out within the development footprint and across the special lease area and this prominent species was not identified. However, on the basis of presence of associated vegetation types, *Cycas ophiolitica* may be present in the woodland and open forest habitats on HHI on slopes dominated by *Eucalyptus tereticornis* and / or *Eucalyptus crebra*.

E = Endangered; V = Vulnerable

7.4.4 Marine Threatened Species

7.4.4.1 Humpback Whale

Humpback whale, *Megaptera novaeangliae,* which is listed as vulnerable and as a migratory animal under the EPBC Act, was identified in the protected matters search report as known to be breeding in the area.

Australian humpback whales undertake annual breeding migrations along the east coast of Australia from June to October from Subantarctic cold-water summer feeding grounds to warm-water winter calving grounds in the central Great Barrier Reef (DEH 2005a). For the south-east coast region, from Bowen and further south, the peak migration of humpback whales is July for the northward migration and mid-September to October for the southward migration. Populations of humpback whale that migrate along Australia's east coast appear to be genetically distinct from the west coast population.

Humpback whales are known to prefer migrating through deeper (>30 m) offshore waters (Smith *et al.* 2012), however individuals may enter the near shore coastal zone. Calving mothers are known to travel or rest closer inshore, where waters are more sheltered (Ersts and Rosenbaum 2003). Barriers along parts of the migratory route are known to cause a bottleneck where populations must pass closer inshore (within 30 km of the coastline) (DEH 2005a).

The migration pathway of 12 Australian humpback whales was derived from satellite tracking by Smith *et a*l. (2012). The data showed that humpback whales tend to travel close to shore along Fraser Island, then move offshore travelling near the Bunker and Capricorn Group of islands, before coming closer to shore again north of Rockhampton around the islands south of the Mackay Coast region (Smith *et al.* 2012).

There is a limited understanding of habitat critical to the survival of humpback whales, however, important areas for resting and calving along the east coast of Australia have been identified (DEH 2005, Smith *et al.* 2012). The known areas of calving for humpback whales in Queensland and the Great Barrier Reef (which is based on observations of mothers with very young calves) is very broad, occurring between approximately 14°S and 27°S, and less frequently along the migratory pathways within 30 km of the coastline, such as near Stradbroke and Moreton Islands (DEH 2005a). Known resting areas in Queensland, as indicated by cow-calf pairs and attendant males during the southern migration, occur around the Whitsundays, Hervey Bay, Moreton Bay, the Swain Reefs complex Great Barrier Reef, Bell Cay, and the Palm Island Group (DEH 2005a).

Baseline and monitoring surveys of marine megafauna for the Western Basin Dredging project in Gladstone were conducted between November 2008 and July 2009, and in 2011 (summer: between February and March, and April; and autumn: June) (GHD 2009, 2011a, b). The survey area encompassed the southern reaches of Rodds Bay through to Port Alma and included the oceanic side of Curtis Island. Survey methods used a combination of aerial and boat-based surveys (GHD 2009, 2011a, b).

Although the surveys coincided with northern migration of humpback whales, only one whale was observed. The observation was made in May 2009 off the northern tip of Curtis Island in relatively shallow water (GHD 2009) and was considered likely to be a melon-headed whale (*Peponocephala electra*). No other species, including humpback whales, were observed.

The observations made by the baseline and monitoring program reaffirmed data from the Border Protection Command aerial surveillance program from 2003 to 2007 (provided in Smith et al. 2012) along the Great Barrier Reef. That program showed that no whales were observed inshore near the Gladstone region. Instead whales were readily observed near the Bunker and Capricorn Group of islands. The satellite tracking of humpback whales along the east coast of Queensland undertaken by Smith et al. (2012) also supports that whales are not observed to use the inshore shallow waters adjacent Gladstone and immediately south.

The data presented by these survey programs indicate that humpback whales prefer to migrate past the Gladstone and Rodds Bay region further offshore and do not utilise the inshore shallow waters of this area. There is no evidence to indicate that the area is an aggregation or resting area or a bottleneck area where the whales travel closer to shore. In fact, it appears that in this part of the Great Barrier Reef, humpback whales migrate through the Capricorn-Bunker Group, 50-150km offshore from HHI. Breeding and calving may take place along the migratory route and therefore is not expected to occur in waters offshore of HHI. The data also indicate that the inshore waters up to 30m deep near Gladstone and Rodds Bay are not important for any stage of the humpback whale breeding cycle. In addition to being EPBC Act listed threatened species, humpback whales are considered iconic species in the GBRMP and GBRWHA/NHP (http://www.gbrmpa.gov.au/about-the-reef/animals/protected-species, accessed 24/04/2013). In the past, humpback whales have been hunted, however the International Whaling Commission has banned hunting except for limited research and indigenous purposes. Humpback whales were not hunted by Australian indigenous people.

The waters immediately around HHI are not likely to be occupied by humpback whale, and the area is not considered to be important humpback whale habitat.

7.4.4.2 Blue Whale

The blue whale *Balaenoptera musculus* was identified in the protected matters database search as potentially present in waters near HHI. This species is listed as endangered and migratory under the EPBC Act. The Australian Government has mapped aggregation areas and locations where blue whale is likely to be present as shown in **Figure 7.10**. This mapping indicates that blue whale is unlikely to be present off the Queensland coast, except as a transient visitor.

Known feeding areas within Commonwealth waters are off the South Australian and Victorian coastlines and off Rottnest Island in Western Australia (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=36, accessed 14/08/2013). Breeding and wintering areas have not been identified but are likely to be in tropical waters in areas of upwelling where there is a high level of biological productivity, with possible areas including the Indonesian archipelago, eastern tropical Pacific ocean and near the Solomon islands.

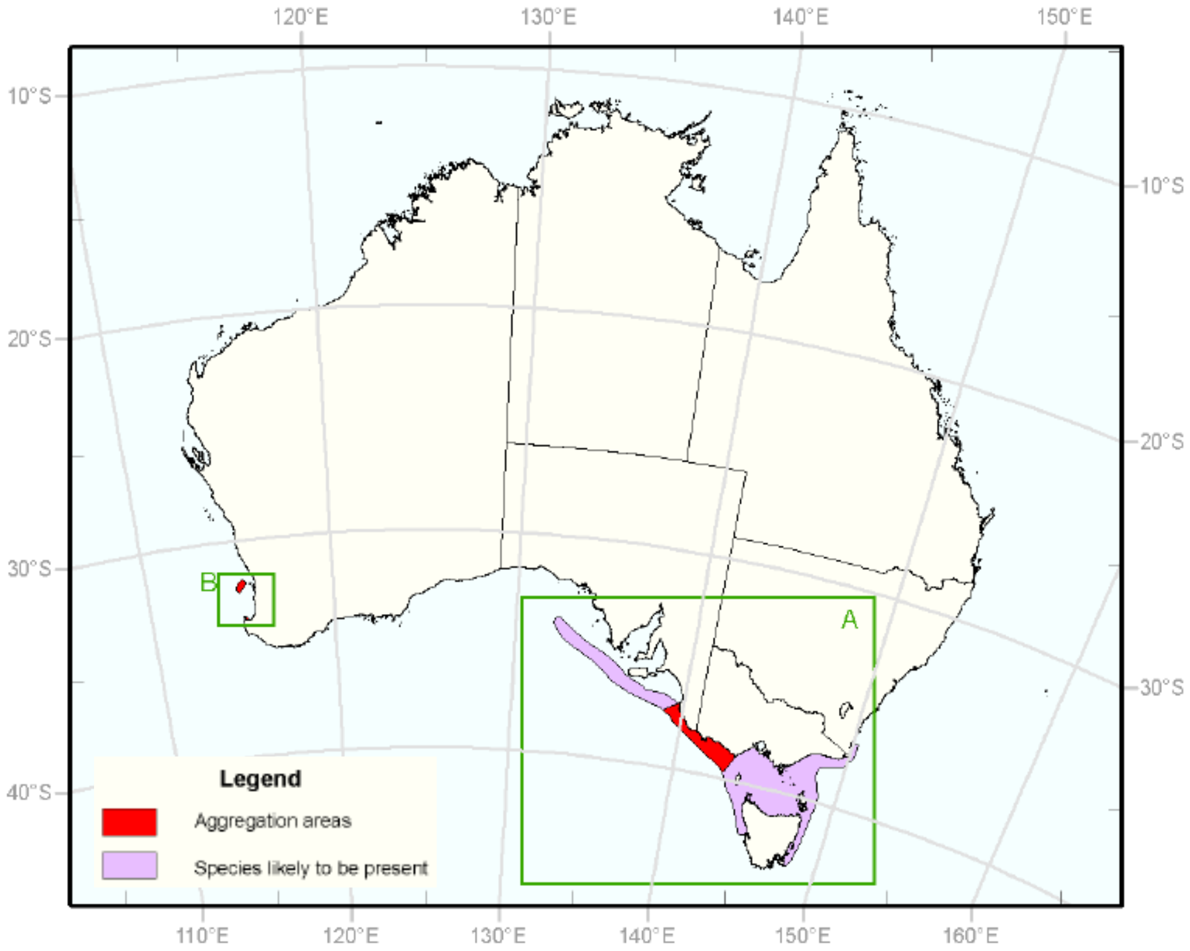

Figure 7.10 - Recognised aggregation areas of the blue whale (DEH 2005b)

Wildlife online does not record any sightings of blue whale within 25km of HHI. As blue whale is easily visible from the air and also feeds at or near the surface, if present in the area on a regular basis, it is expected that sightings would have occurred and been recorded.

On the basis of this information, it is not likely that waters around HHI provide important habitat for blue whale.

7.4.4.3 Marine Turtles

Overview

The EPBC Act protected matters search tool identified that six species of marine turtle may occur in waters around HHI, based on bioclimatic modelling and presence of suitable habitat (Appendix C1). Distribution mapping of all six species also indicates that each could occur in the waters around HHI (Environment Australia 2003).

An analysis of habitat requirements for each species, as well as known nesting sites in Queensland and food preferences is provided in Table 7.9.

Flatback turtle (vulnerable under the EPBC Act), loggerhead turtle (endangered under the EPBC Act) and green turtle (vulnerable under the EPBC Act) have all been identified in the waters around HHI. The flatback turtle and green turtle are considered to be common (GPC, 2011, SKM 2007, Dames and Moore, 1995, see also Section 6.6.5). Figure 6.52 shows key turtle habitat features in waters around HHI.

Leatherback turtle (endangered under the EPBC Act), hawksbill turtle (vulnerable under the EPBC Act) and Olive Ridley turtle (endangered under the EPBC Act) may utilise the area, however, there have been no positive sightings to date despite repeated surveys undertaken in recent years between Port Alma and Rodds Peninsula for GPC (GPC 2011). The summary of habitat requirements presented in Table 7.9 indicates that the waters around HHI would offer only limited habitat and food sources for these three turtle species.

Table 7.9 – Summary of Sea Turtle Habitat Requirements (1)

Species	General Habitat	Nesting Sites	Food
Flatback turtle *Natator depressus* Vulnerable, migratory, marine	Soft bottom habitat over the continental shelf, water depths 10 m to 40 m Observed in waters around Port Curtis and Rodds Bay Nest on sandy beaches	In eastern Queensland nesting between Bundaberg and Torres Strait. Main east coast nesting sites are Peak, Wild Duck, Avoid and Curtis Islands. Minor nesting occurs at Mon Repos and the Mackay Region. Scattered aperiodic nesting occurs on mainland and inshore islands north of Townsville. Nesting occurs from October to January.	juveniles are known to eat gastropod molluscs, squid and siphonophores (soft corals, hydroids, jellyfish) Limited information on adult diet
Loggerhead turtle *Caretta caretta* Endangered, migratory, marine	Juvenile turtles spend about 15 years feeding in open ocean Adults move inshore to coral and rocky reefs, seagrass beds and muddy bays Occasionally observed in waters around Port Curtis and Rodds Bay. Nest on sandy beaches	Main nesting sites in Queensland: • The mainland coast of south-east Queensland (especially Mon Repos and adjacent beaches of the Woongarra Coast and Wreck Rock Beach) • Capricorn-Bunker Groups of the southern GBR (especially Wreck, Tryon and Erskine Islands) • Swain Reefs (especially Pryce Island and Frigate, Bylund, Thomas and Bacchi Cays) and at Bushy Island off Mackay.	Juveniles feed on small animals in the upper 5 m of the water column Adults feed primarily on benthic invertebrates at depths of up to 55 m

Species	General Habitat	Nesting Sites	Food
Green turtle *Chelonia mydas* Vulnerable, migratory, marine	Juvenile turtles spend first 5-10 years in open ocean Adults forage in shallow benthic habitats including coral, rocky reef, seagrass beds and algal mats Commonly observed in waters around Port Curtis and Rodds Bay Nest on sandy beaches	Key nesting and inter-nesting areas: • Capricorn and Bunker Island Groups • Raine Island • Curtis Island and Facing Island • Russel Island and Scott Reef Wellesley Islands • Milman Islet and Boydong Islands • Mon Repos • Murray Islands • Darnley Island (Torres Strait) • Bramble Cay (Torres Strait) • Western Cape York Peninsula • Pisonia Island • North and South Bountiful Islands	Juveniles may eat plankton and other animals. Adults primarily eat seagrass and algae
Leatherback turtle *Dermochelys coriacea* Endangered, migratory, marine	Largely pelagic, coming inshore for breeding Not observed in waters around HHI	No major nesting sites in Queensland, but nesting has occurred at Mon Repos, Moore Park and Wreck Rock beach near Bundaberg.	Carnivorous, feeding on invertebrates including jellyfish, salps, squid and siphonophores
Olive Ridley turtle *Lepidochelys olivacea* Endangered, migratory, marine	Forage over shallow benthic habitats and also deeper habitats and pelagic habitats. Not generally known from seagrass or coral habitats. Not observed in waters around HHI	No records of nesting on eastern Australian coast	Mainly carnivorous (molluscs, crab, shrimps) but may also eat algae.
Hawksbill turtle *Eretmochelys imbricata* Vulnerable, migratory, marine	Juvenile turtles spend first 5-10 years in open ocean Adults forage in tropical tidal and sub-tidal coral and rocky reef habitat and to a lesser extent, seagrass habitat. Two hawksbill turtles observed on the seaward side of Facing Island in Feb/March 2011.	Key nesting and internesting areas in Queensland are all in northern Queensland and Torres Strait, and include Milman Island and the inner GBR Cays north from Cape Grenville ,Central Torres Strait islands, Crab Island, Murray Islands, Darnley Island, Woody Island, Red Wallis and Woody Wallis Islands, Bramble Cay and Johnson Islet (Torres Strait), Western Cape York Peninsula	Juveniles eat plankton Adults feed on sponges, hydroids, cephalopods (octopus and squid), gastropods (marine snails), cnidarians (jellyfish), seagrass and algae.

(1) DotE Species Profile and Threats Database

Flatback Turtle

There are four regional populations of flatback turtle, including an eastern Queensland population, which was considered to be secure but dependent on ongoing conservation actions in 2007 (Limpus 2007).

In southern Queensland, flatback turtle nesting occurs between October and January, with a peak in December. Breeding occurs at intervals of one to five years. Females show a high degree of fidelity to nesting sites, returning to the same site within nesting seasons and in subsequent nesting seasons. (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1765 accessed 30/01/2013).

Although HHI is not recognised as an important turtle nesting site, flatback turtle have been observed to nest on HHI on the beach to the east of the headland, several kilometres from the nearest boundary of the project (see Figure 6.52). Nesting density appears to be consistently low and intermittent (SKM 2007, Hodge *et al*. 2007, Dames and Moore 1995, Limpus 2007). Hodge *et al* (2007) observed two fresh tracks and five old tracks in a three day survey in December 2006. Figure 6.51 shows turtle tracks on the beach at HHI. In 1995, Dames and Moore reported on discussions with representatives of the then Queensland Department of Environment and Heritage. Studies undertaken in the 1980s and early 1990s had indicated a low nesting frequency on beaches along HHI and Wild Cattle Island (0-25 tracks observed per annum), compared to medium levels of nesting activity Facing and Curtis Islands (25-50 nests per annum) and very high levels at Peak Island, Rosslyn Bay and islands off Yeppoon (hundreds of nests per annum) (Dames and Moore 1995).

Ongoing census of nesting beaches between Bundaberg and Yeppoon have not identified HHI as among major or minor nesting sites for flatback turtles or any other turtle species (Limpus 2007). The seagrass meadows (see Section 6.6.5) and waters around HHI generally may be utilised by green and flatback turtles during the internesting period.

Hodge *et al*. (2007) noted that HHI was a "minor nesting site supporting approximately 10 nesting females in the 2006/2007 breeding season. This is consistent with the results reported in Dames & Moore (1995) that HHI was classified by the then Queensland Department of Environment and Heritage as a low nesting frequency beach (0-25 nests). In his ecological review, Limpus noted major and minor nesting sites but did not classify HHI or any locations within 30 km of HHI as either minor or major nesting sites.

Other turtle species have not been recorded using HHI beaches for nesting and information presented in Table 7.9 indicates that HHI is not considered an important nesting site for any turtle species.

Green Turtle

Green turtles are known from waters around HHI and nest at several locations in central and southern Queensland. There are seven regional populations of green turtle in Australian waters with limited genetic exchange between populations. The population of green turtles in the southern GBR was estimated at about 8,000 in 2005 and populations were considered to be increasing. (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1765 accessed 30/01/2013).

While green turtles can migrate significant distances, average migration is approximately 400 km. Adult green turtles are relatively sedentary in their foraging habitats, feeding in shallow rocky reef, coral reef and seagrass areas. Females may nest several times in one season, sometimes on different beaches, and tend to remain within 5-10 km of the beach in the inter-nesting period.

In the southern GBR, green turtle nesting occurs from October to March, peaking in January. Breeding and egg laying appears dependent on sea temperature and successful nesting requires sand temperature between 25°C and 33°C, with sands low in salt, well aerated and with high humidity.

Threatening Processes

Key threats to all species of turtle are identified as:

- By catch of marine turtles in fisheries
- Customary harvest by Aboriginal and Torres Strait Islander people
- Habitat loss
- Marine debris
- Shark control activities
- Boat strike
- Pearl farming and other aquaculture activities
- Defence activities
- Degradation of water quality and associated degradation of foraging habitat (Environment Australia 2003).

Of these threats, bycatch in fisheries, marine debris and boat strike are present in waters around HHI and the wider Rodds Bay area.

In addition, the following threats affect turtle nesting and hatching success:

- Light pollution
- Tourism and recreational activities
- Vehicle damage on beaches
- Faunal predation, including from feral pigs and dogs.

Light pollution from existing development is potentially an issue for turtle nesting beaches on HHI, with Hodge et al (2006) noting apparent disorientation of nesting tracks attributable to the glow from Boyne Island which is visible from the beaches of HHI.

In recent years, severe weather events over the summer of 2010/2011 and 2012/2013 appear to have impacted on seagrass health and abundance and there have also been increased boat strike incidents in the Gladstone area in recent years (http://www.ehp.qld.gov.au/gladstone/marine-stranding.html, accessed 16/03/2013). It is too early to say what effect these events might have on turtle populations.

Assessment of Importance

The waters around HHI and the beaches of HHI are considered of **moderate importance** in relation to marine turtles as these waters provide foraging habitat for moderate numbers of two vulnerable turtle species (flatback turtle and green turtle) and occasionally loggerhead and hawksbill turtles. Flatback turtle and green turtle have important nesting sites on nearby islands, including Curtis Island and Facing Island.

In addition to being EPBC Act listed threatened species, marine turtles are considered iconic species in the GBRMP and GBRWHA/NHP (http://www.gbrmpa.gov.au/about-the-reef/animals/protected-species, accessed 24/04/2013). Marine turtles have also been traditionally hunted by indigenous people. Hunting of marine turtles in waters around HHI is undertaken in accordance with a Traditional Use of Marine Resources Agreement (see also Section 7.6.4).

While beaches on the north coast of HHI appear suitable for turtle nesting, the beaches are used only at a very low frequency by flatback turtles and have not been identified as minor or major nesting sites for any turtle species.

7.4.4.4 Whale Shark

The protected matters search tool identified the possible presence of the whale shark, *Rhincodon typus,* and HHI is within the distribution range of this shark. The whale shark is listed as vulnerable and migratory under the EPBC Act.

This species inhabits open ocean and coastal waters. In Australian waters, whale shark are known to congregate at Ningaloo Reef, Christmas Island and Coral Sea. Port Curtis and Rodds Bay are not situated near any known aggregation areas.

Whale shark are filter feeders, eating plankton and small schooling fish.

Aerial surveys undertaken by GPC in 2011 (Survey 1 on 21 April 2011 and Survey 2 on 13 June 2011) identified four sharks but did not identify to species level. However, as whale shark are distinctive from above and, if whale shark was observed, it is likely that it would have been identified to species level.

On 7 January 2013, the Noosa News reported a single whale shark sighted by divers at Jew Shoal Reef, offshore from the mouth of the Noosa River, at the northern end of the Sunshine Coast (http://www.noosanews.com.au/news/whale-shark-at-play/1707830/).

Whale shark might may occur in Rodds Bay and waters surrounding HHI. The area is not likely to provide important resources for this species.

7.4.4.5 Green Sawfish

Green sawgish, *Pristis zijsron*, is vulnerable under the EPBC Act. Its range has been mapped as extending from Broome in Western Australia, thoughout the Northern Territory and Queensland coasts to Jervis Bay in NSW, however the species is presumed extinct in NSW and there have been no reports south of Cairns since the 1960s (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68442, accessed 14/08/2013). Green sawfish is not however listed as a threatened species in Queensland.

Suitable habitat of shallow muddy inshore coastal waters and estuarine waters is present in waters surrounding HHI. The species has never been recorded in the Central Queensland area, with no records between Moreton Bay and Townsville (Stevens et al,2005).

Key threats include:

- Commercial fishing (bycatch and net entanglement)
- Illegal harvesting for sharkfin products
- Habitat alteration and destruction, particularly loss of soft bottom habitat through development.

The extent of threat from recreational fishing is not known, but probably accounts for a very small proportion of total bycatch. Sawfish rostrum have traditionally been a popular souvenir (Stevens et al, 2005).

Given that the species' range appears to have contracted to north of Cairns, and that there are no records within several hundred kilometres of HHI, it is considered unlikely that green sawfish is present in waters around HHI, in spite of presence of suitable habitat and this species is not considered further.

In any case, the PTP will not generally contribute to identified threats since the proposed development has been designed to avoid direct and indirect impacts on estuarine, coastal and marine habitats. Recreational fishing may increase but will be under relatively strict control given that the waters around HHI are protected as a Dugong Protection Area, which prevents use of certain netting methods and also within the Great Barrier Reef Marine Park/Coast Marine Park and subject to recreational fishing licence requirements under Queensland legislation (see also Section 8.7.6).

7.4.5 Summary of Values – Listed Threatened Species and Ecological Communities

Based on the criteria established in Section 1.7.4, the following values are present in and around HHI in relation to listed threatened species and ecological communities:

- The two patches of *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* are considered of **highest importance** as this is a critically endangered ecosystem
- Waters around HHI are considered of **moderate importance** as coastal, intertidal and subtidal marine habitat around HHI provides foraging habitat for two vulnerable marine turtle species, low frequency nesting habitat for one vulnerable marine turtle species and occasional foraging habitat for an endangered turtle species
- Intertidal and supratidal salt flats, mud flats and mangroves are considered of **lower-moderate importance** as there is some evidence that the vulnerable water mouse may be present in this habitat
- Other terrestrial habitats on HHI are considered of **lower importance** as these habitats have not been identified as supporting any listed threatened species, apart from occasional use by grey-headed flying fox and possibly several other birds. Suitable habitat exists for three brigalow belt reptiles, although HHI is outside the modelled range for each species.

7.5 Listed Migratory Species

7.5.1 Migratory Birds (Marine and Terrestrial)

The protected matters search report identified the potential for seven migratory terrestrial birds and five migratory marine birds to be present on HHI, on the basis of bioclimatic modelling. Ten of these have been identified in fauna surveys of HHI, and the other two may potentially occur on the basis of suitable habitat. SEWPaC also requested that the likelihood of occurrence of several pelagic migratory bird species be considered. A summary of the distribution, habitat and current threats of these marine and terrestrial migratory birds is provided in Table 7.10. Migratory shorebirds are discussed separately in Section 0. Australian painted snipe is discussed in Section 7.4.3.6. Southern giant-petrel is discussed in Section 7.4.3.9.

Information presented in Table 7.10 indicates that all of the migratory terrestrial and marine bird species present or likely to be present on HHI are common and have a wide variety of habitat preferences, including in the case of most terrestrial migratory birds, disturbed and urban habitats.

All of the species are widely distributed and there is no evidence that HHI is within an area that supports ecologically significant proportion of any of these species. The habitat does not appear to be providing any habitat of critical importance to any stage of the life cycle of any of the species known or potentially present, and HHI is not located at the northern or southern extent of the range of any of these species. Of the species present or potentially present, the white-bellied sea-eagle is the only one where the population appears at risk of decline, with this species listed as vulnerable in southern states, but not in Queensland.

On this basis, HHI is considered of lower importance in relation to migratory terrestrial and marine birds as the area is used intermittently by migratory bird species that are relatively common and have wide habitat preferences and ranges.

Table 7.10 – Migratory Terrestrial and Marine Birds

Name	Likelihood of Occurrence	Australian Distribution and Habitat (1)	Population Status and Threatening Processes (1)
White-bellied sea-Eagle *Haliaeetus leucogaster*	Known from surveys	• Widely distributed through coastal and inland areas, including across much of Queensland • Uses coastal habitat and inland wetlands, typically featuring large areas of open water • Breeding recorded in all habitat types • May occur in urban areas • Forages over waters and terrestrial areas • Home range may be in the order of 100 km^2 • Feeds on fish, birds, reptiles, mammals and crustaceans, may eat carrion and offal, will eat introduced and native species • Adult birds and breeding pairs are generally sedentary but forage over wide areas and may move in response to factors such as drought • No apparent genetic isolation of populations	• Population is thought to be declining in southern states and the species is listed as endangered in South Australia, vulnerable in Tasmania and threatened in Victoria. Provision of artificial water sources in inland areas may be supporting population increases in inland areas • Key threats are loss of breeding habitat, disturbance during breeding/nesting, shooting, ingestion of poisons and reduction in prey • These threats are generally absent on HHI and immediately adjacent coastline, but present within foraging/home range
Whitethroated needletail *Hirundapus caudacutus*	Known from surveys	• Distributed along eastern Australian coastal areas inland to the Great Dividing Range and, in south-east Queensland, New South Wales and Victoria, inland of the Great Dividing Range • Breeding does not occur in Australia, present in Australia October to April • Feed on insects, with almost exclusive aerial foraging • Forages across a wide range of habitats, including urban areas • Occasionally roosts in trees, usually in dense foliage or hollows	• No apparent threats • No concerns regarding species decline
Barn swallow *Hirundo rustica*	Possible – potentially suitable habitat occurs on HHI and HHI is within known distribution range	• Distributed in coastal areas of northern Australia from Brisbane to Exmouth • Breeding does not occur in Australia, present in Australia over southern summer • Feed on insects, with almost exclusive aerial foraging • Feeds over open country in coastal lowlands, often near towns and cities, also freshwater wetlands, shrub thickets and grasslands • Perches on overhead wires and bare branches	• No current concerns of population decline • Threats may include habitat loss and pesticide ingestion • These threats are absent on HHI

Name	Likelihood of Occurrence	Australian Distribution and Habitat (1)	Population Status and Threatening Processes (1)
Rainbow bee-eater *Merops ornatus*	Known from surveys	• Distributed across mainland Australia • Breeds in Australia, from August to January. Nests in burrows • Forages across open forests, woodlands and shrublands, also in cleared and semi-cleared habitats including farmland and urban areas • Usually forages in close proximity to permanent water • Major food source is flying insects but may also take worms, spiders and tadpoles • Foraging is usually aerial, with some ground foraging. Prey is taken back to a perch to eat. • Perches in bare trees and also artificial structures	• Not considered globally threatened • Main identified threat is cane toad predation of nests. Cane toads are present on HHI. • Nests are vulnerable to flooding, predation and disturbance by livestock
Black faced monarch *Monarcha melanopsis*	Known from surveys	• Distribution along east coast of Australia from Cape York to western Victoria • Insectivorous • Forages over a wide range of habitats including urban areas • No other information available	• Species is common • Predation by cats; this threat is present on HHI • Flying into windows of buildings.
Satin flycatcher *Myiagra cyanoleuca*	Possible – potentially suitable habitat occurs on HHI and HHI is within known distribution range	• Eastern and south-eastern Australia in coastal and inland areas • Inhabit eucalypt forests, rarely found in regrowth forests • Breed in Australia, nesting in the fork of a tree, usually in the outer branches • Breeding in November-January • Insectivorous, mostly foraging within trees, picking insects from branches and leaves. May occasionally eat seeds.	• No current concerns of population decline • Clearing and logging of forests, particularly mature trees. Previous logging on parts of HHI may have removed suitable trees
Rufous fantail *Rhipidura rufifrons*	Known from surveys	• Occurs in northern and eastern Australia in coastal and inland areas • Breeds from September to February • Main habitat is wet sclerophyll forests, may be seen in parks and gardens but probably transient in these locations • Forages in forests, eating insects	• A common species with no concerns regarding decline • Land clearing and habitat fragmentation may be threatening processes
Fork-tailed swift *Apus pacificus*	Likely to occur as an occasional aerial summer visitor over the study area.	• Occurs throughout Australia as a non-breeding summer visitor. Less common in coastal areas compared to inland plains. • Forages aerially on insects • It may occur over any habitat type, including cleared land and urban areas. • Roosting and perching on land, trees or structures is very rare	• Population is considered stable throughout its range

Name	Likelihood of Occurrence	Australian Distribution and Habitat (1)	Population Status and Threatening Processes (1)
Great Egret *Ardea alba*	Known to occur.	• Distributed across Australia • Major breeding sites in Queensland are in the Channel Country of south-western Queensland with minor breeding sites on western Cape York and Central Queensland coast. No known breeding sites on or near HHI • Inhabits shallow wetland habitats, including artificial dams and ponds and moist grasslands. Creation of open water-storage ponds associated with the golf course will create suitable feeding habitat.	• Population is not well understood as the species is highly mobile following wetland habitat. It is not listed as threatened under EPBC Act or any State or territory legislation • Key threatening process is loss of wetland habitat or modification of flows in wetland habitat
Cattle Egret *Ardea ibis*	Known to occur.	• Occurs across much of Australia, apart from the driest areas • Utilises grasslands, wetlands, pasture and crops. Strongly associated with grazing animals (Marchant and Higgins 1990). • Feeds on grasshoppers and other insects • Main breeding sites are on the East coast of Australia from Newcastle to Bundaberg, with breeding also taking place at major inland wetlands. No nesting colony is known to occur on or near HHI.	• First documented occurrence in Australia in 1948, but has become widespread across the continent • It is not listed as threatened under EPBC Act or any State or territory legislation • Key threats are loss of breeding habitat through wetland degradation or destruction
Little Tern *Sterna albifrons*	Known to occur Not known to breed on HHI	• Inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits • Also utilises exposed ocean beaches • A likely regular visitor foraging for small fish over coastal and estuarine waters, and resting on open beach spits and sand banks. • One of two breeding populations in Australia breeds on the east and south-east coast of mainland Australia and Tasmania • No breeding colony occurs on or near HHI. Beaches on HHI are very narrow at high tide and unlikely to offer suitable breeding habitat.	• Global and Australian population appears stable • Listed as endangered in Queensland • Listed as least concern on IUCN redlist of threatened species (http://www.iucnredlist.org/details/106003276/0 accessed 14/08/2013) • Breeding failure is naturally high as nests are laid on open beaches and vulnerable to predation and storm events • Habitat loss and degradation of estuarine habitats is also a threat
Crested Tern *Thallaseus bergii*	Known to occur. Not known to breed on HHI	• Irregular distribution across the Australian coast and islands • A likely regular visitor foraging for small fish over coastal waters, and resting on open beach spits and sand banks. • Inhabits open ocean, oceanic islands, beaches, tidal rivers, salt swamps, lakes and larger rivers. • Nests in areas of short, sparse vegetation on offshore islands, reefs and cays, sand spits or rocky points (Higgins & Davies 1996). Limited suitable habitat on HHI. No breeding colonies identified on or near HHI. • Nesting occurs from October to January on the East coast	• Listed as least concern on IUCN redlist of threatened species (http://www.iucnredlist.org/details/106003263/0 accessed 14/08/2013)

Name	Likelihood of Occurrence	Australian Distribution and Habitat (1)	Population Status and Threatening Processes (1)
		• Capricorn-Bunker group, 50-150km east of HHI, is identified as a biologically important area for this species in the National Conservation Values Atlas	
Caspian stern *Sterna caspia* *Hydroprogne caspia*	Known to occur Unlikely to breed on HHI	• Found in sheltered coastal embayments (harbours, lagoons, inlets, bays, estuaries and river deltas), with sandy or muddy margins preferred • Forages in open wetlands, including lakes and rivers and tidal channels or over submerged mudbanks. Less commonly forages over the ocean • Feeds mainly on fish and some aquatic invertebrates as well bird eggs and carrion • Breeding occurs on the Wellesley Islands, south-east Gulf of Carpentaria; islands off the far north coast, from Bird Island, south to Three Isles; and from islands around Shoalwater Bay, including Pelican Rock, south to Fairfax Island in the Capricorn Bunker Group. • Breeding habitat includes sand spits, sand banks and beaches of sand or shell. Beaches on HHI are very narrow at high tide and unlikely to offer suitable breeding habitat. • Inland breeding records occur at Lake Bindegolly and Lake Moondarra • No known breeding colonies on or near HHI	• Listed as least concern on IUCN redlist (http://www.iucnredlist.org/details/106003258/0, accessed 14/08/2013)
Black-naped tern *Sterna sumatrana*	Not identified in PMST but requested to be assessed by SEWPaC (28 June 2013) Potentially present, unlikely to breed	• Known to breed on islands of the Capricorn-Bunker group, 50-150km east of HHI • Breed and roost on islands, with occasional breeding and roosting on islands close to the mainland • Nesting habitat is usually bare sand or shingle beaches, typically 1.5m above the high water mark and usually away from vegetation. Beaches at HHI may be too narrow at high tide to provide suitable nesting habitat • Forage on and around reefs and lagoons, in rock pools and open ocean • Present inshore only when blown by strong onshore winds	• Common and widespread throughout northern and north-eastern Australia • Listed as least concern in IUCN redlist (http://www.iucnredlist.org/search , accessed 22/8/2013)
Wedge-tailed Shearwater *Ardenna pacificus*	Not identified in PMST but requested to be assessed by SEWPaC (28 June 2013) May occur as a rare visitor or blown ashore in severe weather events	• Inhabits open ocean and breeds on offshore islands • Typically found in areas where water temperature is above 21°C • Breeding locations include islands and cays of the Great Barrier Reef, with the largest breeding colony at Capricorn Bunker Group, 50-150km east of HHI • Breeding colonies are large and easily identified (no breeding colonies identified on HHI).	• Species is common and and widespread in Australia and throughout Indian and Pacific Oceans • Listed as least concern in IUCN redlist (http://www.iucnredlist.org/search , accessed 22/8/2013) • Key threat is bycatch from longline fishing

Name	Likelihood of Occurrence	Australian Distribution and Habitat (1)	Population Status and Threatening Processes (1)
		• Feed on marine fish and invertebrates	
Flesh-footed Shearwater *Ardenna carneipes*	Not identified in PMST but requested to be assessed by SEWPaC (28 June 2013) May occur as a rare visitor or blown ashore in severe weather events	• Breeds on offshore islands • Nearest breeding location to HHI is Lord Howe Island • Mostly occurs over continental shelves and slopes, occasional visitor to inshore waters • Forages almost entirely at sea, feeding on small fish and marine invertebrates	• Locally common in waters of southern Australia and the Southern Indian Ocean and South-west Pacific Ocean • Listed as least concern in IUCN redlist (http://www.iucnredlist.org/search , accessed 22/8/2013) • Key threat is bycatch from longline fishing
Common Noddy *Anous stolidus*	Not identified in PMST but requested to be assessed by SEWPaC (28 June 2013) May occur as a rare visitor or blown ashore in severe weather events	• Occurs on offshore islands of the Queensland coast and across the northern Australia and Western Australia coast (Higgins and Davies 1996).	• Listed as least concern in IUCN redlist (http://www.iucnredlist.org/search , accessed 22/8/2013)
Red-footed booby *Sula sula*	Not identified in PMST but requested to be assessed by SEWPaC (28 June 2013) Unlikely to occur at HHI except as an occasional vagrant	• Typically confined to tropical waters between 30°N and 30°S • Nests on oceanic islands, usually in deep waters • No known breeding populations within several hundred kilometres of HHI • No suitable breeding habitat on HHI • Forages over open ocean, rarely coming close to continental land masses	• Listed as least concern in IUCN redlist (http://www.iucnredlist.org/search , accessed 22/8/2013)

(1) SPRAT Database, accessed 04/02/2013, 14/08/2013

Evaluation of impacts of PTP on listed migratory terrestrial and marine birds is undertaken in Section 8, and where potentially significant impacts are identified, further evaluation is provided in Section 10. Where the likelihood of occurrence assessment presented in this section indicates low likelihood of occurrence, or that the species is not present, no further assessment has been undertaken.

7.5.2 Migratory Shorebirds

7.5.2.1 Overview

Earlier surveys of HHI (AGC Woodward Clyde 1993, Dames and Moore 1995, SKM 2007) did not focus on migratory shorebirds as the proposed developments which were the focus of these surveys did not directly affect, or occur close to major intertidal shorebird habitat. The Dames and Moore survey concluded that the area was not important for migratory waders but it the geographical extent of the survey area is not clear.

Between January 2011 and October 2012 nine migratory shorebird surveys of the entire Curtis Coast between the Fitzroy River Delta at Port Alma in the north and Rodds Peninsula in the south were undertaken on behalf of Gladstone Ports Corporation (GHD 2011a, b, c, d, Sandpiper Ecological Surveys 2012a, b, c, Wildlife Unlimited 2012). The surveys included surveys of migratory shorebird habitat on HHI as well as in adjacent areas.

Migratory bird data from the range of studies undertaken was reviewed, collated and analysed by BAAM (2012, Appendix E). Given that migratory shorebirds move regularly between feeding and roosting areas, the Rodds Peninsula and Mundoolin/Colosseum areas are considered by BAAM as a conglomerate site, as shown on Figure 6.56, which includes migratory shorebird habitat on HHI as well as on the adjacent mainland.

The collated findings of migratory shorebird surveys, including species lists, are provided in Section 6.7.7.2 and Appendix E. Evaluation of impacts of PTP on listed migratory shorebirds is undertaken in Section 8, and where potentially significant impacts are identified, further evaluation is provided in Section 10.

7.5.2.2 Assessment of Importance

Importance of a site for shorebirds in Australia is assessed against the following criteria outlined in the EPBC Act Draft Migratory Shorebird Guidelines (DEWHA 2009a, b):

<u>International importance</u>:- A site should be considered internationally important habitat if it regularly supports:

- ≥1 per cent of the individuals in a population of one species or sub-species of waterbird, or
- A total abundance of ≥20,000 waterbirds.

A site is considered to ‘regularly support’ a population of a given size if:

a) The requisite number of birds has been recorded in two-thirds of the years for which adequate data are available, the total number of years being not less than three and with no less than five surveys, or

b) The mean maximum annual count, taken over at least three years, meets the required level (Clemens et al 2008).

National importance:- A site should be considered nationally important habitat if it supports at least:

- 0.1 per cent of the flyway population of a single species
- 2,000 migratory shorebirds, or
- 15 shorebird species.

For permanent wetlands, which includes intertidal wetlands, 'support' is defined as: migratory shorebirds are recorded during surveys and/or known to have occurred at the site within the previous five years (DEWHA 2009a,b).

The combined Mundoolin/Colosseum and Rodds Peninsula area is internationally important for one migratory shorebird species, supporting more than 1% of the East Asian-Australasian flyway population of Eastern Curlew Numenius madagascariensis during two of the survey events undertaken over 2011 and 2012. While this assessment is based on only two years of surveys, the maximum count exceeded the 1% threshold in both years. The area is not known to support a total abundance of more than 20,000 waterbirds.

The combined Mundoolin/Colosseum and Rodds Peninsula area also meets all three criteria for recognition as a site of national importance for migratory shorebirds, namely:

1) It supports more than 0.1% of the East Asian-Australasian flyway population for ten species;
2) It supports more than 2,000 migratory shorebirds; and
3) It supports more than 15 shorebird species, supporting at least 24 migratory shorebird species.

Migratory shorebird habitats, including roosting sites and foraging habitats within the Mundoolin/Colosseum and Rodds Peninsula area are therefore recognised as 'important habitat' for the purposes of impact assessment (DEWHA 2009a,b).

At a regional level, other sites surveyed along the Curtis Coast also meet the criteria for "important habitat", representing a continuum of important habitat extending along the entire Curtis Coast.

The combined Mundoolin/Colosseum and Rodds Peninsula area supports approximately 22% of the overall migratory shorebird population surveyed along the Curtis Coast between Port Alma and Rodds Peninsula by the GPC surveys. The average density of foraging shorebirds on intertidal mudflats was 0.90 shorebirds per hectare in Mundoolin/Colosseum and 0.63 shorebirds per hectare in Rodds Peninsula, somewhat lower than the average density of 1.75 shorebirds per hectare on the remainder of the Curtis Coast (GHD 2011c).

7.5.3 Migratory Marine Species - Mammals

7.5.3.1 Overview

The EPBC protected matters search tool identified seven migratory marine mammal species that may occur in the waters around HHI, based on bioclimatic modelling. These species are shown in Table 7.11. The dugong, *Dugong dugon*, and Indo-Pacific humpback dolphin, *Sousa chinensis*, are known to occur in waters around HHI as well as the broader Port Curtis/Rodds Bay area and are discussed below. The humpback whale may occur offshore during migration periods and is discussed further in Section 7.4.4. Other marine species listed in Table 7.11 are not expected to be present in waters surrounding HHI, or in the broader Port Curtis/Rodds Bay area.

Marine megafauna surveys undertaken in the Port Curtis and Rodds Bay area have not identified any other marine migratory mammals that were not listed in the protected matters search tool (GPC 2011).

Table 7.11 – Protected Matters Search Tool Output – Migratory Marine Mammals

Common Name	Scientific Name	EPBC Act Status	Likelihood of Occurrence
Bryde's whale	*Balaenoptera edeni*	Migratory, Cetacean.	Typically found offshore (>200 m depth) but SPRAT database includes HHI within the distribution of this whale. Not observed in marine megafauna surveys (GPC 2009, GPC 2011)
Blue whale	*Balaenoptera musculus*	Endangered, Migratory, Cetacean,	Not typically found in inshore areas along the Queensland coast. Not observed in marine megafauna surveys (GPC 2009, GPC 2011)
Dugong	*Dugong dugon*	Migratory, Marine	Known to occur (GPC 2011)
Humpback whale	*Megaptera novaeangliae*	Vulnerable, Migratory, Cetacean	Refer Section 7.4.4.
Killer whale, Orca	*Orcinus orca*	Migratory, Cetacean.	Possible in surrounding offshore waters but not known from this area. Not observed in marine megafauna surveys (GPC 2009, GPC 2011)
Indo-Pacific humpback dolphin	*Sousa chinensis*	Migratory, Cetacean.	Known to occur (GPC 2011).
Australian snubfin dolphin (formerly Irrawaddy dolphin)	*Orcaella heinsohn* Formerly *Orcaella brevirostris*	Migratory, Cetacean.	Not known to occur south of Port Alma (GPC 2009, GPC 2011).

7.5.3.2 Dugong

Dugong feed on seagrass almost exclusively, with preferences for *Halophila sp.* and *Halodule sp.* If seagrasses are scarce, dugong may eat algae. An adult dugong requires around 21-36 kg of seagrass per day. (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 04/02/2013). Dugong may travel large distances, presumably in search of seagrass and warmer waters. Localised movements relate to feeding activities and tidal amplitude as some seagrass beds are exposed at low tide. Location of seagrass beds in waters around HHI is shown in Figure 6.44. Table 6.24 describes the types of seagrass in each of the beds identified on Figure 6.44.

Dugong occur on coastal waters of northern Australia, extending from Exmouth in the west to Moreton Bay in the east with occasional sightings along the NSW coast. Australia supports a significant proportion of the world's dugong population, with four main areas of occurrence:

- Western Australia
- Gulf of Carpentaria
- Torres Strait and northern GBR
- Queensland urban coast, covering from Cooktown to the New South Wales border.

Dugong are listed as vulnerable under the Queensland *Nature Conservation Act 1992* and Western Australia *Wildlife Conservation Act 1950* but are not listed as threatened under the EPBC Act.

Within the Queensland urban coast area, the most important locations for dugong are:

- Hinchinbrook Island
- Cleveland Bay
- Shoalwater Bay
- Hervey Bay
- Moreton Bay.

Dugongs are known to occur in Port Curtis and Rodds Bay however this area is not among the most important locations for dugong, (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 04/02/2013, Marsh et al 2001, Marsh and Lawler 2006, Grech and Marsh 2007). In relation to waters around HHI, a dugong was observed in Boyne Creek at high tide, and another dugong was observed off the eastern end of HHI at low tide (GPC 2011).

HHI is located within the Rodds Bay Dugong Protection Area which extends from Rodds Peninsula, south of HHI to Curtis Island to the north (Figure 6.40). Dugong protection areas are established under the Queensland *Fisheries Act 1994*. Regulations under the *Fisheries Act 1994* establish restrictions on fishing methods in dugong protection areas.

Section 6.6.4.2 contains details of dugong surveys undertaken locally which indicate populations within Rodds Bay DPA in the order of approximately 100-300 dugongs in the period 1986-2005. Earlier results may have been an overestimate as methodology for estimating dugong population sizes from aerial surveys has improved (Pollock *et al.* (2006).

This correlates with the dugong density model established by Grech and Marsh (2007) which has been applied for the Gladstone region, including Rodd's Bay Area (GHD 2009), and indicates that waters around HHI are of low to medium density for dugong at low tide and, on high tide were recognised as supporting a dugong density of low to high (Figure 7.11). In comparison, waters in Gladstone Harbour are of medium and medium-high density for dugong on both low and high tides (GHD 2009) (Figure 7.12).

Professor Helene Marsh (pers. comm., 5/8/08 in SKM 2010) indicates that the spatially explicit population model of Grech and 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 7.11, Figure 7.12).

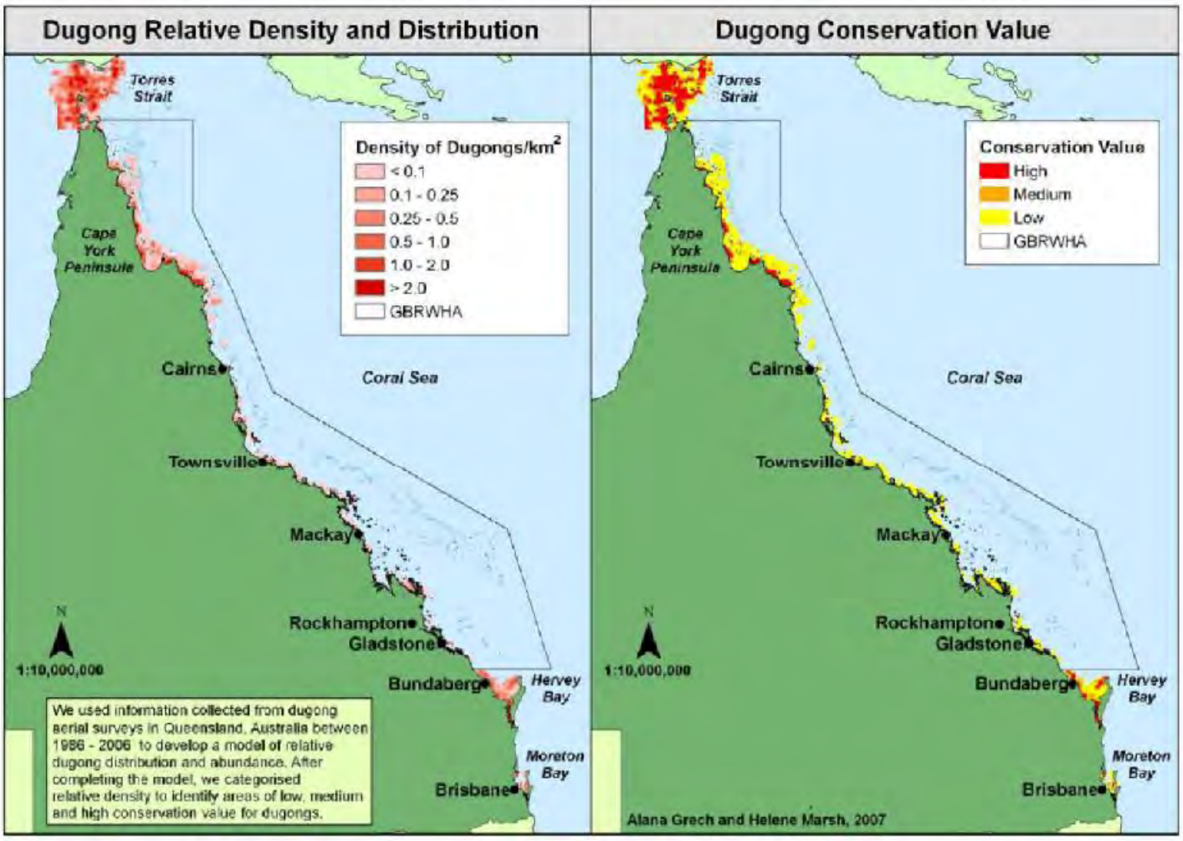

Figure 7.11 - Relative Dugong Density and Conservation Value on the East Coast of Australia (Based on the Model of Grech and Marsh 2007)

Model output obtained specifically for the area around HHI (A. Grech, person comm. 6/8/08) indicates that dugongs are likely to occur in most parts of Rodds Bay, but that the dugong population is low relative to other areas of Queensland. The dugong density values indicate the probability of occurrence of dugong in a particular cell. 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.

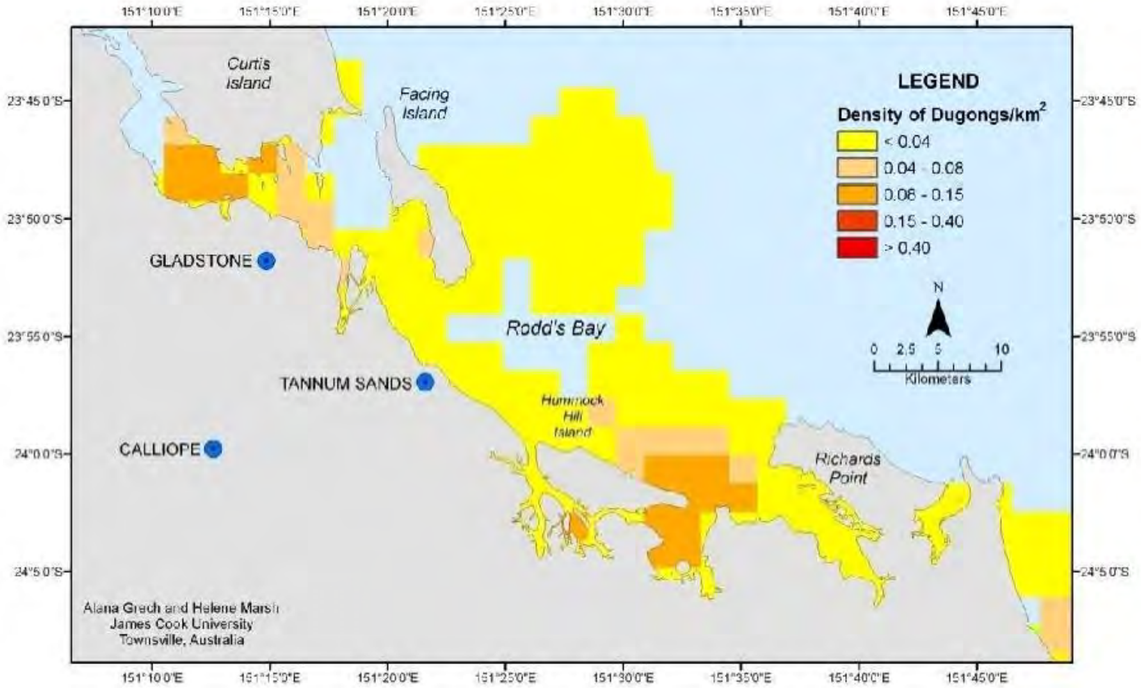

Figure 7.12 - Distribution of Relative Dugong Density in the Area around HHI (Estimated by the Model of Grech and Marsh, 2007 (Source: A. Grech))

The modelled relative density of dugongs throughout Rodds Bay DPA is always less than 0.15/km^2. Densities of 0.08-0.15/km^2 are estimated in sheltered waters of the inner Gladstone Harbour and to the east of HHI. This is supported by relatively low numbers of sightings (GPC 2011). By comparison, modelled densities in the Shoalwater Bay, Great Sandy Strait, and Moreton Bay areas can exceed 1.0 dugong per km^2.

The higher density areas around HHI correspond to seagrass meadows. As discussed in Section 6.6.2.5, there are relatively stable seagrass beds to the east of HHI. In Seven Mile Creek and waters to the south-east of HHI, the seagrass beds are *Zostera capricorni*, which is not a preferred food of dugong, but will be eaten when other food is not available. Seagrass beds to the north-east of HHI. including a bed close inshore and several beds around 3-5 km offshore are low density *Halophila sp* and *Halodule sp*, which are preferred by dugong.

In the southern and central Queensland coast, the estimated dugong population between Dunk Island and Bundaberg ranged from 3,500 dugongs in 1986 to 1,700 animals in 1994 to about 4,000 dugongs in 1999. On this basis, the Rodds Bay DPA may support 5-10% of the dugong population in the southern two thirds of the GBRMP. Aerial surveys indicate that the numbers of dugong in the Hervey Bay to Great Sandy Strait region have fluctuated from about 2,200 in 1988, to 800 in 1994, 1,650 in 1999 and 1,710 in 2001 (Lawler et al 2002).

A recent population estimate for dugong within the GBRMP indicated about 14,000 animals.

SEWPaC reports that while there has been a decline in dugong populations in Queensland since the 1960s, populations were considered stable after the most recent count in 2005, and most high conservation value habitats are at low risk of impact from anthropogenic activities. There is also evidence pointing to a reduction in dugong numbers globally (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 04/02/2013).

More recently, there have been media reports of declines in dugong numbers, particularly in the southern GBRWHA (http://www-public.jcu.edu.au/news/current/JCU_110255 accessed 14/03/2013). In media statements, Professor Helene Marsh, a cetacean specialist at James Cook University has noted that severe weather events in the summer of 2010/2011 have led to reduction in health of seagrass beds and that this appears to have correlated with lower numbers of dugong, including in the Gladstone area. Dugong stranding and mortality was also considered to have increased. Actual survey data on overall dugong populations has not been published.

Population fluctuations between individual locations may not necessarily indicate overall species decline as dugong are reasonably mobile and will move between feeding areas in response to changes in abundance of seagrass (Marsh et al 2002). Seagrass is sensitive to salinity and light penetration. The abundance of seagrass therefore changes seasonally due to wet season runoff of fresh, turbid water and also inter-annually in response to extreme wet weather events. Anthropogenic factors including direct disturbance and activities that reduce light penetration can also affect seagrass productivity. Historic data on seagrass occurrence in water surrounding HHI is presented in Section 6.6.2.5 and also available in Rasheed et al (2003) and Thomas et al (2009).

Dugong are long lived and females do not generally breed until at least 10 years old. Dugong have a low breeding rate, typically producing a single calf every 3-7 years. Breeding may be delayed by lack of seagrass resources. Female dugong appear to give birth in shallow areas.

MacDonald (unpublished thesis, 2005), studied the genetics of dugong populations and found that there did not appear to be any genetically distinct dugong populations within Australia, with “a significant level of gene flow occurring around Australia”. Gene flow between dugong populations in Australia and neighbouring countries was also apparent.

In addition to being EPBC Act listed migratory species, Dugong are considered iconic species in the GBRMP and GBRWHA/NHP (http://www.gbrmpa.gov.au/about-the-reef/animals/protected-species, accessed 24/04/2013). Dugong have also been traditionally hunted by indigenous people. Hunting of dugong in waters around HHI is undertaken in accordance with a Traditional Use of Marine Resources Agreement (see also Section 7.6.4).

Known local and regional threats to dugong populations include:

- Entanglement with shark nets and by catch in commercial fishing operations. There are commercial fishing activities throughout Port Curtis and Rodds Bay and shark nets deployed at Tannum Sands.
- Destruction or die back of seagrass beds. Seagrass beds naturally fluctuate in area and density of cover in accordance with natural events, particularly turbid freshwater runoff from large

storm events. Dredging and land reclamation projects may result in direct loss of seagrasses, and sediment plumes from dredging or runoff from disturbed land areas can also cause seagrass dieback. Dugong appear to have adapted to these natural fluctuations by moving in response to availability of seagrass, however cumulative decline in seagrass meadows has been identified as a major cause of dugong population decline.

- Boat strike and boating activities. There is significant boating activity in the waters of Port Curtis, involving vessels of all sizes in both commercial and recreational categories. The sheltered waters behind HHI are currently visited by a small number of recreational boats.
- Indigenous harvest. It is not known to what extent indigenous harvest takes place in the central Queensland area.
- Disease and parasitic infections. There is no data on whether dugong populations in Rodd Bay DPA are affected by disease and parasitic infections, but the level of intermingling between groups would suggest that disease and parasitic infections could spread between populations.

Other threatening processes may include:

- Chemical pollution including oil spills and heavy metal contamination
- Acoustic pollution.

Commercial fishing and Indigenous hunting, particularly in north Queensland and the Torres Strait region (Heinsohn *et al.* 2004), provide the two main areas of uncertainty of dugong mortality from anthropogenic activities in Queensland. However, even allowing for poor reporting of dugong strandings in some areas, the reported mortality of about 85 dugong for 2010 and 63 for 2009 along the approximately 2000 km of Queensland's urban coast is considered to represent a low mortality rate among the thousands of dugong that live along this coast. This low incidence of dugong mortality is considered indicative of the effectiveness of the combined benefits of the species protection provided via the NC Act, habitat protection provided via the *Marine Parks Act 1982* and the *Great Barrier Reef Act 1975* and associated activities in keeping dugong mortalities within sustainable levels.

Waters around HHI are considered of moderate importance in relation to dugong, based on known occurrence, known foraging habitat and the outputs of the dugong density model (Grech and Marsh 2007).

Evaluation of impacts of PTP on dugong is undertaken in Section 8, and where potentially significant impacts are identified, further evaluation is provided in Section 10.4. Where the likelihood of occurrence assessment presented in this section indicates low likelihood of occurrence, or that the species is not present, no further assessment has been undertaken.

7.5.3.3 Indo-Pacific Humpback Dolphin

Within Australia, the Indo-Pacific humpback dolphin is known to occur in coastal areas from Exmouth to the Queensland/New South Wales border (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=50 accessed 16/03/2013). The dolphins inhabit shallow waters to depths of about 15-20 m, usually up to 5 km from the coast, and often associated with bays and estuaries. Fish are the dolphin's main food source, with crustaceans and other invertebrates also occasionally targeted.

The Indo-Pacific humpback dolphin is known to occur in waters around HHI.

Indo-Pacific humpback dolphins were the most commonly sighted marine megafauna species in surveys of the Port Curtis and Rodds Bay area undertaken in 2011. The surveys covered five areas from Port Alma in the north to Rodds Bay, with the Rodds Bay area including waters adjacent to HHI. For boat based surveys, survey 1 was undertaken in February-March 2011 and survey 2 in June 2011. For aerial surveys, survey 1 was undertaken on 21 April 2011 and survey 2 on 13 June 2011.

For boat based surveys, 85 of the 201 sightings were Indo-Pacific humpback dolphins and in aerial surveys, 57 of 180 animals sighted were Indo-Pacific humpback dolphins (GPC 2011).

Results for boat based surveys are presented in Figure 7.13 and indicate that by far the highest number of Indo-Pacific humpback dolphin sightings was in the Port Curtis area.

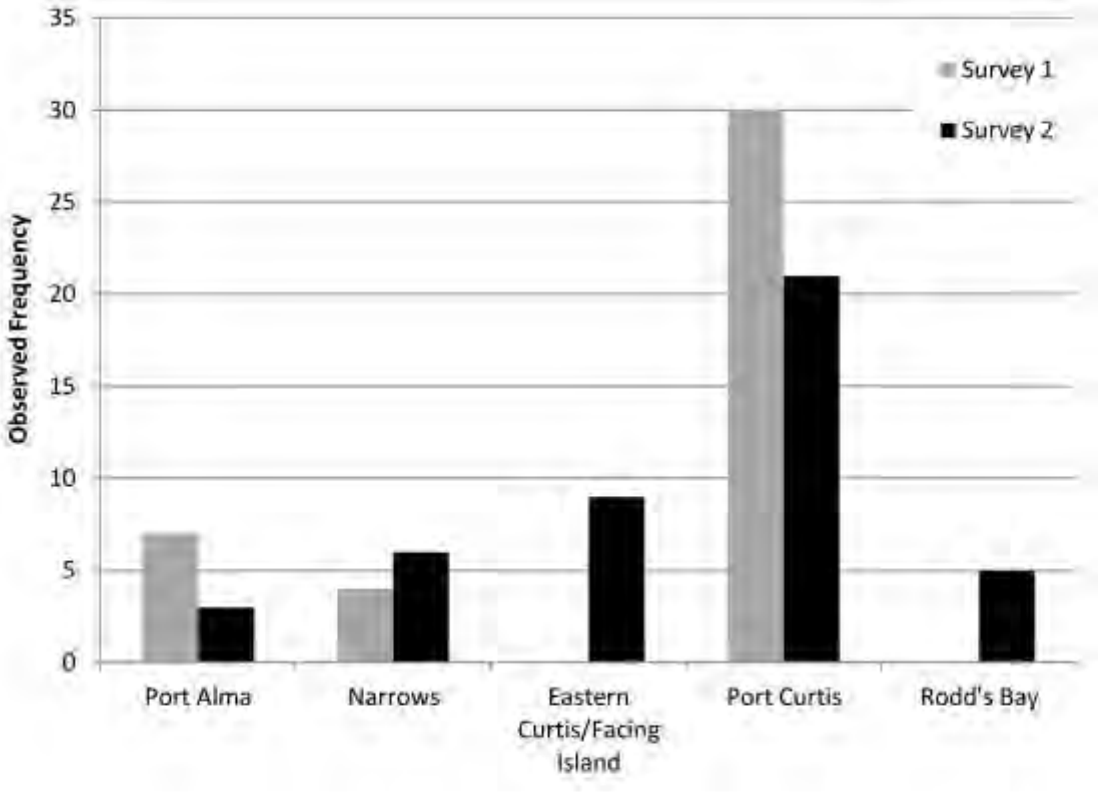

Figure 7.13 - Indo-Pacific Humpback Dolphin Sightings – Boat Based Surveys 2011 (GPC 2011)

Results for aerial surveys are presented in Figure 7.14. There was a lower observation frequency of Indo-Pacific humpback dolphin compared to boat based surveys. Numbers of Indo-Pacific humpback dolphins observed in Rodds Bay were more similar to Port Curtis.

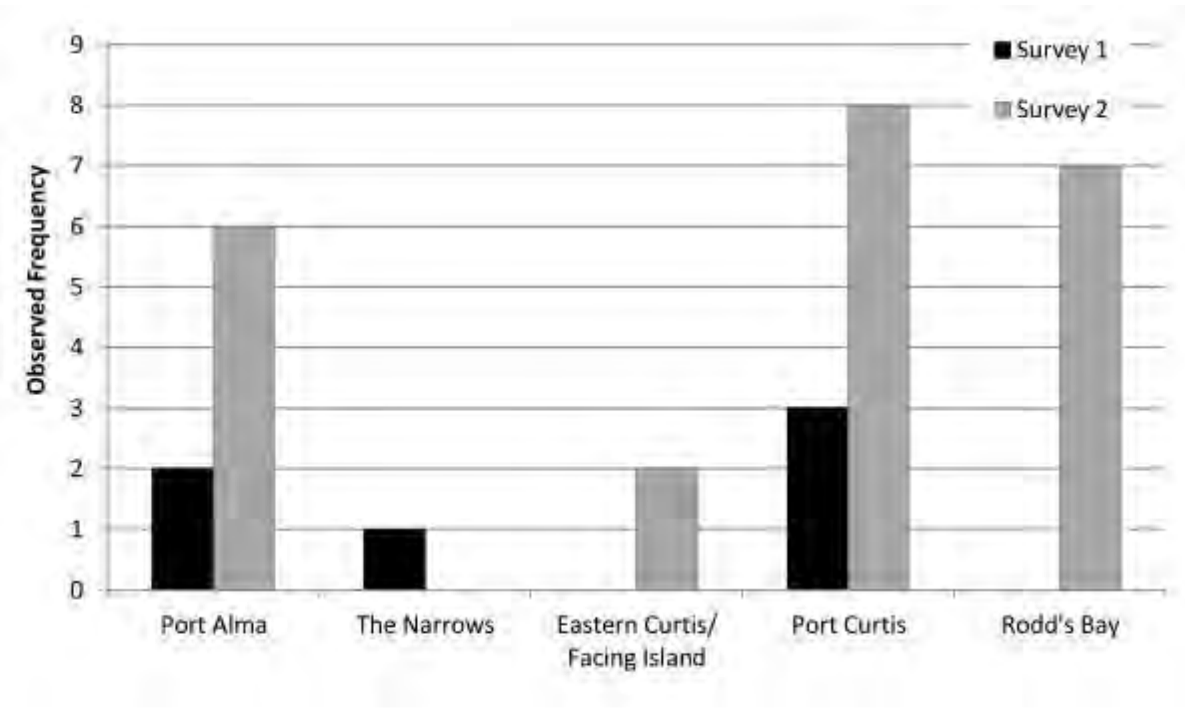

Figure 7.14 - Indo-Pacific Humpback Dolphin Sightings – Aerial Surveys 2011 (GPC 2011)

Insufficient longitudinal data is available within the Port Curtis/Rodds Bay area to draw any conclusions on local population stability (GPC 2011).

Data on population stability or decline is not available, however as many populations utilised areas that have subsequently been developed as ports, there are concerns that populations in these locations may be declining due to degradation of water quality, vessel interactions and other habitat degradation. Indo-Pacific humpback dolphins are also vulnerable to by-catch in commercial fisheries and in Australia and other locations are killed in shark nets. Indo-Pacific (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=50 accessed 05/02/2013).

There are shark nets off Tannum Sands and commercial fishing takes place offshore from HHI. No data is available on by catch of dolphin. Marine stranding data and data on vessel strike incidents is also not available.

Waters around HHI are considered of low to moderate importance for the Indo-Pacific humpback dolphin. Further discussion on potential impacts of PTP on dolphins is provided throughout Section 8.

7.5.4 Migratory Marine Species – Reptiles

Three marine turtle species are known to occur in waters around HHI, flatback turtle, *Natator depressus*, green turtle, *Chelonia mydas*, and loggerhead turtle, *Caretta caretta*, and suitable habitat for other marine turtles also occurs in the area. Marine turtles are discussed in Section 7.4.4.

The protected matters search report also identified the potential presence of the estuarine or salt-water crocodile, *Crocodylus porosus*. This species is known to occur in low densities in the Fitzroy River, and may be an occasional vagrant further south. Numbers in the Fitzroy River are considerably lower than in catchments further north, with less than 0.5% of the Queensland population.

A survey undertaken by the Queensland DERM between September 2009 and February 2010 did not identify any estuarine crocodiles in waterways south of the Fitzroy River (Sullivan *et al.* 2010). The survey included Wild Cattle Creek, immediately north-west of HHI, Colosseum Creek (Colosseum estuary) and Turkey Beach.

The salt-water crocodile is listed as vulnerable under the *Nature Conservation Act 1992*. Surveys in 2009/2010 confirmed a limited population recovery (Sullivan *et al.* 22010).

As it is unlikely that crocodiles occur in waters around HHI, no further assessment of impacts has been undertaken.

7.5.5 Migratory Marine Species – Sharks

The protected matters search tool identified the possible presence of the whale shark, *Rhincodon typus,* and HHI is within the distribution range of this shark. As this species is listed as both vulnerable and migratory, it is discussed in Section 7.4.4.

The protected matters search tool also identified the possible presence of the porbeagle or mackerel shark *Lamna nasus*. The Gulf of Maine research institute identifies this as a pelagic shark with worldwide distribution, mostly in cold and temperate waters (http://www.gma.org/fogm/Lamna_nasus.htm accessed 14/08/2013). The species is generally found in offshore waters but may be found in shallow inshore waters occasionally.

A biological profile prepared by the Florida Museum of Natural History maps distribution in Southern waters as extending only to the Victoria / NSW border and notes that the shark is rarely found in waters above 18°C (http://www.flmnh.ufl.edu/fish/Gallery/Descript/Porbeagle/Porbeagle.html, accessed 14/08/2013). The Australian population is likely to be distinct from other populations.

This information would indicate that porbeagle is not likely to utilise waters around HHI as core habitat, but may occasionally stray into these waters.

As waters around HHI are not likely to provide important or significant habitat for the porbeagle, no further assessment of impacts is presented.

7.5.6 Summary of Values – Migratory Species

Based on the criteria established in Section 1.7.4, the following values are present in and around HHI in relation to migratory species:

- Intertidal and subtidal waters are of **moderate importance** as these areas are utilised by dugong, Indo-Pacific humpback dolphin and marine turtles
- The Mundoolin/Colosseum and Rodds Bay conglomerate of migratory shorebird sites is considered of international and national importance for migratory shorebirds and therefore of **highest importance** in relation to this assessment. This includes an important site located on the south-east of HHI
- Terrestrial habitat on HHI is of **lower importance** as it is occasionally utilised by some common and widespread species of migratory terrestrial birds.

Potential impacts on migratory species for which waters around HHI are likely to provide important habitat are assessed in Section 8. Where potentially significant impacts are identified, a more detailed assessment is provided in Section 9.

7.6 Great Barrier Reef Marine Park

7.6.1 Marine Park Boundaries, Zoning and Restrictions on Use

HHI lies within the Mackay Capricorn Management Area of the GBRMP and the Mackay/Capricorn management area of the Queensland administered GBRCMP.

Hummock Hill Island is situated on the landward boundary of the GBRMP Zone MPZ17 – Gladstone. The GBRMP boundary runs from offshore to the northern tip of the Island, along the northern shoreline, and to the southern tip of the Island where it cuts across the entrance of Rodds Bay to Rodds Peninsula. The area of the GBRMP adjacent to Hummock Hill Island is jointly administered by the GBRMPA and Queensland. The landward limit of the GBRMP boundary on the island is the low-water mark; areas between the low-water mark and highest astronomical tide (HAT) are classified as "internal waters of Queensland", areas above the low water mark on the Island are not part of the GBRMP but are in the GBRCMP administered by Queensland State. The boundaries of the GBRMP are presented in Figure 6.35.

It is prohibited to undertake mining activities, including prospecting and exploration activities, in the GBRMP. It is also prohibited to undertake any activity which causes or may cause damage to the GBRMP. A permit is required for placement of any structure in the GBRMP, and also for operation of tourism vessels and discharge of waste.

A zoning system has been developed for the GBRMP and GBRCMP to guide other uses and activities that may take place in various locations, with the level of restriction reflective of the environmental and conservation values of a particular location. Both the marine park and coast marine park are covered by a single zoning plan, an excerpt of which is shown in Figure 7.15. Colour coding and designations for zones are shown in Figure 7.16. The zoning system is also based on protecting representative areas of each of the bioregions present in the marine park/coast marine park, such that at least 20% of each bioregion is protected (http://www.gbrmpa.gov.au/zoning-permits-and-plans/rap, accessed 16/02/2013).

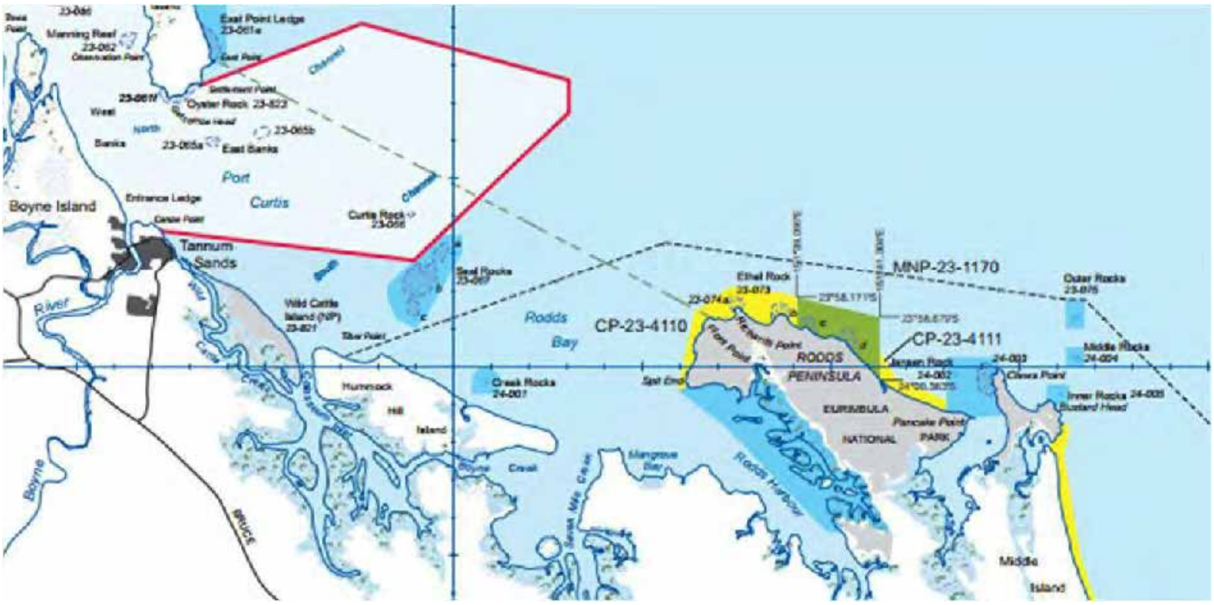

Figure 7.15 – Great Barrier Reef Marine Park/Coast Marine Park Zoning (GBRMPA 2011)

ACTIVITIES GUIDE

(see relevant *Zoning Plans* and *Regulations* for details)

	General Use Zone	Habitat Protection Zone	Conservation Park Zone	Buffer Zone	Scientific Research Zone [2]	Marine National Park Zone	Preservation Zone
Aquaculture	Permit	Permit	Permit [1]	✗	✗	✗	✗
Bait netting	✓	✓	✓	✗	✗	✗	✗
Boating, diving, photography	✓	✓	✓	✓	✓ [2]	✓	✗
Crabbing (trapping)	✓	✓	✓ [3]	✗	✗	✗	✗
Harvest fishing for aquarium fish, coral and beachworm	Permit	Permit	Permit [1]	✗	✗	✗	✗
Harvest fishing for sea cucumber, trochus, tropical rock lobster	Permit	Permit	✗	✗	✗	✗	✗
Limited collecting	✓ [4]	✓ [4]	✓ [4]	✗	✗	✗	✗
Limited spearfishing (snorkel only)	✓	✓	✓ [1]	✗	✗	✗	✗
Line fishing	✓ [5]	✓ [5]	✓ [6]	✗	✗	✗	✗
Netting (other than bait netting)	✓	✓	✗	✗	✗	✗	✗
Research (other than limited impact research)	Permit	Permit	Permit	Permit	Permit	Permit	Permit
Shipping (other than in a designated shipping area)	✓	Permit	Permit	Permit	Permit	Permit	✗
Tourism programme	Permit	Permit	Permit	Permit	Permit	Permit	✗
Traditional use of marine resources	✓ [7]	✓ [7]	✓ [7]	✓ [7]	✓ [7]	✓ [7]	✗
Trawling	✓	✗	✗	✗	✗	✗	✗
Trolling	✓ [5]	✓ [5]	✓ [5]	✓ [5,8]	✗	✗	✗

1) Restrictions apply to aquaculture, spearfishing and harvest fishing for aquarium fish, beachworm and coral in the Conservation Park Zone
2) Except for One Tree Island (SR-23-12010) and Australian Institute of Marine Science (SR-19-2008), which are closed to public access and shown s orange, all other Scientific Research Zones are shown as green with an orange outline
3) Limited to 4 catch per apparatus per person (eg crab pots, collapsible traps or dillies)
4) By hand and hand held implement, and generally no more than 5 of a species
5) Maximum of 3 lines/rods per person and with a combined total of 6 hooks per person
6) Limited to 1 line/rod per person and 1 hook per line, Only 1 dory detached from a commercial fishing vessel
7) Apart from traditional use of marine resources in accordance with s.211 of the *Native Title Act 1993*, an accredited Traditional Use of Marine Resources Agreement or permit is required
8) Pelagic species only. Seasonal closures apply to some buffer zones.

Figure 7.16 - Great Barrier Reef Marine Park/Coast Marine Park Activity Guide for Zones

Waters surrounding HHI are zoned for general use. The objective of this zone is: "*to provide for the conservation of areas of the Marine Park, while providing opportunities for reasonable use*" (GBRMPA 2003). As shown in Figure 7.16, most recreational and fishing activities are allowed in the general use zone with some restriction on fishing methods and size of catch. Aquaculture, harvest fishing for aquarium fish, coral, beachworm, sea cucumber, trochus and tropical rock lobster, research activities and tourism activities all require a permit.

The general use zone is the most accessible zone to the public, and provides an important connection between the community and the GBRMP/GBRCMP generally, and the more sensitive features of the two marine parks. The general use zone also provides connectivity between the more highly protected zones and representative areas and with adjacent ecosystems that are also important to functionality of the ecosystems within the GBRMP/GBRCMP.

The nearest habitat protection zone is Creek Rocks (24-001), which lies 1-2 km from the nearest point of HHI, and about 5 km north- east of Tiber Point (see Figure 7.15). A habitat protection zone is also located surrounding Seal Rocks (23-067), about 5 km north of Tiber Point. In addition to restrictions placed on general use zones, trawling is prohibited in a habitat protection zone and a permit is required for shipping. The objectives of the habitat protection zone are:

(a) to provide for the conservation of areas of the Marine Park through the protection and management of sensitive habitats, generally free from potentially damaging activities; and

(b) subject to the objective mentioned in paragraph (a), to provide opportunities for reasonable use. (GBRMPA 2003)

The nearest conservation park zone is at Rodds Peninsula, 14 km to the east and the nearest national park zone is also located at Rodds Peninsula, 20 km to the east. There are no buffer zones, scientific research zones or preservation zones within 50 km of HHI.

7.6.2 Bioregional Classifications

The GBRMPA has determined bioregional classifications for reef and non-reef ecosystem components of the GBRMP/GBRCMP.

In terms of reef ecosystems, HHI lies within an area designated as "coastal southern fringing reefs" (RE8). The bioregion information sheet for this bioregion notes that it is "dominated by episodic Fitzroy River flood plumes". The information sheet also notes "southern influence in algal species" and that there are "fringing reefs around high continental islands with high cover of hard and soft coral and algae, but low coral diversity". It should be noted that there are no fringing coral reefs on HHI. There are two submerged reefs to the north of HHI, Creek Rocks and Seal Rocks (see also Section 7.6.1). Submerged reefs make up 5% of reefs in this bioregion. (https://www.google.com/url?q=http://www.gbrmpa.gov.au/__data/assets/pdf_file/0018/6129/re8.pdf&sa=U&ei=7ewZUcbDDabnmAWR04GIDw&ved=0CAcQFjAA&client=internal-uds-cse&usg=AFQjCNHB8-VvN_865Ac-A8DH0JLeh8TrXw, accessed 12/02/2012).

In terms of non-reef ecosystems HHI lies within the "high nutrient coastal strip" (NA3). The bioregion information sheet for the "high nutrient coastal strip" identifies the bioregion as consisting of "*terrigenous mud and high levels of nutrients from the adjoining land*". The bioregion features seagrass in sheltered sites and provides good turtle and dugong feeding habitat. (https://www.google.com/url?q=http://www.gbrmpa.gov.au/__data/assets/pdf_file/0020/6077/na3.pdf&sa=U&ei=LusZUejpIuP0mAXKnIFo&ved=0CAcQFjAA&client=internal-uds-cse&usg=AFQjCNFgbLI2cx-1cKPDGhVC1PAhSy4tJw accessed 12/02/2012).

Features identified in the bioregion information sheets relevant to HHI are dugong habitat in the "Port of Gladstone – Rodds Bay" area and turtle foraging habitat. There are no special or unique sites identified on or in the vicinity of HHI.

7.6.3 Visitor Levels and Activities

The GBRMPA records visitors to the GBRMP in terms of visitors carried by commercial tourism operators and other visitors required to pay the Environmental Management Charge. On this basis, visitation to the GBRMP was 1.92 million visitor days in the year ending June 2012. The visitation level in the Mackay-Capricorn region was 120,000 part or full visitor days in the same period (http://www.gbrmpa.gov.au/visit-the-reef/visitor-contributions/gbr_visitation/numbers accessed 25/03/2013). Visitation levels utilising commercial tourism operators to coastal areas of the Mackay-Capricorn management area of the GBRMP is lower than for other regions of the marine park, with visitors accessing the marine park at Gladstone and Agnes Waters/1770 (GBRMPA 2009). Lady Elliot Island receives the highest concentration of visitors in the Mackay-Capricorn region, with other key visitor locations being the Capricorn-Bunker group of reefs, which are a minimum of 50 km offshore from HHI, and coral cays and patch reefs of the outer reef (GBRMPA 2009). This is consistent with lower levels of tourism operators and accommodation in the Mackay-Capricorn management area.

This does not include recreational visitors, which are defined by GBRMPA as people who access the GBRMP independently, for example in a privately owned vessel or by other private means. This data is more difficult to track, however it is estimated that there were 14.6 million recreational visits to the GBRMP from people living in the catchment in 2008 (GBRMPA 2012). Fifty-five per cent of people living in the catchment visited the marine park at least once in 2008. Thirteen per cent of private vessel-based trips to the marine park originated from the stretch of coastline between Rockhampton and Bundaberg.

The most popular activities for recreational visitors (that is, those visitors not utilising commercial tourism operations) in the GBRMP are swimming, motorised boating and fishing with well over half of the recreational visitors to the MP undertaking one or more of these activities. Snorkelling is also popular with about 25% of visitors undertaking snorkelling while less than 10% of visitors undertake sailing, diving and jetskiing (GBRMPA 2009).

7.6.4 Traditional Use

A Traditional Use of Marine Resources Agreement is in place between GBRMPA and the Port Curtis Coral Coast traditional owner group. The agreement covers a marine and coastal area of over 26,000 square kilometres, and encompasses HHI. Traditional Use of Marine Resources Agreement s describe how traditional owners manage traditional use activities in within the GBRMP and GBRCMP. They can also include management strategies that will protect and positively impact sea country of traditional owner groups.

A particular initiative under the Port Curtis Coral Coast Traditional Use of Marine Resources Agreement is a permit system in relation to hunting of marine turtles.

7.6.5 Role of Coastal Zone in Ecological Functions of the Great Barrier Reef

7.6.5.1 Overview

The coastal zone and adjacent land areas that drain into the GBRMP provide a number of functions that affect the health of the coral reef ecosystem and the overall marine park as well as individual species that make up the marine park/coast marine park. The core functions of the coastal zone are considered to be:

- Physical processes associated with regulation of freshwater inputs, sediment inputs and coastal currents
- Nutrient cycling and other chemical processes
- Provision of habitat, food and other resources (http://www.gbrmpa.gov.au/outlook-for-the-reef/great-barrier-reef-coastal-ecosystems accessed 06/02/2013 GBRMPA 2009).

These functions are described below in relation to the coastal zone and waters around HHI. Further information on coastal and marine habitats is provided in Sections 6.5 and 6.6.

7.6.5.2 Physical Processes

HHI lies across the mouth of Colosseum Inlet estuary as named by OzCoasts (http://www.ozcoasts.gov.au, accessed 10/02/2013) (Figure 1.4). There are also several tidal waterways on HHI, including “Sandfly Creek” which essentially bisects the Island. Catchments and runoff from catchments on HHI is discussed further in Section 6.4.

Coastal and estuarine processes and water quality are discussed in Section 6.5.

The PCIMP reports that waters in the vicinity of HHI have generally met the ecosystem health indicator established in relation to turbidity of 20 NTU in the 2005/2006 report period and the 2008/2010 report periods (Storey et al, 2007, Vision Environment 2011). This generally correlates with data collected by SKM from two monitoring events in 2005. In these events, turbidity in estuarine areas ranged from 3.6 to 31.4 NTU (SKM 2007).

A coastal hydrodynamic model was set up for the Port Curtis and Rodds Bay area, including HHI, by the CRC for Coastal Zone, Estuary and Waterway Management (Herzfield et al 2004). As discussed in Section 6.5.3.2, this shows that there is a large but relatively weak anticlockwise gyre in the Rodds Bay area to the north and north-east of HHI at surface. Further offshore, surface currents flow in a north-westerly direction with a shear between the gyre and offshore currents.

An inshore current runs parallel to the coast directing flows from Colosseum Inlet to the north-west along the coast of Wild Cattle Island. Modelling of release of a tracer placed in Rodds Bay, midway between the eastern end of HHI and Rodds Peninsula indicated that the flushing time for this part of the estuary was about five days. The tracer was transported south into the Rodds Bay estuary and, through Seven Mile Creek and Boyne Creek, remaining in the inshore area, moving parallel to the coastline, with small amounts being carried into the Port Curtis area. Very little of the tracer was transported into offshore waters.

HHI and surrounding estuarine systems would appear to have only localised influence on physical processes in the GBRMP, based both on the small catchment sizes and correspondingly small freshwater and sediment inputs from these catchments and estuaries and on coastal hydrodynamic modelling.

7.6.5.3 Nutrient Cycling

The GBR Outlook Report notes the important role of nutrients in supporting life and maintaining biodiversity, and also the potential adverse effects of increased nutrient levels in some habitats and particularly in coral reef ecosystems (GBRMPA 2009).

Nutrients in marine and other aquatic environments are derived almost entirely from catchment runoff. Nutrients may enter estuarine environments in dissolved form or adsorbed to sediments. The ecology of estuarine environments is adapted to relatively high nutrient levels. Dissolved nutrients are taken up by mangroves, seagrasses, algae and other plants. Nutrients attached to sediments tend to settle out of the water column, creating a nutrient rich sediment layer. In natural systems, only small amounts of nutrients will leave the coastal zone for the offshore and open ocean environments.

Estuarine environments tend to be very high in primary productivity and hence support a wide range of plants and animals. A number of fish spend some or all of their lifecycle in nutrient rich estuarine and inshore waters, with an added advantage for juvenile fish of protection from predators.

By contrast, primary productivity in offshore and ocean environments is generally significantly lower, and organisms that live in these environments are adapted to living in low nutrient environments.

Human settlement patterns post European settlement have increased nutrient inputs into estuarine and coastal waters, both through increased sediment inputs due to catchment development, and from release of human and other waste sources. Nutrient status in waters around HHI are discussed in Section 6.4.2.

The PCIMP also examined nutrients in waters surrounding HHI as a reference site for monitoring of environmental health in the Port Curtis area. Water quality monitoring indicated that nutrient levels met water quality guidelines most of the time, with compliance scores of 0.9 or above for nitrate, total nitrogen and orthophosphate. Phosphate levels were elevated for some sampling events.

From this information, it appears that there is some elevation in nutrient levels in waters around HHI, with anthropogenic sources from the Colosseum Inlet and Seven Mile Creek catchments likely to be contributing.

7.6.5.4 Provision of Habitat, Food and other Resources

The Colosseum Inlet estuary is relatively minor within the context of the overall GBRMP/GBRCMP, however is still considered to provide important habitat, food and other resources for a number of animals that are important to the values of the GBRMP.

Although not supporting a major dugong population, the broader Rodds Bay area has been declared a dugong protection area (see also Section 7.5.3 and Section 6.6.1) and dugong have been observed in the area. Green turtles, flatback turtles and occasional loggerhead turtles utilise the area for feeding.

Colosseum Inlet has been declared as a fish habitat area under the Queensland *Fisheries Act 1999*. There are 39 declared fish habitat areas within the GBRMP/GBRCMP, ranging in area from 64ha to 170,000 ha. The area of the Colosseum Inlet is 11,572 ha.

7.7 Conservation Objectives

Identified conservation objectives in relation to protection of MNES values are as follows:

- Aesthetic values are retained such that views from within the WHA/NHP are not degraded
- Coastal processes of beach and dune formation are not altered
- Estuarine processes associated with tidal waterways and erosion and accretion of sand banks and mud flats are not altered
- HHI remains clearly recognisable as a continental island
- Aboriginal cultural heritage is conserved and managed through the agreed cultural heritage management plan
- Coastal wetlands, supratidal, intertidal and subtidal habitats are not degraded
- Waters around HHI continue to provide habitat for marine turtles and dugong
- Water quality and hydrological conditions in coastal and enclosed coastal waters surrounding HHI is not degraded when compared to water quality objectives

- Representative examples of all terrestrial ecological communities and habitats are retained and protected
- Floristic diversity, including EPBC Act listed ecological communities, is retained and protected
- Migratory shorebird habitat is not disturbed or degraded
- All elements that contribute to the outstanding universal value of the GBRWHA are retained in recognisable and viable condition
- Threats to the GBR ecosystem and habitats and species that are components of the ecosystem are not exacerbated
- Tourists, other visitors and residents are made aware of the MNES values and other environmental values of HHI and surrounding waters and how to protect these values while staying at the development and undertaking activities in and around HHI.

The proponent has also identified broader environmental performance targets and development principles to guide the project and these are shown in Section 2.2.

SECTION 8
Identification of Impacts

Contents

8. Identification of Impacts

8.1 Introduction

When examining impacts of a proposed action on particular values such as MNES values, it is necessary to examine the range of mechanisms by which direct and indirect impacts on a particular value can occur.

In order to determine potential impacts of the project on MNES values identified in Section 7, an impact scoping process has been undertaken. This section focuses on identifying those impacts on MNES that might be potentially significant. Potentially significant impacts will then be evaluated in more detail in subsequent sections focussing on each controlling provision (listed threatened species and ecological communities – Section 9, listed migratory species – Section 10, GBRWHA/NHP – Section 11, GBRMP – Section 12). Cumulative impacts are then further explored in Section 13.

A distinction exists between impacts, being intended and reasonably foreseeable outcomes of an action, and hazards, being unplanned outcomes that may arise as a result of an unforseen event. As hazards may also give rise to impacts on MNES, a qualitative approach to hazard and risk assessment was also adopted in the methodology (see Section 1.7). Hazards are identified in Section 8.2.2 and impacts associated with potential hazards are also evaluated in Sections 8.3 to 8.10.

8.2 Identification of Impacts and Hazards

8.2.1 Impact Pathways and Groupings

This impact assessment is focussed on impacts on MNES. However, as the cause and effect relationships that lead to impacts on MNES can be complex and, in some cases, indirect, an impact pathway mapping technique was used to set out the cause and effect relationships between actions that will be undertaken for the proposed project and potential impacts on MNES values. Cause and effect relationships have only been explored for those aspects of the proposed development that might affect MNES and hence, for example, effects of noise and dust on human receptors are not considered. Impact pathways were identified based on the following aspects of the project:

- Clearing of vegetation
- Earthworks
- Construction and ongoing presence of buildings and other infrastructure
- Water supply, waste and wastewater generation and management
- Other human activities including transportation and land and water based recreational activities
- Creation of an actively managed conservation area.

Impact pathways for each of these aspects are shown in Figure 8-1 to Figure 8-6.

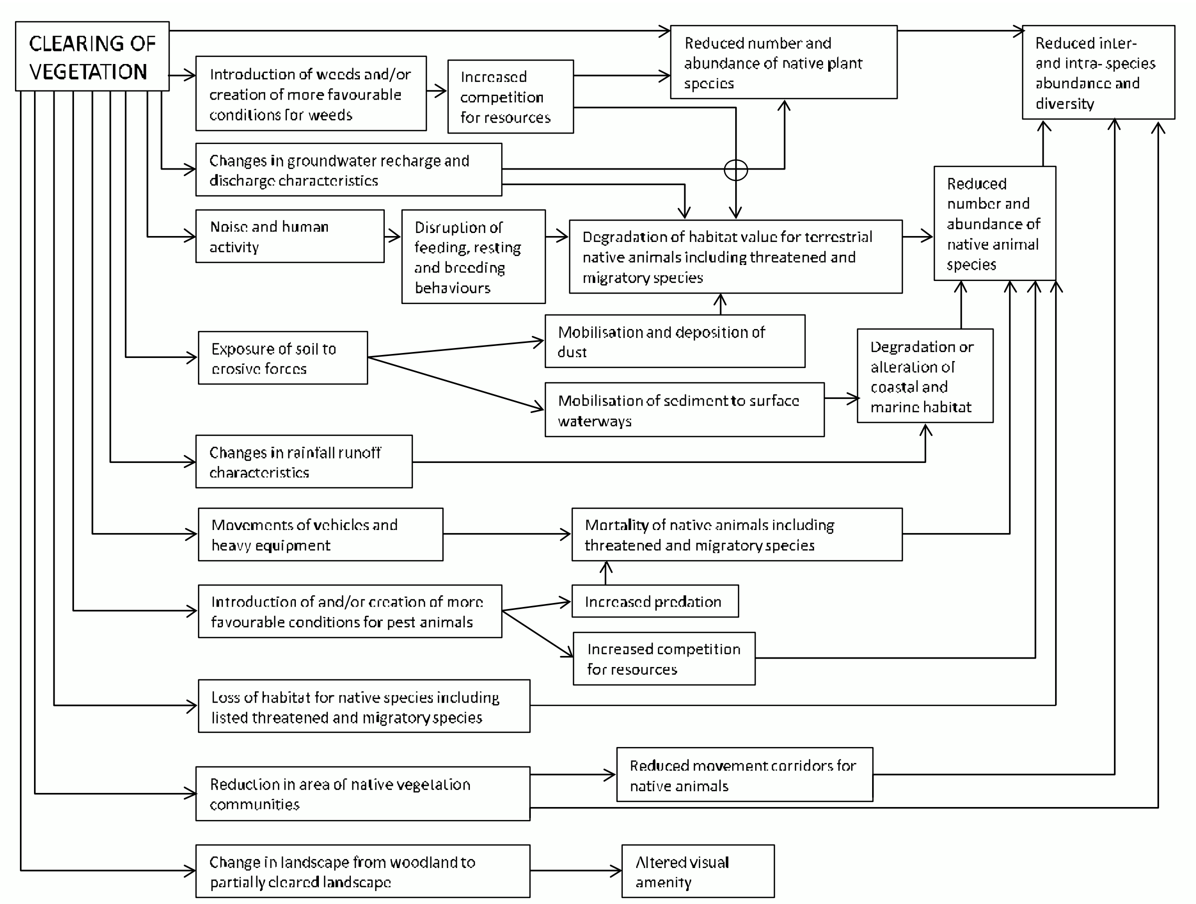

Figure 8-1 – Potential Impacts Arising from Clearing of Vegetation

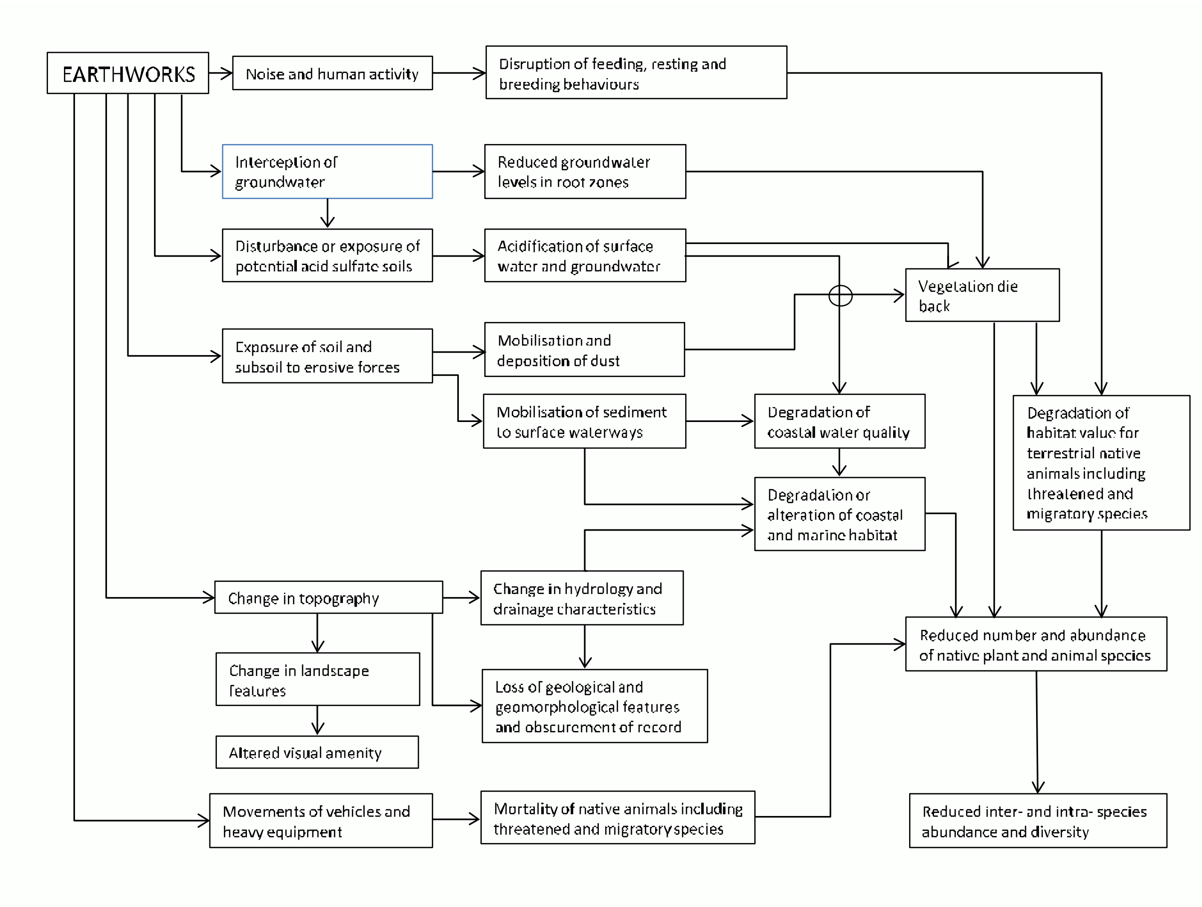

Figure 8-2 – Potential Impacts Arising from Earthworks

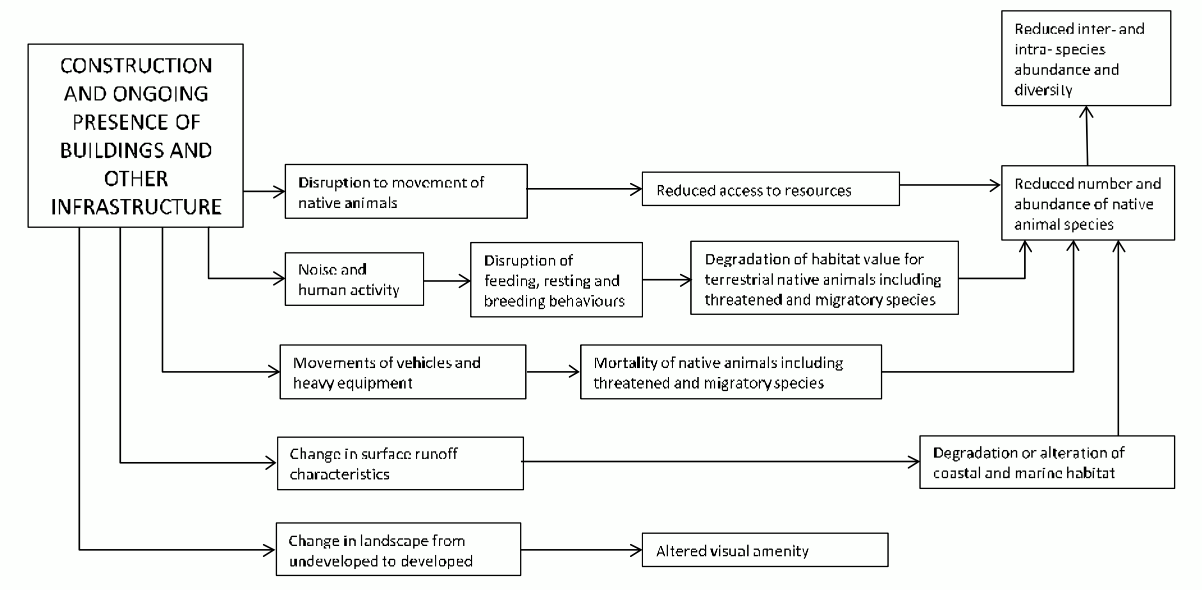

Figure 8-3 – Potential Impacts Arising from Construction and Ongoing Presence of Buildings and Other Infrastructure

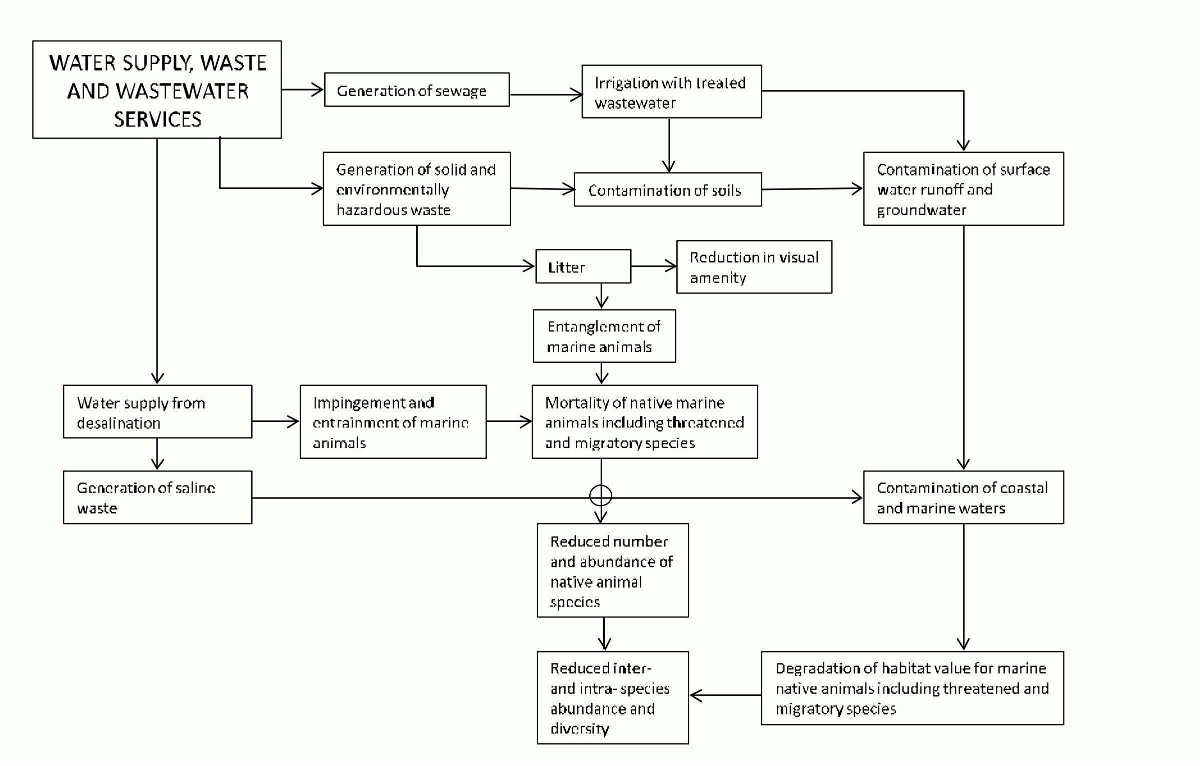

Figure 8-4 – Potential Impacts Arising from Water Supply, Waste and Wastewater Services

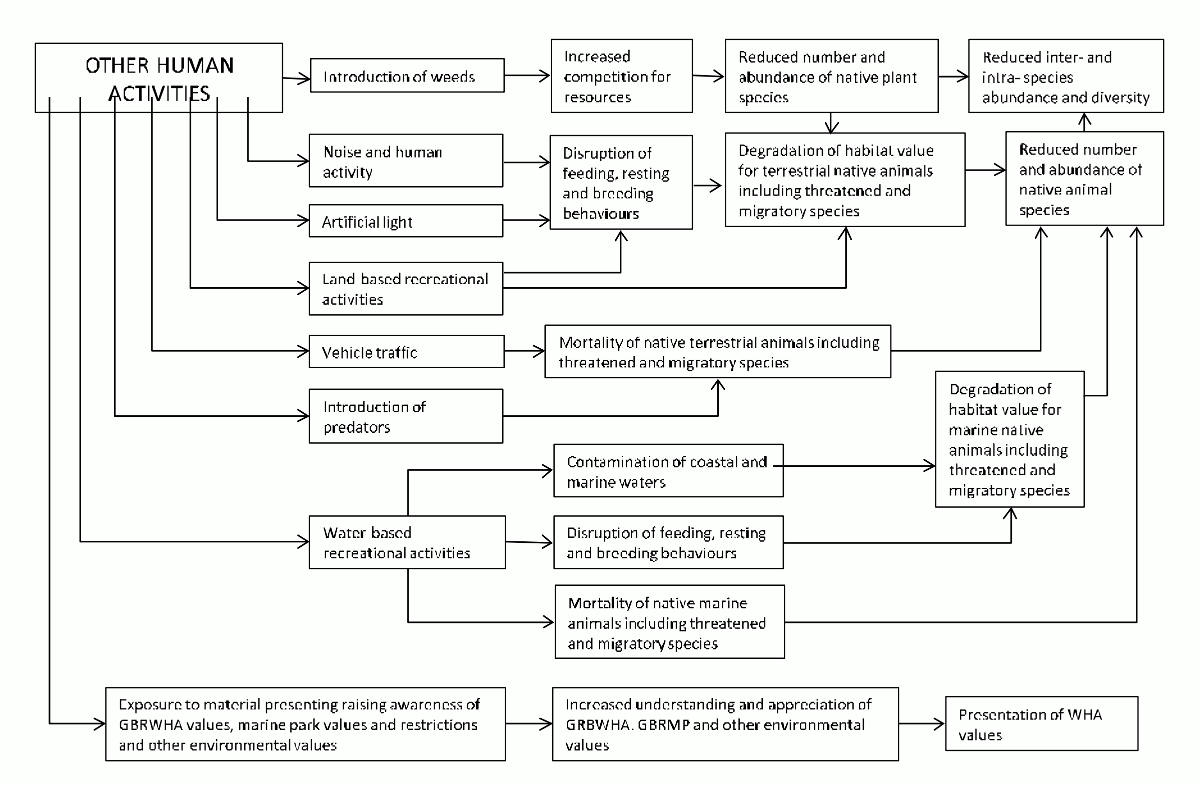

Figure 8-5 – Potential Impacts Arising from Human Activities (Land and Water Based)

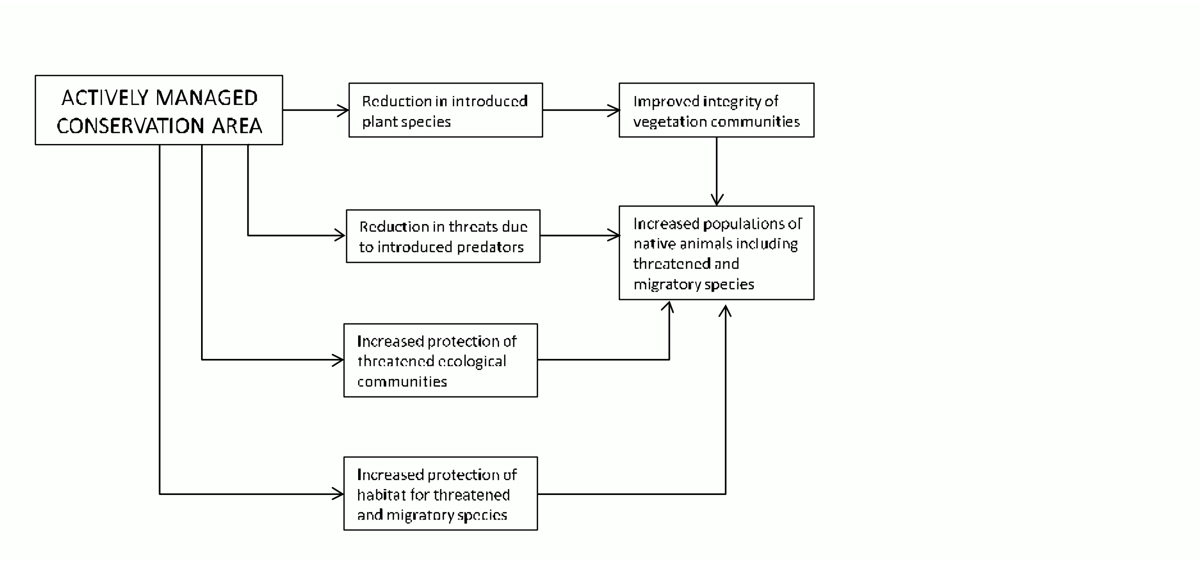

Figure 8-6 – Potential Impacts Arising from Creation of an Actively Managed Conservation Area

Primary impact groups were then identified through the impact pathway analysis and aggregated into the following groups for further evaluation in Section 8.3 to Section 8.10:

- Direct impacts on terrestrial, intertidal and marine habitat and ecological communities (Section 8.3)
- Indirect impacts on terrestrial vegetation and habitat (Section 8.4)
- Impacts on water quality (Section 8.5)
- Impacts on terrestrial threatened and migratory animals (Section 8.6)
- Impacts on marine threatened and migratory animals (Section 8.7)
- Increased levels of activity in the GBRWHA/NHP and GBRMP (Section 8.8)
- Changes in landscape character and visual amenity (Section 8.9)
- Impacts on geological and geomorphological features and processes (Section 8.10).

The methodology set out in Section 1.7.4 is used to determine whether potentially significant impacts on MNES might occur by exploring both the significance of the MNES value present, and the severity of impact on that value. Where only a minor or negligible change is expected (and hence severity of impact is low or negligible), and/or MNES values are absent, impacts are identified as not requiring further consideration. Where impacts are potentially significant in terms of effects on MNES values, these are subject to a more detailed assessment in Sections 9 to 12 to determine the need for further mitigation measures and whether unacceptable impacts are expected. This more detailed assessment focusses on aggregate impacts on particular values.

Note that impacts associated with decommissioning are not covered as the project is effectively a permanent facility. This is discussed further in Section 2.9.

8.2.2 Hazard Identification

Hazards are unplanned or unforseen events. In impact assessment, hazards are treated somewhat differently from impacts, which are the planned or known consequences of the proposed action.

For the project, the following hazard events have been identified that may impact on MNES:

- Bushfire - discussed in Section 8.4.11
- Spill or leak of hydrocarbons - discussed further in Section 8.5.11
- Spill or leak of other environmentally hazardous substances - discussed further in Section 8.5.13
- Overflow of sewage management and treatment systems - discussed further in Section 8.5.6
- Overflow of desalination (brine) waste - discussed further in Section 8.5.10.

Note that the nature of topography and drainage of HHI is such that flooding is not considered to be a hazard and exacerbation of flood extent or duration of inundation will not occur. Storm surge and other extreme weather events are also not expected to increase as a result of the project and the project is designed to address these hazards.

A methodology for assessing the environmental risk associated with each hazard is set out in Section 1.7.5.

8.3 Direct Impacts on Terrestrial, Intertidal and Marine Habitat and Ecological Communities

8.3.1 Overview

Direct impacts on terrestrial habitat and ecological communities and associated GBRWHA values may occur through the following activities:

- Direct disturbance to vegetation communities and habitat from terrestrial vegetation clearing
- Direct disturbance to marine habitat from construction of the proposed bridge and boat ramp
- Fragmentation of terrestrial habitat
- Fragmentation of marine habitat
- [Partial] removal of the causeway
- Anchor damage to seagrass beds from recreational boats
- Protection of habitat through an actively managed conservation area
- Preparation and implementation of Wildlife and Habitat Management Plan within the development footprint.

8.3.2 *Direct Impacts from Vegetation Clearing*

Development of the PTP will require full or partial clearing of up to 410 ha of native vegetation. The extent of clearing of vegetation types is shown in Figure 6.55 and Table 8.1 together with the corresponding regional ecosystem designations as defined under the *Vegetation Management Act 1999*. It is proposed to retain approximately 50 % of mature habitat trees in the following vegetation types:

- *Eucalyptus crebra* woodland,
- *Corymbia spp., Eucalyptus spp., Acacia spp*. open forest to low closed forest
- *Eucalyptus populnea* woodland
- *Eucalyptus tereticornis* and *E. crebra* dominated forest.

The total development area of 465 ha also includes areas that will be managed as interfaces between development and habitat and conservation areas, wildlife corridors, screening vegetation and open space.

Table 8.1 – Vegetation Clearing by Regional Ecosystem Type

Vegetation Type	Corresponding Regional Ecosystem	Area on HHI (ha)	Area Impacted (ha)	% of Total Extent on HHI
Casuarina glauca open forest	12.1.1	31.10	1.4	4.5%
Saltpan vegetation including grassland, herbland and sedgeland	12.1.2	369.80	0.2	0.1
Mangrove shrubland to low closed forest	12.1.3	437.70	0.1	0.03
Microphyll/notophyll vine forest on beach ridges	12.2.2	189.90	0.00	0.0
Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest	12.2.11	926.60	170.8	18.4
Fore dune complex	12.2.14	65.50	1.0	1.5
Eucalyptus tereticornis woodland to open forest	12.3.3	154.80	2.0	1.1
Eucalyptus tereticornis and E. crebra dominated forests	12.12.12	382.0	153.2	40.1
Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland	12.3.6	60.9	0.00	0.0
Eucalyptus populnea woodland	12.3.10	160.10	1.1	0.7
Eucalyptus crebra woodland	12.12.7	137.70	80	58.1
Eucalyptus melanophloia woodland	12.12.8	10.60	0.00	0.0%
Themeda triandra grassland and wind-sheared shrubland and woodland.	12.12.19	1.00	0.5	48.8
Eucalyptus moluccana open forest	12.12.28	28.70	0.1	0.5
TOTAL native		2982.1	410.4	

As shown in Table 8.1, approximately 0.2 ha of saltpan vegetation and 0.1 ha of mangrove vegetation will be removed as part of the project. This is required for construction of the bridge and boat ramp, which are proposed to be located at the existing causeway (see Figure 2.1) and upgrading of part of Clarkes Road that cross supratidal mudflats. Clearing is not required for the desalination plant intake as this will be attached to the bridge structure.

Mangroves and saltpan vegetation have already been cleared in this area for the causeway and approach roads, which were constructed possibly as early as 1886 (SKM 2007). Hence, connectivity of the fringing mangrove system on both sides of Boyne Creek has been severed for a long period of time.

The bridge will be an elevated structure and mangroves are likely to grow in under the bridge, however the boat ramp will create an ongoing barrier of approximately 50 m width. If present, water mouse and other ground dwelling animals may also be discouraged from crossing this area by traffic associated with launching and retrieving boats.

There is no clearing of the threatened ecological community, Littoral Rainforest and Coastal Vine Thickets of Eastern Australia.

There are two vegetation communities present on HHI which, when considered against the Queensland regional ecosystem classifications, are not found elsewhere in the GBRWHA/NHP. These are *Eucalyptus melanophloia* woodland (RE 12.12.8) and *Eucalyptus tereticornis* and *E. crebra* dominated forests (RE 12.12.12). The *Eucalyptus melanophloia* woodland is present as a patch of around 10 ha and no clearing of this patch is proposed. Clearing will also not occur within about150m of this patch, providing an adequate separation distance from disturbed areas and edge effects.

Approximately 382 ha of *Eucalyptus tereticornis* and *E. crebra* dominated forest is present on HHI, and the project will require clearing of 40 % of this extent. The viability of any vegetation patch is dictated by its size and shape, but also its connection with other areas that facilitate the ecological functions necessary to maintain ecosystem health. Size and shape determine the extent to which an area is impacted by edge effects.

The 230 ha of retained *Eucalyptus tereticornis* and *E. crebra* dominated forests (RE 12.12.12) is largely located at the edge of the development in a band that is as little as 250m in width, but is generally much wider, in some instances exceeding 1km. This can be seen on Figure 6.55. The outside edge of this vegetation is contiguous with other retained vegetation on HHI, effectively creating a continuous patch >2,000ha in area such that, the retained *Eucalyptus tereticornis* and *E. crebra* dominated forests is part of a larger area of vegetation rather than occurring as isolated patches.

In a study on patch sizes of sclerophyll forests in a fragmented landscape in northern NSW (Ross, 2005) it was found that larger patches conserved a greater diversity of species than smaller patches. The study defined 'large patches' as being 10-100ha in area and utilised reference sites that were 140-1,400ha in area for comparison. The study showed there was little difference between native species richness and the presence of exotic species between large patches and reference sites. Given the area of continuous vegetation retained on HHI is greater than the maximum reference site in the Ross (2005) study, and is contiguous with adjacent vegetation, it is expected that the viability and habitat values of *Eucalyptus tereticornis* and *E. crebra* dominated forests (RE 12.12.12) will be maintained on the basis of patch size.

However, consideration must also be given to the impacts of edge effects. Ross (2005) found that for sclerophyll forests edge effects generally penetrate 15m into an edge and never exceed 20m. This is less than the minimum width of *Eucalyptus tereticornis* and *E. crebra* dominated forests (RE 12.12.12) adjacent to the development (see Figure 6.55). Hence, while much of the retained area of RE 12.12.12 fronts the proposed development only a small percentage of it will be potentially subject to edge effects. As discussed in Section 8.3.9, it is intended to actively manage the interface between the development footprint and conservation area. The viability of the remaining areas of *Eucalyptus tereticornis* and *E. crebra* dominated forests (RE 12.12.12) is not expected to be affected by edge effects. More discussion on management of edge effects is provided in Section 8.4, particularly 8.4.2, 8.4.5 and 8.4.9.

From an ecological point of view, the lower density of precincts in woodland areas of the development is not considered to be disadvantageous compared to a more consolidated footprint. Indeed, this approach allows 50% of habitat trees to be retained within the development footprint and provides a high level of permeability allowing native animals to move through the development footprint. Most of the fauna known or likely to be present in the woodland areas of HHI are common in urban and urban fringe areas and are expected to utilise retained habitat trees and small patches of bushland within the precinct footprint provided these areas are managed for habitat values as is proposed through the Wildlife Habitat Management Plan (see Section 8.3.9).

In terms of the ratio of “edge” to the area of the conservation area, a more consolidated development may have slightly shorter “edges”, that is the length of the interface between the development footprint and adjacent conservation area may be slightly shorter. However, the development footprint has a somewhat convoluted shape as a result of avoiding endangered regional ecosystems and other key habitat areas and minimising clearing of “of concern” ecosystems. It is this convoluted shape that has the most influence over the length of the edges and consolidation of some precincts would not reduce the length of the edge, or the “edge to area” ratio significantly.

Vegetation clearing may impact on EPBC Act listed threatened species and communities and migratory species as follows:

- Availability of foraging habitat for the vulnerable grey-headed flying fox, *Pteropus poliocephalus*, may be reduced. This is discussed further in Section 9.2.1
- Potential habitat for yakka skink, *Egernia rugosa*, and collared delma, *Delma torquata*, may be lost. This is discussed in Section 9.2.2
- Potential water mouse, *Xeromys myoides*, foraging and nesting habitat will be lost. While the area to be cleared is very small in the context of the total available habitat, the potential impacts are discussed further in Section 9.2.3
- Foraging habitat for terrestrial migratory bird species may be reduced. This is discussed in Section 10.3

- A small area of foraging and roosting habitat for migratory shorebirds will be lost, equivalent to less than 0.001%of available habitat. While the area that would be lost is very small in the context of available habitat in the immediate area, the Mundoolin-Colosseum area provides internationally important habitat for migratory species and therefore, even quite small impacts are potentially significant. This impact is discussed further in Section 10.2.

In terms of overall impacts on biodiversity in the GBRWHA, vegetation clearing may also reduce habitat for a range of common native animals, however all habitat types will be retained at a viable extent. Floristic diversity is also maintained, however there would be a reduction in the occurrence of the *Eucalyptus tereticornis* and *E. crebra* dominated forest (RE 12.12.12). Potential impacts on WHA values relating to biological diversity are discussed further in Section 11.5.2.

Clearing of vegetation will also result in changes to the landscape character of HHI. This is discussed further in Section 8.9 and a more detailed assessment of impacts specifically on the OUV of the GBRWHA/NHP is provided in Section 11.2.

8.3.3 Direct disturbance of Muddy Substrate from Bridge and Boat Ramp

Construction of the bridge and boat ramp will occur in the first one to two years of the proposed PTP. Design of these facilities and construction methods are described in Section 2.8.

Construction of the bridge will cause minor loss of muddy substrate in Boyne Creek due to placement of pylons to support the bridge. While the bridge design has not yet been prepared, the maximum disturbance of intertidal and subtidal areas is expected to be less than 4000 m^2. In addition, the proposed boat ramp will extend about 0.5m below lowest astronomical tide, and will therefore cause loss of about 5,000 m^2 of muddy substrate on the edge of Boyne Creek.

This is a very small area in the context of available muddy substrate in the Boyne Creek/Colosseum Inlet/Seven Mile Creek estuary system. OzCoasts estimates 31 km^2 of intertidal flats in the Colosseum Inlet estuary (which includes part of Boyne Creek) and 55 km^2 of open water, almost all of which is underlain by soft bottom habitats (http://www.ozcoasts.gov.au/search_data/detail_result.jsp accessed 30/03/2013). Assuming similar areas of habitat in the Seven Mile Creek estuary, this represents less than 0.005% of this type of habitat.

Muddy substrate does support a range of crustaceans and macroinvertebrates that provide food for fish, and some other marine animals, however given the total available area in the Colosseum estuary, any reduction in this food source would be negligible.

The hard structures of the boat ramp and bridge pylons will provide a hard substrate. While the upper surface of the boat ramp is unlikely to provide hard substrate habitat, the sides of the boat ramp and bridge pylons are expected to be colonised by algae, crustaceans and various other sedentary shellfish.

Overall, the severity of the impact associated with loss or alteration of habitat arising from the proposed bridge and boat ramp is considered negligible and impacts are therefore not significant. Impact of loss of this substrate on MNES is therefore not further assessed.

Potential water quality impacts from bridge and boat ramp construction are discussed in Section 8.5. Potential visual impacts associated with the bridge are discussed in Section 8.9.

8.3.4 Fragmentation of Habitat – Terrestrial

Habitat fragmentation can affect:

- The ability of animals to access key resources such as foraging areas and water, and increased exposure to predation and other hazards when moving through cleared areas
- Breeding interactions, and hence maintenance of genetic diversity within and between populations of plants and animals.

Ground dwelling animals and arboreal mammals are more vulnerable to fragmentation, however where wide cleared corridors are created, birds can also be affected.

Where habitat is fragmented by a road, this can also introduce the risk of mortality from vehicle strike and this is discussed in more detail in Section 8.6.3.

On HHI, a steep ridgeline partially bisects the island and would offer a barrier to movement for some animals. The flatter area between Hummock Hill and the headland offers unimpeded movement, however the existing airstrip has already been cleared with little regrowth which may discourage some animals from moving across this area.

Semi-permanent water resources are available at a farm dam located in the southern part of the development area, to the east of the main ridgeline. Seasonal water resources are also available in the sand dune systems to the west of the headland.

While the development footprint of the project has been designed to avoid clearing in key habitat areas and to ensure that no habitat type is entirely lost, some habitats will become partially fragmented. With the exception of the Headland Resort Precinct, development is relatively low density, and connectivity is also retained through bands of vegetation typically between 100 m and 300 m in width which will be sufficient for the types native animals present on HHI to move between larger intact habitat areas. This can be seen on Figure 6.57.

It is proposed to retain approximately 50% of mature habitat trees located outside the building envelope in the Ocean View and Colosseum Precincts which will also enhance movement of birds and many arboreal mammals through these areas. Most of the animals known or likely to be present on HHI are known to occur in modified semi-urban and rural areas, and therefore likely to move through modified habitats available within the PTP footprint provided that intermediate shelter such as habitat trees is available.

The location of the golf course has also been selected to minimise impacts on east-west connectivity and will be landscaped with locally indigenous species with attention paid to providing sheltered corridors for smaller ground-dwelling animals. For these corridors to be effective in facilitating wildlife movement, width will need to be in the order of 20-50 m and include salvaged logs and rocks as well as multi-layered vegetation. This will maximise landscape permeability through the area between Hummock Hill and the headland and northern beach. An intact east-west vegetation corridor of minimum width 300 m will also be retained to the south of the Golf and Beach Resort Precinct.

Fragmentation by the proposed arterial access road will be minimised by design of the central portion of this road linking the Ocean View Resort Precinct with the Headland Resort Precinct. In this section, the road will be two separate single lane carriage ways, each five to six metres in width and separated by a naturally vegetated strip of 50–60 m in width. This section will align with the main east-west movement corridor through the golf course. For larger ground dwelling animals and birds, this configuration will minimise disruption to movement and allow animals to shelter between lanes rather than make the road crossing in a single movement.

Smaller ground dwelling animals such as brigalow reptiles, if present, may still be discouraged from crossing the roadway due to the openness of the road shoulder and pavement. While foraging ranges for these species are thought to be small, larger intergenerational dispersal movements between breeding colonies may be important. Further discussion of this issue is provided in Section 8.6.3 and 9.2.2.

Further discussion of potential impacts on native animals from vehicle strike is provided in Section 8.6.3.

Typical movement pathways for migratory shorebirds moving (commuting) between foraging and roosting areas are along the coastline, typically flying at heights below about 150m. The proposed bridge will cross this coastal movement corridor, however birds will easily be able to fly over the bridge and the bridge is not expected to deter the birds from moving along the coastline.

In terms of access to water resources, the project will provide additional water resources in the form of recycled water storage and stormwater retention ponds in the Golf and Beach Resort Precinct and the Colosseum Precinct. These ponds will adjoin the vegetation corridor running to the south of the proposed golf course and therefore be readily accessible from both the east and west portions of the island. The existing farm dams will remain reasonably accessible, but there will be some low density development around these areas. As part of development of management plans for the proposed Conservation Area, consideration can also be given to provision of permanent or semi-permanent water resources to the east of the proposed development.

In terms of foraging resources, similar type and quality of resources are available on either side of the proposed development, and hence, even if animals are restricted in east-west movement, this is not likely to restrict access to foraging resources.

In terms of breeding and genetic exchange, there may be some restrictions on movements of ground dwelling animals, however as mentioned above, most animals on HHI are known to move through modified semi-urban and rural landscapes and will probably not be particularly restricted by the proposed development (see also discussion regarding vehicle strike in Section 8.6.3).

While this effect alone is unlikely to diminished overall terrestrial biodiversity in the GBRWHA, biodiversity is an important part of the OUV of the GBRWHA and hence this issue is considered further in terms of aggregated impacts on biodiversity and hence, the OUV of the GBRWHA in Section 11.5.2.

The vine forest patches of the island support a diversity of plant species. Amongst the species present are those dispersed by wind and by wildlife, most notably birds. Patches of vegetation rely not only on the maintenance of abiotic and biotic processes that support plant survival but also ongoing recruitment of new propagules. As there is no direct clearing of the *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* associated with the project, the distance between the two patches will remain at approximately 2 km and any existing wind-blown seed dispersal mechanisms will not be affected. Dispersal of seeds by birds is also not expected to be affected as birds will be able to move readily across the project footprint.

In relation to fauna species of conservation significance known or likely to occur on HHI, severity of impacts is considered low or negligible as follows:

- Fragmentation is identified as a general threat to black-breasted button quail, but, if present on HHI, black-breasted button quail will be able to utilise movement corridors would be available through the golf course and to the south of the golf course. In any case, the two large patches of coastal vine thicket habitat are not disturbed in any way. Fragmentation impacts on black-breasted button quail are not considered to be significant, and therefore do not require further assessment
- Fragmentation is not expected to affect grey-headed flying fox as this animal moves between and amongst foraging resources aerially, and is known to move freely through urban areas
- Fragmentation is identified as a general threat to yakka skink, collared delma and brigalow-scaly foot, particularly in relation to intergenerational movements. If present on HHI, sufficient connectivity is retained throughout the proposed development footprint to avoid severance of populations that might interbreed provided that road crossing points are available. This is discussed further in Section 9.2.2.
- Fragmentation is also not expected to affect any of the migratory terrestrial or marine birds as these move between foraging and roosting resources aerially and are generally known to move through urban areas
- There is no fragmentation of migratory shorebird habitat and the bridge is not expected to deter movement along coastal movement corridors
- Severance of water mouse foraging habitat at the site of the existing causeway will continue. The proposed bridge structure may provide some shelter for water mouse moving across this area that is not currently present, thus reducing exposure in this area. The proposed boat

ramp might however discourage water mouse from moving through the area when there is activity at the boat ramp. Water mouse are nocturnal and it is expected that there will be periods of time during the night when there is no activity at the boat ramp.

There are not considered to be any important breeding populations of listed threatened or migratory species on HHI and hence, severance of breeding populations is not considered to be an impact of the development.

As a condition of the Queensland Coordinator-General's report, the proponent is required to address wildlife movements, including wildlife corridors and management of road-related impacts on wildlife in a Wildlife and Habitat Management Plan. This is described further in Section 8.3.9.

Hence, impacts of fragmentation on listed species of conservation significance are not considered significant and do not require further assessment.

8.3.5 Fragmentation of Habitat – Marine

Fragmentation of marine habitat is not expected, as the only structures placed into the marine environment are bridge pylons and a boat ramp on the shore of HHI adjacent to the existing causeway. The proposed bridge will be elevated and allow free passage of marine fauna and tidal currents. The proposed boat ramp is flush with the bed and bank of Boyne Creek and will not present any barrier to movement. No fragmentation of marine habitat is expected.

Partial removal of the existing causeway may reduce fragmentation. This is discussed in Section 8.3.6.

8.3.6 Removal of the Causeway and Upgrade of Clarke's Road Causeway - Habitat Impacts

The existing causeway across Boyne Creek may present some barrier to movement of marine animals, however, no observations have been made to determine the extent of this effect. GPC aerial surveys of marine megafauna did not identify any of turtles and dugong west of the causeway however this may have been a function of survey effort and water clarity rather than indicative of any barrier effect.

It is a condition of Queensland Government Coordinator-General's report on the HHID that:

> *As part of the bridge construction works, the existing causeway within Boyne Creek between HHI and the mainland must be removed to the level of the existing depth adjacent to the causeway. All existing causeway material, outside of the permanent footprint of the Boyne Creek bridge and boat ramp, is to be removed and all fish habitats restored. The footprint of the causeway must be restored and rehabilitated within two years of commencing works associated with the HHID, or within six months of completing the Boyne Creek bridge, whichever is sooner. (Queensland Coordinator-General, February 2011).*

The Coordinator-General's report on the proposed HHID also concludes that:

> *It is considered that the overall benefits of constructing the bridge and removing the current causeway, including improved navigation for boats and potential benefits to fish and other marine fauna, would outweigh the potential impacts on the marine fish habitat (i.e. removing small areas of mangrove and saltflat communities, as noted earlier in this report). As advised by DEEDI [the then Department of Employment, Economic Development and Innovation, which included Queensland Fisheries Service], removing the subtidal causeway would constitute an offset for potential impacts on marine fish habitat caused by construction on tidal lands.*

The location of the causeway is shown on Figure 2.3 and it has been in place for over 100 years. It is a rock and log structure and except at very low tides is below the water surface. The undated photo in Figure 8-7 shows the causeway at very low tide and demonstrates that the causeway has a similar effect to a weir in a river due to the high tidal flows in Boyne Creek. The presence of the causeway may affect movement of marine megafauna such as dugong, dolphins and marine turtles at low tides, and in evaluation of the HHID EIS (SKM 1007), Queensland Fisheries Service also raised concerns about the potential to block or impede fish movement.

Figure 8-7 – Causeway at Low Tide (undated photo)

Partial breaching of the causeway, involving removal of a central section of about 70 m would remove artificial impediments to animal movement, providing some improvement to habitat connectivity, especially at low tide.

Although artificial, the rock and log structure has been in place for a long time and is expected to be providing some microhabitat for crustaceans, other invertebrates and fish. The hard substrate and relatively fast flowing currents would benefit some sessile filter feeders. Partial removal of the causeway will cause loss of hard substrate habitat which, while artificial, has been in place for some years. This may, to some extent, be replaced by the proposed boat ramp and bridge structures, although these will provide less sheltered microhabitats, compared to the causeway.

Overall, the area of habitat loss is insignificant in the context of productivity of the Colosseum inlet which includes over 80 km^2 of intertidal and subtidal soft substrate and will not cause any change in food resources for fish and significant marine fauna such as turtles, dugong and dolphins.

Potential water quality impacts in relation to causeway removal are discussed in Section 8.5. Potential impacts on geological and geomorphological processes are discussed in Section 8.10.

On the mainland, there is also a section of Clarkes Road that crosses a salt pan area via a causeway (see Figure 1.2 and Figure 8-8). Direct disturbance to this area from the road upgrade is included in figures presented in Table 8.1 and is approximately 0.2ha. OzCoasts estimates approximately 21 km^2 of salt pan habitat in the Colosseum Inlet (http://www.ozcoasts.gov.au/search_data/detail_result.jsp, accessed 30/03/2013), not counting the Seven Mile Creek estuary, and hence the loss of habitat from the causeway upgrade is negligible.

Figure 8-8 - Existing Clarks Road Causeway across Supratidal Saltflats (undated photo)

The salt pan area becomes inundated at high tides up to the location of the causeway. As the causeway does not have any culverts and currently blocks any tidal flows across the saltpan there is a potential benefit from upgrade of the road in that culverts will be installed to allow tidal movements. Restoration of tidal flows would likely compensate for any loss of salt pan habitat associated with upgrade of the proposed access road.

Overall, the severity of potential impacts on habitat for threatened and migratory animals from partially removing the causeway across Boyne Creek and upgrading the Clarke's Road causeway are likely to be negligible and no significant impact is expected. The overall area of disturbance is negligible in the context of available habitat in the Colosseum Inlet/Boyne Creek/Seven Mile Creek system.

Consideration has also been given to leaving the causeway in place. As the causeway has been in place for up to a century, marine megafauna may have adapted to the causeway being in place and hence, may not be considered to be adversely affected by the presence of the causeway, particularly as adequate water depth exists at high tide. However, the Queensland Government has requested that the causeway be partially removed, and hence this option has been considered in detail by the proponent. On balance, the impacts of partially removing the causeway appear negligible (see also Sections 8.5.14 and 8.10.3) and hence, as there is a potential benefit to marina megafauna movement and fisheries from partially removing the causeway, the proponent is willing to remove it.

8.3.7 Anchor Damage

Damage to benthic habitats from anchoring of recreational vessels has been identified as a threat to marine habitats in the GBRMP and also the GBRWHA (GBRMPA 2012) (See Figure 1.4 for the boundaries of these areas relative to HHI). Coral reef and seagrass ecosystems are identified as being at risk.

There are no coral reef ecosystems in the waters surrounding HHI, however there are some rocky reefs offshore with coral cover as shown in Figures 6.48 and 6.49. There are also extensive seagrass beds in Seven Mile Creek and offshore from the eastern end of HHI, as well as smaller patches within Boyne Creek, as shown in Figures 6.45 and 6.46.

Seagrass beds offshore from HHI will only be accessible to the smaller recreational boats that might be launched from the boat ramp in fine weather. Some anchoring may occur over these seabeds but there is no particular reason for boats to anchor over these seagrass beds compared to the adjacent sandy substrates and density of anchoring will be low.

The Seven Mile Creek area has been identified as a fishing spot and may attract recreational boats. The seagrass beds in Seven Mile Creek are largely located on an intertidal sand and mud flat, with some occurring in deeper waters. Subtidal and to a lesser extent intertidal seagrass beds in Seven Mile Creek may potentially be exposed to anchor damage if recreational fishing increases as a result of the project, however as the seagrass beds in Seven Mile Creek are in shallow waters and often exposed at low tide, anchoring in these areas may be limited.

The smaller seagrass patches in Boyne Creek and the upper estuary are located on the intertidal banks of waterways in locations where boats will not drop anchors due to proximity to land and shallow water depth. Boats are not likely to beach on these areas as the substrate is muddy and the banks are backed by dense mangroves in most locations, and thus access to land is not afforded.

While seagrasses will regenerate after disturbance reasonably quickly, repeated damage from an activity such as anchoring would be expected to reduce biomass (Campbell and McKenzie 2001, Campbell and McKenzie 2004). This in turn could affect turtles, dugong and other marine fauna which feed on seagrasses.

While the number of boats using the Seven Mile Creek area is likely to remain low due to natural navigational constraints, the area is considered of moderate importance for turtles and dugong (see Section 7.2.5) and hence the potential for significant impacts on threatened species and migratory species is further evaluated in Section 9.9 (turtles) and Section 10.4 (dugong). This potential impact will commence in years one to two of the proposed PTP as the boat ramp is one of the earliest components to be constructed.

8.3.8 Protection of habitat through a Conservation Area

As discussed in Section 2.6, the proponent is committed to surrender the remainder of the special lease on completion of the proposed development and will also have the remainder of HHI declared as a conservation area under the Queensland *Nature Conservation Act 1992*. Subject to agreements with the Queensland government, this would include Lots 1-11 on FD841442 as shown on Figure 2.6 and Figure 2.7. All of this area is within the GBRWHA and the boundary is contiguous with the Great Barrier Reef Coast Marine Park (GBRCMP) at mean high water springs. Regardless of whether the declaration as a conservation area goes ahead, the proponent is required by conditions of the Queensland Coordinator-General's report to manage the balance of HHI for conservation purposes as explained in Section 2.6.3.

As required under the Queensland *Nature Conservation Act 1992* and by conditions of approval, the proponent would develop an active management plan for the conservation area,

The conservation area will be actively managed, and management measures will include:

- Active management of interface areas around the edge of the PTP to control weeds, feral animals, and impacts of "edge effects" (see also Section 8.4.2, 8.4.3 and 8.4.9 for further discussion on management of these issues). Particular attention will be given to locations where sensitive environmental features are located within 100m of the boundary of PTP, including:
  - The 10.6 ha patch of *Eucalyptus melanophloia* woodland (corresponding to Queensland regional ecosystem classification 12.12.8 as shown in Figure 6.55)
  - Intertidal and mangrove habitat adjacent to the bridge and boat ramp (see Figure 2.3 for location of the bridge and boat ramp)
  - Where the critically endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia runs close to the headland (see Figure 7.1 for the location of this community in relation to the proposed development footprint)
- Management of access to the conservation area to encourage appreciation of the natural environment through bushwalking and nature trails. Access will not however be provided to sensitive areas such as the coastal vine thicket and shorebird roosting/foraging areas which are currently inaccessible by foot (see also Section 10.2.4). Vehicle access will not be provided to the public.
- A weed and pest animal management program including control of existing weeds and prevention of further infestation
- Vegetation management and regeneration program focussing particularly on restoring understory species which have previously been affected by grazing and fire where practicable
- Fire management including prevention of uncontrolled fires and routine firing of those vegetation communities that are known to benefit from regular burning (see also Section 8.4.11).

- Extension programs to support the management and the interaction of residents within the area, and would include:
  - Promoting an understanding of the environmental values of the island, the OUV of the GBRWHA and also the adjacent GBRMP/GBRCMP
  - Presentation of the area as part of the GBRWHA, highlighting the contribution that land areas within the GBRWHA make to the OUV of the WHA
  - Voluntary conservation works and environmental education
  - Education on interacting and living with wildlife and landscape values
- Visual monitoring of beaches for turtle nesting and also nesting of terns between October and January each year and, in the event that nesting is identified to have occurred, placement of temporary fencing and warning signs to prevent access. In this event, rangers will also monitor and enforce these exclusion zones.

The management plan will also consider the potential effects of climate change on terrestrial ecosystems and species when determining management approaches, with a goal of increasing resilience of terrestrial ecosystems to effects of climate change.

Agreements in place with traditional owners envisage that traditional owners will be involved in management and presentation of the conservation area, including in roles such as rangers and guides.

Compliance with these requirements will have the following benefits:

- Threat of development of the area of *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* mosaic that sits within the special lease will be removed by the change in land tenure and management of the conservation area will provide for control of existing weed invasion within the full extent of *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* on HHI. This would place a large area of this endangered ecological community in protected estate.
- If present, the tenure of a large area of habitat for the vulnerable black-breasted button quail would also be moved from a potentially developable area to a protected area. Threat of predation would also be reduced by programs to reduce existing predators. Note that cats will not be allowed within the development and dogs will only be allowed under control and hence, new threats from predation will not be introduced.
- Threat of development of two vegetation communities within the special lease that are poorly represented in the GBRWHA would be removed and additional protection provided to floristic diversity in the Capricorn-Mackay region of the GBRWHA. This is discussed further in Section 11.5.
- A significant vegetated buffer already exists between the proposed development and migratory shorebird habitat and this would be retained and protected from threat of future development. This is discussed further in Section 10.2 and the location of the migratory shorebird habitat in relation to the development footprint shown in Figure 6.56.

A net positive impact in terms of conservation security of these areas is therefore expected. The contribution that these areas make to the OUV of the GBRWHA (see Section 7.2) will be retained and enhanced by proactive management, particularly in relation to weeds and feral predators which may in turn enhance resilience to climate change impacts.

The conservation area would not encompass the majority of migratory shorebird habitat identified in Section 7.5.2 as the land parcel boundaries do not include intertidal areas. In any case, these areas are already part of the GBRCMP, the boundary of which comes to the high water mark and will be contiguous with the conservation area. The conservation area would preclude development adjacent to these migratory shorebird roost and foraging habitats, thus providing broad buffers from the land side to those sites located on HHI.

If the proposed managed conservation area is given formal status under the Queensland *Nature Conservation Act 1992*, this will also remove any threat of development of the balance of the special lease and the remainder of HHI (see also Section 8.3.8). This is not currently proposed as an offset as, under the EPBC Act Environmental Offsets Policy, offsets are only required where there is a significant residual impact. However, the proponent notes that an offset of this type was required for the Great Keppel Island Revitalisation Project (EPBC 2010/5521) (Conditions 51 to 58). The proposed conservation area on HHI will have a similar impact on protecting/enhancing those attributes and values of HHI that contribute to the OUV of the GBRWHA.

8.3.9 Wildlife Habitat Management Plan

As a condition of the Queensland Government's Coordinator-General's report for the HHID (February 2011), if the project goes ahead, the proponent is required to prepare a comprehensive Wildlife Habitat Management Plan for management of wildlife and habitat within the proposed development footprint. This Wildlife Habitat Management Plan will complement the conservation area management plan, providing for an holistic approach to management of conservation values across all of HHI, both within and outside of the proposed development footprint.

In accordance with Condition 14 of Schedule 1 of the Coordinator-General's report, the Wildlife Habitat Management Plan must:

(i) define the impact of the development on the species populations

(ii) provide for the survival of the species in the wild

(iii) achieve a net conservation benefit for the species

(iv) consider and address changes to species composition that may potentially occur as a result of the development.

Matters to be covered in the Wildlife Habitat Management Plan include:

- Management of access to the beach and foreshore areas (as turtle nesting would not take place within or immediately adjacent to the PTP footprint, management of these areas is covered under the Conservation Area management plan outlined in Section 8.3.8).

- Provision of wildlife corridors and fauna passage, including fauna crossings of roads or other measures as required to minimise impacts of roads on native fauna
- Pest and predator management and management of domestic pets
- Managed interfaces between the proposed development footprint and the conservation area (see also Section 8.3.8)
- Prevention of fire. In this regard, any firebreaks required will be established within the development footprint and will be managed to prevent weed invasion and other “edge” effects to the adjacent conservation area.
- Management of impacts of artificial lighting on animals
- Community awareness raising
- Rehabilitation of disturbed areas.

Particular attention will be given to locations where sensitive environmental features are located outside the PTP footprint but within 100m of the boundary, including:

- The 10.6 ha patch of *Eucalyptus melanophloia* woodland (corresponding to Queensland regional ecosystem classification 12.12.12 as shown in Figure 6.55)
- Intertidal and mangrove habitat adjacent to the bridge and boat ramp (see Figure 2.3 for location of the bridge and boat ramp)
- Where the critically endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia runs close to the headland (see Figure 7.1 for the location of this community in relation to the proposed development footprint).

As shown on Figure 6.58, there is a significant distance between the development footprint and migratory shorebird habitat.

8.3.10 Summary of Potentially Significant Impacts

Potentially significant impacts on EPBC Act listed threatened species and ecological communities and listed migratory species associated with direct impacts on terrestrial, intertidal and marine habitat are identified in Table 8.2.

Table 8.2 – Summary of Potentially Significant Impacts - Terrestrial, Intertidal and Marine Habitat

Potential Impact	Threatened Plants, Animals and Ecological Communities	Migratory Species
Clearing of vegetation	Potentially significant Refer Section 9	Potentially significant Refer Section 10
Construction of the bridge and boat ramp	Negligible impact	Negligible impact
Fragmentation of terrestrial habitat	Negligible impact for most species Potentially significant for brigalow reptiles, if present. See Section 9.2.2 for further assessment.	No impact as all migratory terrestrial species are birds
Fragmentation of marine habitat from bridge and boat ramp	No impact	No impact
Partial removal of the causeway	Negligible impact, potential benefit	Negligible impact, potential benefit
Anchor damage to marine substrates	Potentially significant Refer Section 9.3.2	Potentially significant Refer Section 10.4.2
Protection of terrestrial habitat in a conservation area.	Potential benefit Refer Section 9	Potential benefit Refer Section 10

In combination, impacts of habitat clearing may affect biodiversity values that contribute to the OUV of the GBRWHA/NHP. This is discussed further in Section 11.5. Potential benefits in terms of protection of GBRWHA/NHP values may arise from removal of the causeway and protection of terrestrial habitat in a managed conservation area. Potential benefits of the managed conservation area and breaching of the causeway in relation to values and attributes of the GBRWHA are further discussed where relevant in Section 11.

There are no impacts from habitat clearing in the GBRMP.

8.4 Indirect Impacts on Terrestrial Vegetation and Habitat

8.4.1 Overview

Indirect impacts on terrestrial vegetation and habitat, including migratory shorebird habitat, may arise from:

- Weed infestation and proliferation
- Changes in overland flow characteristics
- Changes in groundwater recharge and discharge characteristics
- Deposition of dust
- Noise-related disturbance that may affect use of habitat
- Aircraft utilising the airstrip
- Human activity
- Microclimatic changes at edges of vegetation patches

- Artificial light
- Increased bushfire risk.

Where these impacts affect biodiversity or amenity values, impacts on the OUV of the GBRWHA may also occur.

8.4.2 Weed Infestation and Proliferation

Vegetation clearing can create more favourable conditions for existing weed species, which may out-compete native vegetation.

HHI already has some level of weed invasion including lantana, *Lantana camara*, groundsel, *Baccharis halimifolia*, rubber vine, *Cryptostegia grandiflora*, *Cenchrus echinatus*, and prickly pear, *Opuntia* spp. Grazing and earlier land management practices including annual burning to improve pasture have led to spread of weeds across much of the proposed development area and also into areas such as the *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* (AGC Woodward Clyde 1993, SKM 2007). Rubber vine has been identified in the EPBC Act Policy Statement 3.9 *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia A nationally threatened ecological community* as a weed of “particular concern” (DEWHA), 2009g).

Given that weeds are present across the proposed development area, there is potential for further proliferation of weeds if native vegetation is removed.

The most significant aspect of this is where weeds proliferate along edges of remnant native vegetation that are exposed due to vegetation clearing for development and access tracks. Conditions in these edge areas may change due to increased exposure to sunlight, wind and rain and this may favour weed species over native species. This can effectively reduce the habitat values of these edge areas, thus reducing the overall native habitat on HHI. Where access tracks are created in vegetated areas, weed propagules may be introduced along the access track by pedestrians or vehicles.

For the PTP, weed prevention and management has been addressed in a number of ways:

- Sensitive habitat areas and vegetation communities that may be sensitive to weed invasion or proliferation are outside the development footprint and separated from the edge of the development by a minimum of 100m, except for a small area of the coastal vine thicket critically endangered ecological community near the headland, which is separated by 80m (see also Figure 7.1). This will avoid impacts of weed invasion along cleared edges on these areas.
- Weed management is incorporated into the management approach for the conservation area and the Wildlife and Habitat Management Plan (see also Sections 8.3.8 and 8.3.9). These programs will prevent proliferation of weeds through monitoring of at risk areas, such as along access tracks and the edge of cleared areas and weed control responses where weed proliferation is detected. The programs will also actively control existing weed invasion across HHI, particularly in th critically endangered coastal vine thicket ecological community.

- Turf selection for the golf course will have regard to avoiding potential for turf grasses to spread beyond the golf course. The most likely turf species will be a hybrid green couch variety as this is well suited to coastal environments and sandy soils, and is hardy. Hybrid green couch is a sterile grass that does not flower or produce seeds. Although it can spread through sending out runners, it is unlikely to thrive outside the managed, irrigated areas of the golf course and in any case, is easily managed through monitoring of the perimeter of the golf course and removal of any runners that spread beyond the edge of the fairways and greens.
- Construction environmental management measures will be adopted to minimise the risk of new weed species being introduced by construction equipment, and proliferation of existing weed species in disturbed areas. These measures will include the following requirements:
  - All construction vehicles, plant, equipment and materials must be free of weeds before being brought onto HHI. In this regard:
    - A Weed Hygiene Declaration completed in accordance with Queensland DAFF requirements (or other relevant requirements in place at the time) will be required for all vehicles, plant, equipment and materials
    - The proponent's environmental superintendent will be trained and certified in inspection techniques for vehicles, plant, equipment and materials and will check Weed Hygiene Declarations for all construction contractors
  - The proponent will arrange regular inspections of active construction areas will be carried out to check for weed invasion or proliferation. If inspections indicate weed infestation or proliferation, construction contractors will be required to take remedial action
  - Contractors undertaking construction works will be required to leave disturbed areas free of weeds, and with suitable ground cover in place to minimise weed infestation or proliferation.

With these measures in mind, potential impacts of weed infestation and proliferation on MNES are discussed below.

In relation to the threatened ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*, development is not proposed within or immediately adjacent to this community, and hence, increased levels of weed invasion are not considered likely to occur. Further, the proponent is required by the Queensland Coordinator-General's report to manage this area as part of a protected area covering the balance of HHI (see also Section 2.6.3 and Section 8.3.8). Further assessment of impacts of weed invasion on threatened ecological communities is therefore not required.

In relation to habitat for listed animals of conservation significance:

- Weed levels in coastal vine thicket habitat for black-breasted button quail are unlikely to increase due to the separation distance from PTP, and active management in this area will seek to reduce existing weed levels
- Water mouse utilises intertidal habitat that is not vulnerable to weed invasion and in any case there is only very minor disturbance in this area associated with the bridge and boat ramp
- Grey-headed flying fox utilises trees in sclerophyll forests as a feed resource that will remain intact unless subject to very severe weed invasion from vine or creeper type weeds. The weed management programs for the managed conservation area and within the Wildlife and Habitat Management Plan will ensure that weeds are controlled before such severe levels of weed infestation can occur.
- Migratory terrestrial and marine birds known or potentially occurring forage aerially or on small ground dwelling animals and insects or forage over marine habitats. Even if weed invasion does occur, food sources for these species are not likely to be significantly reduced
- The yakka skink, collared delma and brigalow scaly-foot, if present, are vulnerable to weed invasion as these are ground dwelling animals and are vulnerable to changes in habitat wherever weeds replace native ground cover. Mitigation measures are required to address weed invasion in the PTP footprint and active management of the proposed conservation areas may reduce weed levels in existing habitat
- Clearing and development is not proposed within at least 500 m of important migratory shorebird habitat, and in any case, this intertidal and supratidal habitat is not generally vulnerable to weed invasion.

Hence, impacts from weed invasion on MNES values associated with listed conservation significant and migratory species are not considered likely to occur, and are not considered further.

Weed invasion may also affect the general flora and fauna diversity of HHI. Biodiversity of terrestrial ecosystems contributes to the OUV of the GBRWHA/NHP. While the vegetation and habitat within the PTP footprint is not considered to be of more than local value (lowest importance), very severe weed infestation could still affect these values if not managed through the proposed weed control programs. Weed control programs implemented as part of the managed conservation area will control or reduce current weed levels, with associated benefits for overall biodiversity and habitat condition. Note that further discussion of the potential for PTP to impact on the contribution that HHI makes to terrestrial biodiversity components of the OUV is provided in Section 11.5.

8.4.3 Changes in Overland Flow Characteristics

Changes in overland flow characteristics through some vegetation types can cause changes in composition of plants, ultimately altering the ecological community and associated habitat values.

The project has been designed such that there is minimal topographical change and overland flow conditions outside the perimeter of the footprint are not affected. Stormwater management devices will also maintain low flow patterns in ephemeral creeks. Further information is provided in Section 8.5.9 and Appendix D2.

Changes to ecological communities are therefore not expected as there will be no changes in overland flow characteristics.

8.4.4 Changes in Groundwater Recharge and Discharge Characteristics

As discussed in Section 6.3.6 and 6.4.3, there are some groundwater discharge zones in HHI and associated groundwater dependent ecosystems. These zones are associated with the break of steeper slopes in the south-east area of the special lease, as shown on Figure 6.27, with an area of approximately 25 ha identified as potential discharge zones. These areas are prone to seasonal waterlogging and possibly salinization and locations of actual discharge areas are generally identifiable by the presence of Melaleuca spp. species tolerant of waterlogging and salinity (see also Section 6.3.6). These areas have not been identified as containing habitat or potential habitat for EPBC Act listed threatened or migratory animals, or contributing to the floristic diversity component of the OUV of the GBRWHA.

Changes in the surface water runoff and infiltration characteristics up-slope of these areas will in turn change the recharge and discharge characteristics. Such changes may arise from changes in overland flow characteristics and infiltration characteristics due to vegetation clearing, earthworks and/or the placement of roadways and other impermeable surfaces.

Reductions in recharge may lead to decreased tendency for waterlogging in discharge areas and hence, die back of Melaleuca spp. and associated changes in species composition. Increase in recharge and associated discharge may lead to salinisation given that some of the soils in the upslope areas have relatively high salt content and groundwater in these areas is brackish to saline (see Section 6.4.3).

Clearing of vegetation in the discharge areas may make these areas more prone to waterlogging and salinisation which may in turn be problematic for occupiers and users of development in this area.

About 60% of the identified discharge area occurs in the Ocean View and Colosseum precincts (see Figure 6.27). Development in these areas will consist of low density “acreage style” villas and houses, with building envelopes not exceeding 50% of each lot, and areas of undisturbed vegetation between developed lots (see also Figure 2.3). With this style of development, there is minimal change to either surface runoff or recharge characteristics and hence, minimal change to discharge characteristics is expected. During the detailed design stage, further attention will be given to placement of individual buildings to avoid areas of potential waterlogging.

Given the minimal nature of proposed development in these areas, impacts on MNES associated with changes in recharge/discharge characteristics in discharge areas are not expected and further assessment is not required. However, some management measures have been identified for inclusion in the EMP:

- During the detailed design phase, further delineate potential discharge areas and site lots, buildings and roadways to minimise the need for vegetation clearing and also susceptibility of developed areas to waterlogging effects
- Avoid placement of impermeable roadways at the top of slopes above identified recharge areas.

Monitoring of these areas will also be undertaken as part of an overall terrestrial ecological monitoring program and if adverse effects are observed, further mitigation measures may be required.

There is also an extensive freshwater lens underlying the sandy soils in the north-west area of the special lease (see also Section 6.4.3 and Figure 6.26). This perched aquifer is recharged through infiltration of surface rainfall on sandy/loamy soils and is likely to be variable in size. Based on the inferred area of this lens determined by AGC Woodward Clyde in studies on use of the aquifer for water supply for a previously proposed development on HHI (AGC Woodward Clyde 1993), approximately 20% of this aquifer will be overlain by the proposed golf course and stormwater/recycled water storage ponds. The remainder is outside the proposed development footprint.

Clearing of native vegetation will increase recharge characteristics in some areas, while construction of fairways, pathways and stormwater/recycled water storage ponds will tend to reduce the recharge characteristics. Overall, these effects are expected to balance out any impacts on recharge of this aquifer and significant changes are not expected. Impacts on MNES are not expected to arise. Monitoring of groundwater levels will be undertaken as part of management of the golf course.

Potential impacts of golf course irrigation on groundwater are discussed in Section 8.5.7 and impacts of pesticide use are discussed in Section 8.5.12. Potential impacts arising from dewatering of any excavations in this area of shallow groundwater are discussed in Section 8.5.5.

8.4.5 Deposition of Dust

Dust may be generated during vegetation clearing and earthworks. Prolonged dust deposition on plants at rates can measurably reduce photosynthetic capacity and affect plant growth. There are no published guidelines as to acceptable dust deposition levels. Katestone noted that mineral dusts (coal) might cause adverse effects at deposition levels over about 200 $mg/m^2/day$ (Katestone, October 2012) while SKM noted that plant growth might be affected by cumulative deposition levels of chemically inert dust over 5 g/m^2. SKM also noted that, even for major mining activities, adverse effects on vegetation from dust deposition were rarely seen more than 100 m from haul road routes (SKM 2007).

Dust deposition rates depend both on the rate of dust generation and also the nature of leaves, as dust is less likely to adhere to smooth leaves such as are typical of eucalypts and melaleuca. Wind direction and speed can also influence dust deposition, with high levels of dust deposition occurring in less windy conditions, while windy conditions tend to disperse dust more widely, with lower deposition rates.

Rain events remove dust from vegetation. Rain events over 100 mm typically remove all deposited dust and smaller events will partially remove dust, particularly from smooth leaved species (Katestone 2012). For vegetation to suffer adverse impacts from dust deposition, the cloaking effect needs to persist for some time. The effect of rain events in an area such as HHI, which is prone to relatively high annual rainfall and relatively large rainfall events is likely to mitigate any dust-related impacts except in consecutive dry years.

The project is to be developed over approximately 20 years, with the area that may be exposed to dust generation at any one time likely to be in the order of 10-20 ha. Dust generating construction activities (vegetation clearing and earthworks) in each area will be relatively short duration, unlikely to extend beyond three to four months. Only vegetation immediately adjacent to work areas is likely to be affected.

Given emission rates from wind erosion and earthworks activities, even without controls in place, it is unlikely that dust deposition rates from these activities would exceed the conservative limit for mineral dusts of 200 $mg/m^2/day$ and is very unlikely cause deposition in excess of 5 mg/m^2 (SEWPaC, January 2012). In any case, short term exposure to dust is unlikely to have any detrimental impacts on vegetation and in most years, wet season rainfall would remove dust on at least an annual basis.

Once initial vegetation clearing and earthworks phases are complete, the remainder of construction activities and operation activities will not leave significant exposed soil surfaces vulnerable to wind erosion and dust generation and deposition rates would be similar to pre-development levels. All roads are to be sealed, and hence, traffic-generated dust will not occur post-construction.

Overall, no dust related impacts are expected particularly on the *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* which is separated from development by other vegetation. The minimum width of this separation is 80m, but for most of the vine thicket communities, the separation distance is well in excess of 100m (see also Figure 7.1). Assessment of potential impacts of dust generation on MNES arising from the PTP are therefore not assessed further, however, the following standard mitigation measures will be included in the EMP in relation to control of dust during vegetation clearing and earthworks:

- Clearing vegetation as late as possible to minimise the time that soils are exposed to wind erosion between vegetation clearing and earthworks

- Using water sprays to minimise dust lift off during earthworks and on unsealed access tracks
- Minimising speeds on unsealed access tracks and across other exposed areas to around 40 km/hour
- Revegetating exposed areas as soon as possible after completion of earthworks.

8.4.6 Noise

8.4.6.1 Guidelines for Noise Related Impacts on Fauna

SKM (2007) identified that development on HHI would generate noise both during construction and operation, but that noise levels were unlikely to exceed noise objectives for human comfort.

While there are no formal guidelines for noise related impacts on fauna, SLR reviewed noise impacts on terrestrial fauna, including wetland bird species, for the Abbot Point Cumulative Impact Study (SLR 2012). The review noted that:

- Continuous noise levels below 65 dB(A) LAeq would cause only minor responses in some terrestrial animals
- Continuous noise levels above 85 dB(A) LAeq would cause avoidance of an area by some species
- Episodic (single event or sudden noise sources) over 60 dB(A) might cause an alarm or flight response in some species
- Episodic (single event or sudden noise sources) over 80 dB(A) might trigger avoidance of an area by some species.

The study also identified that wetland birds were utilising a sediment pond near the existing coal terminal with noise levels of 54 dB (SLR 2012).

The noise levels identified by SLR are generally higher than those that would be acceptable for human comfort and residential amenity.

In relation to migratory shorebirds, seabirds exhibit alert behaviours to most levels of noise exposure, but begin to take flight in response to noise exposure levels greater than 85 dBA (Brown 1990), consistent with observations that sound levels of 43-87 dBA have limited effects on foraging shorebirds, but sound levels of 84-100 dBA cause most shorebirds in an habituated population to leave the area of disturbance (Smit and Visser 1993). Disturbance reactions are generally stronger when disturbing sounds are combined with visual disturbance (Smit and Visser 1993). Also, intermittent bursts of noise are generally more disturbing than continuous noise; birds are expected to habituate more readily to the latter (Smit and Visser 1993).

8.4.6.2 Construction Noise

Construction activities required for the project are the same as for HHID and therefore conclusions of HHID EIS in relation to noise are transferrable. SKM (2007) identified that noise levels from most construction activities at the HHID would be in the range L_{Aeq} 45-65 dB(A) within 50-100 m of construction activities with construction activities taking place in the day time only. Blasting is not expected to be required for any component of the PTP and construction is also not expected to require pile driving.

Construction activities do not take place within at least 500 m of significant migratory shorebird habitat and is therefore not expected to have any impact on migratory shorebirds. Five of the seven species of terrestrial migratory birds are known to utilise urban areas and all species are habitat generalists and can easily forage away from noise sources, with no effect expected for short term noise.

In relation to threatened species and fauna species generally, construction noise may cause an alert or flight response for short intervals, and affecting only a small area of habitat. Habitat for black-breasted button quail is not affected due to distance from any construction activities. Grey-headed flying fox is not expected to be affected, and in any case, forages at night when little or no construction activity is expected. There are no camps of grey-headed flying fox on HHI and hence daytime noise is not a concern in relation to roosting.

Little is known about the potential for noise to disturb reptiles such as yakka skink, collared delma and brigalow scaly-foot. Noise-related disturbance is not identified as a threat on the Australian Government's Species Profile and Threats database (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl accessed 30/03/2013). Yakka skink forage at dawn and dusk and if present, may be disturbed from foraging activities, however any impacts would be short term and localised. Brigalow scaly-foot is nocturnal and hence is unlikely to be disturbed as little or no construction activity is proposed at night. If present, the health of these reptiles is not likely to be significantly affected by short term, localised disturbance.

Construction noise is therefore not considered likely to cause any adverse impacts on fauna including listed threatened and migratory species.

In relation to the OUV of the GBRWHA and the GBRMP, construction noise from most areas of the project is not expected to be audible from marine and coastal areas and therefore amenity and enjoyment of users is not expected to be affected. Construction noise will be audible on the land component of the GBRWHA, however HHI is not currently accessible to the public and hence, any disturbance from construction noise is not likely to affect enjoyment of the GBRWHA. Construction of the proposed bridge and boat ramp will be audible to users of the GBRWHA while in Boyne Creek, however, this will be short-lived, with duration less than 12 months. Noise levels will be low to moderate. The bridge and boat ramp location is not within the GBRMP.

8.4.6.3 Operation

SKM (2007) identified that the main potential sources of noise associated with the operation of the proposed development include:

- Recreational boating activities
- The operation of air conditioning equipment and refrigeration plant at the proposed commercial and retail areas
- Occasional use of generators
- Mechanical plant for water and wastewater treatment systems
- Outdoor public address systems and entertainment at hotels/resorts and the proposed Golf Club
- Road traffic
- Aircraft using the proposed landing strip on the island
- Human conversation, televisions, stereos and radios in use within accommodation units.

For most of these activities, provided that the activity complies with the noise criteria for human amenity set out in the Queensland *Environmental Protection (Noise) Policy 2008*, noise levels will not exceed those likely to cause disturbance to fauna. Compliance requirements for various mechanical plant and equipment such as air conditioners, generators and the water and wastewater treatment plant systems as well as outdoor public address systems will need to be assessed as part of detailed design. For all of these types of equipment noise minimisation and attenuation measures are readily available if noise issues arise.

Noise from recreational boats and aircraft may affect migratory shorebirds and this is assessed in more detail in Section 10.2.4.

8.4.7 Aircraft

Allowance has also been made for an airstrip in the project. It is not intended to allow regular commercial flights from this airstrip however, subject to interest from a suitable operator and demand from visitors to the PTP, it is possible that scenic flights may be operated from the airstrip on a commercial basis. In peak periods, around 10-20 flights per day might be expected, but it is expected that most days, there will be less than 10 flights per day.

Potential impacts associated with aircraft operating scenic flights would depend on the route taken, the frequency of flights and the size of aircraft utilised. Depending on these factors, impacts may occur to utilisation of habitat by migratory shorebirds. This is discussed further in Section 10.2.4.

While scenic flights across the GBRWHA/NHP and GBRMP will improve access to and enjoyment of the GBRWHA/NHP and GBRMP, impacts may also occur. This is discussed further in Section 8.8.3.

8.4.8 Human Activity

Over and above noise and light impacts, there will be an increase in human activity on HHI as a result of the project. Highest levels of human activity will occur within the proposed development footprint. The development footprint has been designed to avoid any areas of high and moderate value habitat for listed threatened and migratory species however development adjacent to these areas of retained vegetation presents an opportunity for humans to enter these areas.

Controlled access will be provided to the beach west of the headland and signage used to direct visitors to these access points and warned not to access the beach via informal routes. This area has not been identified as providing habitat for any listed threatened species, and provides some minor roosting and foraging resources for migratory birds (see Section 7.5). This area is erosion prone and measures to avoid impacts on beach and dune formations are discussed further in Section 8.10.2.

Walking trails will be provided within and adjacent to the project, however these will avoid sensitive vegetation communities and habitats including:

- The beach east of the headland, where very low levels of flatback turtle nesting are known to occur in some years and suitable habitat is also present little tern nesting. This beach is not currently readily accessible from the project area due to steep slopes and thick vegetation. There is an existing access track through the coastal vine thicket to the beach about midway between the headland and Sandfly Creek which leads to a beach hut that is currently in use. It is not proposed to connect this access track to the development.
- Most of the coastal vine thicket community is fairly dense and impenetrable. As mentioned above, there is one track through the vine thicket to the beach associated with an existing beach shack, however, it is not intended to connect this to walking trails associated with the development.
- Access to intertidal areas including mangrove and saltpan habitats will not be provided and the nature of these habitats is such that humans will generally not seek to enter unless paths are available. This will minimise potential for increased disturbance to water mouse, if present in this habitat.
- Internationally important migratory shorebird roosting and foraging areas in the south-east of HHI (sites 65a, 65b and 65c on Figure 6.56). These are separated from the development footprint by Sandfly Creek, an intertidal creek with no formal crossing points as well as dense vegetation. There are no existing access tracks leading to the roosting and foraging sites. While it is possible that people may access these roosting and foraging sites on foot from the development, this would be difficult and is unlikely to be attempted except by bird watchers who would be sensitive to the need to avoid disturbance to roosting and foraging birds.

Other listed threatened and migratory species such as the grey-headed flying fox and migratory terrestrial birds are not likely to be disturbed by human activity.

The conservation area management plan will designate the key important migratory shorebird roosting and foraging areas and coastal vine thicket as no access zones. In the event of turtle or little tern nesting, affected beach areas will also be designed no access zones. The tourist information centre will include information on these no access zones and signage will also be placed to warn people from accessing these areas if required. It is also not proposed to provide vehicle access to beaches or any other areas outside the development footprint. While land-based human activity is not expected to impact on habitat for any listed threatened and migratory species, the conservation area management plan will include monitoring of these areas and, if human access is occurring and creating any impacts on habitat values, further measures will be implemented to prevent access.

The beach east of the headland will be checked on a weekly basis from October to January to detect nesting of flatback turtles or little terns. Flatback turtle nesting can be detected from turtle tracks on the beach and disturbance at the nest site. Little tern nests can be detected from the nesting behaviour of one or more pairs. In the event that turtle nesting, or nesting of little terns or other tern species is identified to have occurred, exclusion zones will be established and enforced under the conservation area management plan (see also Section 8.3.8).

As identified in Section 8.4.6, activity associated with recreational boating may impact on migratory shorebirds and this is discussed further in Section 10.2.4.

Potential disturbance to marine animals from recreational boating is discussed in Section 8.7.3.

Human activity also has potential to introduce or spread weeds and can be associated with increased predation risk if humans bring domestic dogs and cats to the PTP. Weed infestation and proliferation is discussed in Section 8.4.2 and predation issues are discussed in Section 8.6.5.

8.4.9 Microclimatic Changes at Edges of Vegetation Patches

When areas of native vegetation are partly cleared, the edges of remaining vegetation can become exposed to increased sunlight, wind and rain and may also experience altered surface runoff patterns if overland flow patterns are changed. These microclimatic changes generally do not extend more than tens of metres into the remnant vegetation area and are less marked in the open woodland type vegetation that is most typical of the proposed development area.

In open woodland vegetation, mature trees and large shrubs are not expected to be particularly vulnerable to edge effects, however, ground level vegetation may be affected.

The extent to which edge effects reduce viability and habitat value of remnant ecosystems depends in part on the patch size. Edge effects may reduce the habitat value of smaller patches of vegetation that remain within the overall proposed development footprint, particularly by reducing ground cover vegetation. As discussed in Section 8.3.2, edge effects typically penetrate 15m into an edge and never exceed 20m for sclerophyll forests.

It is a condition of the Coordinator-General's report for the HHID that the interface between development and habitat management areas and the conservation area be managed as shown and described in Section 2.6.3. Management of the interface between development and conservation and habitat areas is discussed further in Section 8.3.9.

In the context of clearing of vegetation for the project, the threatened ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* will not be exposed to edge effects as clearing is not proposed within 100 m of this vegetation community. Near the headland, the separation distance is reduced to 80 m however, the area immediately adjacent to the community, that is, the area between the development boundary and the community, is currently non-remnant and thus, the edge of the community in this area is already exposed to edge effects. It is proposed to manage this area as part of the offsets required under Queensland legislation, thus restoring it to remnant status.

There is also a minimum separation distance of 150 m between the 10 ha patch of *Eucalyptus melanophloia* woodland (RE 12.12.8) and any development, and hence the extent of occurrence of this vegetation community in the GBRWHA will not be reduced by indirect impacts of edge effects.

With the proposed managed interface areas, floristic diversity within the GBRWHA is not expected to be reduced. The key sensitive areas of *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and *Eucalyptus melanophloia* woodland (RE 12.12.8) will be protected from edge effects by management of the interface between development and conservation and habitat areas, and remnant areas of 12.12.12 are large enough that, even if edge effects occur, the patches will remain viable and hence continue to maintain floristic diversity in the WHA (see also Section 8.3.2). Other habitat types will also be protected by the proposed managed interface.

Overall, the severity of impact from microclimatic changes around the edges of native vegetation is assessed as low, due to the provision of managed interfaces between the development and conservation and habitat areas.

8.4.10 Artificial Light

A number of studies have identified the potential for artificial light to affect behaviour of nocturnal species. In relation to land-based species of conservation significance present or potentially present at HHI:

- Black-breasted button quail forage during the day and roost in the coastal vine thicket at night. As there is no proposed development within several hundred metres of the coastal vine thicket, light-related impacts are not considered significant
- Grey-headed flying fox are known to forage over urban areas, including from camps established in urban areas and would therefore not appear to be affected by light.
- Some reptiles including the brigalow scaly-foot are nocturnal. GHD (August 2012) identified that artificial light may assist nocturnal reptiles in foraging, but may also increase risk of predation. This is discussed further in Section 9.2.2.

- Terrestrial migratory birds that are present forage during the day. Five of the seven species present or potentially present are known to utilise urban and semi-urban areas and would not appear to be affected by artificial light.
- Terrestrial marine birds that are present also forage during the day. Egrets are known from urban and semi-urban areas and are not likely to be affected by artificial light. If terns nest on beaches, measures to avoid light spill in relation to turtle nesting will also avoid impacts on tern nesting areas.
- Migratory shorebirds may avoid areas illuminated by street lights (see Appendix E). Illumination at night time may improve foraging efficiency but may also make shorebirds more vulnerable to predation (GHD August 2012). However, given that the closest area of important migratory shorebird habitat is at least 500 m from the development footprint, it is not expected that lighting from the proposed development will illuminate this habitat.

In relation to general native animal diversity, light spill may increase foraging success for nocturnal species, but also increase risk of predation. Insects are attracted to lights and this can increase foraging success for insectivorous animals, including birds.

Detailed design of buildings and other facilities will consider the need to avoid light spill, and monitoring will be undertaken post development to check the effectiveness of these measures, and implement additional screening measures as required. All external lighting will be required to comply with the Australian Standard AS 4282—1997, Control of the obtrusive effects of outdoor lighting. This will include requirements for lighting to be downward facing and of the minimum level of brightness required for safety of people. While not directly applicable to PTP, reference will also be made to guidance on lighting controls in the Gladstone and Calliope Planning Schemes as these represent appropriate local and regional standards.

In relation to marine animals of conservation significance, flatback turtles are known to nest in very low numbers on the beach east of the headland. Potential impacts of lighting from the project on the beach where turtles have been observed to nest are discussed further in Section 9.3.3.

It is unlikely that light spill from the proposed development will affect the key migratory shorebird sites ((sites 65a, 65b and 65c on Figure 6.56) due to the distance between these sites and the development and existing screening vegetation that is to be retained as part of the managed conservation area. Further, there are no components of the master plan that face towards the migratory shorebird feeding and roosting sites.

Lighting from the project may also be visible to viewers in boats located in the GBRWHA/NHP and GBRMP. This is discussed further in Section 8.9.

Lighting from land based development is not identified in the Australian Government's Species Profile and Threats database as threat to dugong. The most recent Great Barrier Reef Outlook Report does not report any threats to animals associated with artificial light apart from potential impacts on turtle nesting and hatchling movements (GBRMPA 2009).

8.4.11 *Increased Bushfire Risk*

Fire caused by lightning strikes is a natural factor in many Australian ecosystems, and indigenous people have also used fire as an environmental management technique. Seeds from some Australian plants rely on fire to germinate and fire also maintains balance between different plant species, particularly limiting dominance by certain ground cover species.

However, where the frequency of fires is been altered by human development and land management methods, this can be detrimental to ecosystems. Where weed invasion has occurred, fire can also provide an opportunity for weeds to proliferate.

Burning was used as a land management technique during grazing of HHI to promote pasture growth and reduce undergrowth. Since then, the proponent has noted that there have been several bushfires on HHI, but the cause is unknown, and may be from natural causes or by campers.

The project will increase human activity and hence, may increase the risk of accidentally or deliberately lit bushfires. Planning and building regulations also require developments to be protected from bushfire hazards. HHI has been identified by the Queensland Government Rural Fire Service as being of moderate bushfire risk (http://www.ruralfire.qld.gov.au/Bushfire%20Planning/, accessed 24/03/2013).

The Queensland Herbarium has provided fire management guidelines for regional ecosystems in Queensland (Queensland Herbarium 2013). These are summarised for REs adjacent to the project in Table 8.3. Most of the vegetation communities on HHI are relatively resilient to bushfire and would benefit from low frequency burning.

Table 8.3 – Fire Management

Vegetation Type	RE	Fire Management
Casuarina glauca open forest	12.1.1	SEASON: Early winter or storm burning seasons. INTENSITY: Low to moderate. INTERVAL: Aim for a 6-7 yr minimum threshold at a broad scale planning level. STRATEGY: Aim to retain at least 25-50% unbumt in any given year. Fire exclusion and buffering from fire is not necessary.
Microphyll/notophyll vine forest on beach ridges	12.2.2	STRATEGY: Do not burn deliberately. May need active protection from wildfire in extreme conditions or after prolonged drought.
Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest	12.2.11	STRATEGY: Do not burn deliberately. Burn surrounding ecosystems in conditions that would minimise fire incursion. ISSUES: Protection relies on broad-scale management of surrounding country.
Fore dune complex	12.2.14	STRATEGY: Do not burn deliberately. Burn surrounding ecosystems in conditions that would minimise fire incursion.
Eucalyptus tereticornis woodland to open forest	12.3.3	SEASON: Summer to late-autumn. INTENSITY: Low. INTERVAL: 3-6 years. STRATEGY: Aim to burn 40-60% of any given area. Spot ignition in cooler or moister periods encourages mosaics.

Vegetation Type	RE	Fire Management
Eucalyptus tereticornis and E. crebra dominated forests	12.12.12	SEASON: Summer to winter. INTENSITY: Low to moderate. INTERVAL: 4-25 years. STRATEGY: Aim for 40-60% mosaic burn. Burn with soil moisture and with a spot ignition strategy so that a patchwork of burnt/unburnt country is achieved.
Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland	12.3.6	SEASON: Late summer to mid-winter (after rain). INTENSITY: Planned and occasional unplanned burns (typically of higher intensity) influence the ecology of melaleuca ecosystems. INTERVAL: Heath 8-12 years, Sedge 12-20 years, Mixed grass/shrub 6-20 years. STRATEGY: Aim for a 25-70% burn mosaic.
Eucalyptus populnea woodland	12.3.10	SEASON: Summer to late-autumn. INTENSITY: Low. INTERVAL: 3-6 years. STRATEGY: Aim to burn 40-60% of any given area. Spot ignition in cooler or moister periods encourages mosaics.
Eucalyptus crebra woodland	12.12.7	SEASON: Summer to late-autumn. INTENSITY: Low. INTERVAL: 3-6 years. STRATEGY: Aim to burn 40-60% of any given area. Spot ignition in cooler or moister periods encourages mosaics.
Eucalyptus melanophloia woodland	12.12.8	SEASON: Summer to late-autumn. INTENSITY: Low. INTERVAL: 3-6 years. STRATEGY: Aim to burn 40-60% of any given area. Spot ignition in cooler or moister periods encourages mosaics.
Themeda triandra grassland and wind-sheared shrubland and woodland.	12.12.19	STRATEGY: Burn in association with surrounding country.
Eucalyptus moluccana open forest	12.12.28	SEASON: Summer to winter. INTENSITY: Low to moderate. INTERVAL: 4-25 years. STRATEGY: Aim for 40-60% mosaic burn. Burn with soil moisture and with a spot ignition strategy so that a patchwork of burnt/unburnt country is achieved.

There are three REs adjacent to the development footprint where burning is identified as being potentially harmful, and to be avoided. These are the extensive areas of 12.2.11 (*Corymbia* spp., *Eucalyptus* spp., *Acacia* spp. open forest to low closed forest) and the coastal vine thicket (12.2.2), the foredune complex (12.12.14) and mangroves (12.1.3) (see also Figure 6.56).

The RE 12.2.11 occurs adjacent to the proposed Golf and Beach Resort Precinct, and elements of this RE will also be retained within the golf course as part of golf course landscaping and habitat connectivity. The main potential source of bushfire in this precinct would be from cigarette butts, however the proponent is intending to ban cigarette smoking on the golf course. As the golf course will include mown fairways and water storage ponds, this will restrict the rate of spread of any fires that may be started in this area. The prevailing wind on HHI is from the south-east and this will also drive fires towards the coastline rather than into the remaining areas of 12.2.11.

The majority of the coastal vine thicket is remote from the proposed development footprint. The minimum separation distance is 80-100 m, near the headland, and considerably more for the remainder of the patches of vine thicket. Public access to the coastal vine thicket is not proposed. Prevailing winds from the south-east will reduce the likelihood of fires moving into the vine thicket area. Likelihood of fire entering the vine thicket is low and management of and reduction of fire risk in this area will also be addressed in the management of the conservation area.

A patch of foredune complex (12.12.14) runs as a narrow strip to the north of the proposed Golf and Beach Resort Precinct and Headland Resort Precinct, within the protected erosion prone area. This area will include public access to the adjacent beach and the warning signs and cigarette disposal containers will be provided. Queensland legislation prevents smoking in beaches and public places and this will further reduce the risk of accidental fires from cigarette butts and matches. Open fires will not be allowed in picnic areas associated with the beach or on the beach itself.

Other vegetation communities adjacent to the development footprint tolerate or even benefit from fairly regular burning with frequencies described in Table 8.3. Irrespective of this, controls will be put in place to prevent accidental burning of these areas, with the preference being a controlled burning program as part of the management of the proposed conservation area.

Measures to address bushfire hazard will include both preventative and responsive measures, including:

- All buildings and facilities, including villas and houses, to comply with legislative requirements and Australian standards in relation to:
  - Measures to minimise the risk of accidental fire
  - Fire (smoke) detection systems
  - Fire response systems, including automated fire suppression systems
- Maintenance of managed firebreaks and interface zones between development areas and around areas such as fuel storages. These will be managed as part of the actively managed conservation area and Wildlife Habitat Management Plan (see also Section 8.3.8 and 8.3.9). Provision of a managed interface around the perimeter of the development to protect sensitive areas is also a condition of the Queensland Coordinator-General's report (February 2011)
- Provision within the water supply system for fire fighting water and a fire water reticulation system to allow provision of fire fighting water throughout the development footprint
- Electric or gas barbecues in picnic areas and at the camping ground, with a strict ban on open fires
- Signs and awareness raising regarding the importance of preventing bushfires
- Reinforcement of Queensland legislative restrictions on smoking in public places
- Cigarette disposal containers in public areas where smoking is permissible by law.

The proponent will also consult with the Queensland Fire Service/Rural Fire Service regarding provision of fire fighting response capability such as a volunteer or staffed fire brigade and a fire truck and other equipment. Provision has been made in the resort village and entry village for emergency services facilities if required by Queensland Government.

During construction activities construction contractors will be required to have an emergency management plan including measures for prevention of and response to fires. Minimum requirements will include prevention of driving of vehicles over long grass, designated smoking areas, fire extinguishers and management of welders and other spark sources.

As part of the actively managed conservation area, a fire management plan will be developed, recognising that some areas of native bushland will benefit from a regular burning regime, while others, such as the coastal vine thicket, should be protected from fire.

In the event that uncontrolled bushfire breaks out, HHI is relatively flat and accessible and it should be possible to contain and control fires quickly, thus minimising the area affected.

With these measures in place, the potential for fire risk to increase as a result of the project is considered low. Most vegetation communities adjacent to the proposed development are tolerant to fire at frequencies of between 4 and 25 years. Separation distance between the coastal vine thicket and development, and active management of this area will protect the coastal vine thicket, and additional controls to manage the risk of accidental fire in the foredune complex and RE 12.2.11 woodland adjacent to and within the Golf and Beach Resort Precinct are available and expected to be effective.

The impact of increased fire risk on MNES values of HHI is therefore not considered significant and is not assessed further. A controlled fire regime may benefit biodiversity on HHI.

8.4.12 Creation of Ponds

Uncovered, lined water storage ponds will be created at the golf course and Colosseum Village for storage of recycled water. The combined area is estimated to be about 5.5 ha (see also Section 2.7.2.4 and Figure 2.3). The stormwater management system also includes some detention basins that will contain water in wetter weather conditions.

These ponds may increase the availability of fresh water and aquatic habitat on HHI, which is currently restricted to several farm dams, and some small ephemeral ponds. As water levels in the water storage ponds will fluctuate throughout the year, it is intended that the recycled water storage ponds will have relatively steep sides to minimise the effects of changing water levels. This will reduce the benefit of these ponds as animals will not be able to access them readily from the shore. However, in the detailed design stage, consideration will be given to incorporating fauna access points at suitable locations.

Stormwater detention basins will generally be accessible to fauna but will only contain water in wet conditions, and hence may provide little overall benefit to fauna.

Overall, the ponds are not expected to have any adverse impacts on fauna, and may provide some benefits if access to water resources on HHI can be improved. Birds will be the main type of species to benefit as other animals will not be able to move onto HHI from the mainland. Hence, bird populations may increase. However, the ponds will not provide suitable habitat for migratory shorebirds.

Ponds will need to be monitored for nuisance birds such as ibis and measures taken as required if issues arise from colonisation of nuisance birds.

8.4.13 Summary of Potentially Significant Impacts

Potentially significant impacts on EPBC Act listed threatened species and ecological communities and listed migratory species associated with indirect impacts on terrestrial vegetation and habitat are identified in Table 8.4.

Table 8.4 – Summary of Potentially Significant Impacts – Indirect Impacts on Terrestrial Vegetation and Habitat

Potential Impact	Threatened Plants, Animals and Ecological Communities	Migratory Species
Weed infestation and proliferation	No impact	No impact
Changes in overland flow characteristics	Negligible impact	Negligible impact
Changes in groundwater recharge and discharge characteristics	No impact	No impact
Deposition of dust	Negligible impact	No impact
Noise	No impact	Potentially significant Refer Section 10.2.4
Human activity	Negligible impact	No impact
Aircraft (scenic flights)	No impact	Potentially significant
Microclimatic changes at edges of vegetation patches	No impact	No impact
Artificial light	Potentially significant impact (marine turtles) Refer Section 9.3.3.	No impact
Increased bushfire risk	Negligible impact	Negligible impact
Creation of ponds	Potential benefit (some birds)	Potential benefit (some birds)

In relation to the GBRWHA/NHP, indirect impacts on vegetation communities and habitat may affect biodiversity values that in turn contribute to the OUV of the GBRMWHA/NHP. This is discussed further in Section 11.5.2.

Potential impacts on the amenity values of the GBRWHA/NHP and GBRMP of increased activity levels, including from scenic flights are discussed in Section 8.8 and also in Section 12.2.

Potential impacts on visual amenity values of the GBRWHA/NHP from lighting are discussed in Section 8.9 and also in Section 11.2.

8.5 Impacts on Water Quality - Indirect Impacts on Coastal and Marine Habitat

8.5.1 Overview

Changes in water quality may indirectly impact coastal and marine habitat quality and, where more extreme changes occur, may have acute or chronic toxic effects on marine plants and animals. Water quality changes may arise from:

- Disturbance and subsequent oxidation of acid sulfate soils during construction
- Release of sediment from bridge and boat ramp construction
- Sediment release during construction on land
- Disposal of groundwater intercepted during excavations (construction)
- Wastewater treatment and reuse
- Management of nutrients at the proposed golf course
- Contamination of stormwater
- Changes in overland (freshwater) flow characteristics
- Saline (brine) waste
- Hydrocarbon contamination of surface and groundwater
- Contamination of surface water and groundwater by pesticides
- Contamination of surface water and groundwater by other hazardous materials
- Removal of the causeway
- Human waste discharges from recreational boats
- Hydrocarbon discharges from recreational boats.

Each of these is evaluated below with consideration to potential impacts on environmental values and condition generally, and specifically impacts on MNES. Impacts on MNES may arise due to degradation of habitat for listed threatened and migratory marine animals or if degradation of water quality in turn affects a feature or element that contributes to the OUV of the GBRWHA or marine habitat within the GBRMP.

8.5.2 Disturbance and Subsequent Oxidation of Acid Sulfate Soils

Acidification of tidal waterways from disturbance to and oxidation of potential acid sulfate soils can have a range of impacts including:

- Mortality of fish, crustaceans and other aquatic animals. This in turn affects food sources for a range of aquatic species and species such as migratory shorebirds and water mouse

- Fish disease
- Death, reduced productivity or other changes in aquatic plant communities (http://www.nrm.qld.gov.au/land/ass/impacts.html, accessed 31/03/2013).

The effects of disturbing acid sulfate soils are now well recognised in coastal development, particularly in Queensland, where comprehensive guidelines for testing and management of acid sulfate soils have been developed (see for example http://www.nrm.qld.gov.au/land/ass/products.html).

During construction of the proposed bridge, a small amount of excavation will be required for bridge pylons. Studies undertaken for the HHID EIS indicate a potential acid sulfate soils layer of about 0.5 m thick in this location (SKM 2007). Allowing for excavation for bridge foundations, less than 1,000 m^3 of potential acid sulfate soils will be disturbed.

While detailed design of the proposed boat ramp has not been undertaken, construction of the boat ramp is expected to disturb up to 1,500 m^3 of sediment, including potential acid sulfate soils.

Excavation is not required for the upgrade of the Clarke's Road causeway across supratidal salt flats, but increased pressure from the low embankment required for the upgraded road may displace sediments slightly and if potential acid sulphate soils are present in this location, cause these to be exposed to oxidising conditions. Testing will be undertaken prior to commencement of the causeway upgrade and, if potential acid sulphate soils are present, a management plan will be devised in accordance with Queensland Acid Sulfate Soil Investigation Team's *Acid Sulphate Soil Technical Manual* (in QASSIT (1998) and Dear *et al*. (2002)).

Excavation is not required for the desalination plant intake, which will be attached to the proposed bridge. There are no other activities associated with the proposed HHI that might expose potential acid sulfate soils in the intertidal or subtidal zones.

The volumes of potential acid sulfate soils that will be disturbed is a very small volume that can be readily managed using established and proven techniques. An acid sulfate soil management plan will be prepared and excavated material will be removed from subtidal and intertidal zones for treatment and management. The material will be placed in a bunded location which prevents surface runoff and leachate from the material entering watercourses or the marine environment.

Depending on the properties of potential acid sulfate soil material to be removed from pylon excavations, the material may be neutralised and reused as fill, or removed from the site for disposal at an existing authorised waste disposal facility in the Gladstone region. If the material is to be neutralised and reused as fill, neutralisation will be undertaken in the bunded storage area and validation testing will be undertaken prior to reuse to check that neutralisation has occurred.

Section 6.3.7 also identifies the potential for acid sulphate soils to occur on the relict dune swale and beach ridges that occur on the north-western part of HHI. The main development proposed in this area is the golf course and residential and commercial buildings. Some excavation will be required to install water storage lagoons that will form part of the recycled water storage system (see also Section 2.7.4). Soils will be tested for potential acid sulphate soil characteristics prior to excavation and, if potential acid sulphate soils are identified, a neutralisation and management program developed in accordance with the Queensland Acid Sulfate Soil Investigation Team's *Acid Sulphate Soil Technical Manual* (in QASSIT (1998) and Dear *et al.* (2002)).

Given that effective and well-established management measures are available, and that the amount of potential acid sulfate soils to be disturbed is easily manageable, impacts on water quality and on marine habitats and threatened or migratory marine mammals are considered avoidable. Impacts on the OUV of the GBRWHA would only arise if there was significant impact on biodiversity values which is very unlikely given the small quantity of potential acid sulfate soils involved and the proven effectiveness of management measures. Impacts on the GBRMP are not expected as the majority of excavation works take place in catchments that do not flow directly to the GBRMP.

In accordance with the criteria established in Section 1.7.4, the severity of the impact on all identified MNES is negligible and no further assessment is required.

As disturbance of acid sulphate soils requires active management during construction activities, management measures will be included in the Construction EMP and are also required as a condition of the Coordinator-General's report. An acid sulfate soil management plan will be prepared that will address:

- Minimising the disturbance of potential acid soil
- Immediately removing potential acid sulfate soils to a dedicated bunded area that provides for capture of stormwater flowing from stockpiles
- Treatment with lime at a rate of about 50 kg/tonne. Field pH peroxide test (pH_{FOX}) or similar will be used to test whether neutralisation has been successful
- Reuse of neutralised soils as fill if geotechnical properties are suitable, otherwise disposal at an authorised disposal facility.

8.5.3 Release of Sediment from Bridge, Boat Ramp and Causeway Construction

Construction of the proposed bridge and boat ramp will each require a small area of disturbance in the intertidal and subtidal zone. Upgrading of the Clarke's Road causeway across supratidal salt flats will also involve placement of fill material, although excavation is not expected to be required. A small workboat will be required during bridge and pontoon construction.

Bridge construction is discussed in Section 2.4.5.4 and will require a temporary jetty to be installed to allow access by construction equipment. The bridge will then be constructed outwards from each shoreline, with no required to place construction equipment in Boyne Creek. The total area of disturbance in the subtidal zone from temporary or permanent structures is expected to be less than 5,000 m^2, which is less than 0.005% of the subtidal habitat available in the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary.

Bridge construction activities in the intertidal zone and above high tide will also only require relatively small volumes of excavation, in the order of several hundred cubic metres of soil, and sediment release can readily be controlled using standard erosion and sediment control measures and the following additional measures in the intertidal zone:

- Undertake construction activities involving excavation at low tide
- Remove any excavated material to above the high tide mark immediately (this is also required for acid sulfate soil management)
- If dewatering is required, remove water from excavations using a vacuum truck or pump to a sediment basin located at least 200 m above the high tide mark, for treatment (settlement) and controlled disposal.

The boat ramp is required to extend about 0.5 m vertically below low tide to allow all-tide boat launching in accordance with Queensland Government design requirements. Detailed design of the boat ramp has not been undertaken, however it is estimated that up to 1,500 m^3 of sediment in the intertidal and subtidal zones might be removed or otherwise disturbed. All excavated material will be returned to managed stockpile areas above the high tide level for treatment of acid sulfate soils and containment of sediment laden runoff. Some release of sediment to the water column is expected to occur during construction, but would be a very small quantity, with the duration of release in the order of several days. A sediment net can be deployed around the boat ramp construction area to minimise mixing of sediment plumes with waters of Boyne Creek.

Upgrade of the Clarke's Road causeway across the supratidal saltflats does not require any significant earthworks, however fill material will be placed and, if a severe rain event occurs during this component of construction, some material could be mobilised to the adjacent supratidal and intertidal salt flats. The area adjacent to the causeway are devoid of vegetation with the nearest vegetation being mangroves along the tidal channels, located more than 150m from the causeway. The mangroves themselves form a vegetated barrier 100-300m thick between the saltflats and the tidal channels.

The quantity of material that might be mobilised by a rain event is low and this is not likely to result in any adverse impact on mangroves which are, in any case, adapted to a high-turbidity environment. Given both the small quantity of material that might be mobilised, and likely interception of overland flow by the mangrove fringe, it is unlikely that the material would cause any discernible increase in turbidity of the tidal channels in the vicinity of the causeway.

If very high tides occur during upgrade of the Clarke's Road causeway, contact of tidal waters with loose fill material might also result in some mobilisation of material to the tidal channels. Again, given the small quantity of material that might be mobilised and likely interception by the mangrove fringe, it is unlikely that any discernible change in water quality would be observed.

The upgrade works are expected to take three to four months to complete and hence, any impact will also be very short term. Once the causeway upgrade is complete, the embankments will be stabilised and soils will not be exposed to erosive forces.

Water quality in Boyne Creek has been measured on several occasions by the proponent, and the area is also used as a reference site by the Port Curtis Integrated Monitoring Program (see also Section 6.1.5.2). The PCIMP reports that waters in the vicinity of HHI have generally met the ecosystem health indicator established in relation to turbidity of 20 NTU in the 2005/2006 report period and the 2008/2010 report periods (Storey et al, 2007, Vision Environment 2011). This generally correlates with data collected by SKM from two monitoring events in 2005. In these events, turbidity in estuarine and enclosed coastal areas ranged from 3.6 to 31.4 NTU (SKM 2007).

OzCoasts has estimated that, in the undeveloped catchment case, 300 tonnes (300,000 kg) per annum of sediment would have been released to Colosseum Inlet (including part of Boyne Creek) from catchment runoff while in the catchment condition, annual releases from catchment runoff are estimated to be 3,800 tonnes (3.8 million kg). Estimates for Seven Mile Creek estuary are not available but likely to be similar based on catchment size and characteristics. With controls in place, remobilisation of sediment to the water column of sediment from bridge and boat ramp construction activities would be less 100 kg and unlikely to make any significant difference in the sediment load in the estuary.

Release of sediment from bridge and boat ramp construction may cause localised increases over background levels in sediment levels in the water column, extending several hundred metres from the construction activities. Releases will be minor and episodic, for example, if any nexcavation is required for foundations with the total duration of localised episodic releases likely to occur sporadically over one to two years. Release of sediment from bridge and boat ramp construction is expected to have negligible impact on water quality or water quality dependent MNES values and is not assessed further. The bridge and boat ramp are a minimum of over eight kilometres by sea from the GBRMP and no impact is expected given the small quantity of sediment mobilised and the distance by sea.

In accordance with the criteria established in Section 1.7.4, the severity of the impact on all identified MNES is negligible and no further assessment is required.

Potential effects of the boat ramp and bridge on geomorphological processes are discussed in Section 8.10.

8.5.4 Sediment Release during Construction on Land

During construction, land within the proposed development footprint will be cleared of vegetation and soils will become exposed to erosive forces, particularly from rainfall runoff. Development will occur across the proposed footprint sequentially over an estimated 16 year period and vegetation will not be cleared from each area until immediately before development, thus minimising the area of soil exposed.

This means that in most development years, less than 50 ha of the total development footprint of 465 ha will be disturbed at any one time.

On completion of development of each area, any remaining exposed areas will be stabilised by replacement of topsoil and revegetation. This will be a requirement in all construction contracts. Revegetation will depend on the final use of the area with guidelines as follows:

- For open space areas and lawns that are to be grassed, hydromulch or similar technique will be used. This involves application of a premixed solution of grass seed, fertiliser, and mulch components such as cellulose and wood fibre. The solution provides immediate ground cover and a supportive environment for rapid establishment of grass. Selection of grass species will depend on location and end use, with native grass species to be used wherever practicable.
- Where native vegetation is to be established, revegetation techniques will include hand planting of seedlings and application of seedstock. A protective cover of mulch, hessian or other erosion control product will be applied wherever erosion risk is moderate or high, for example in sloping areas.

During the actual construction activities, erosion and sediment controls will also be required to minimise exposure of soils to erosive forces and capture sediment mobilised from the construction site for any locations where there is potential for runoff from the construction site to enter the coastal environment. Best practice erosion and sediment control is considered adequate to reduce sediment release from construction areas to within acceptable limits (DNRW 2008).

The preparation and implementation of erosion and sediment control plans by a suitably qualified person is a condition of the Queensland Coordinator-General's report, and the proponent will impose this requirement on contractors through the Plan of Development and, where relevant, contract conditions.

Erosion and sediment control methods will be based on the most recent applicable guidelines at the time. Currently, the International Erosion Control Association Australasia's *Best Practice Erosion and Sediment Control Guidelines* (IECA 2008) and the *Queensland Urban Drainage Manual* (DNRW 2008) are considered best practice for Queensland. Erosion and sediment control principles will be based on the following hierarchy:

- Diversion of clean flows around disturbed areas, with provision of scour protection where concentration of flows is likely
- Minimisation of the area of soil exposed to erosive forces by clearing the minimum possible work area at all times, and protecting unused areas, for example through the use of mulch and stabilisation/ revegetation of exposed areas as soon as practicable following the completion of works
- Capture of overland flows from exposed areas in sediment retention devices. For larger disturbance areas, sediment basins will generally be required in accordance with the erosion and sediment control guidelines. This also provides the option of using flocculants if subsoils are particularly dispersive and take a long time to settle. Any discharge of runoff from sediment basins will be in accordance with Table 8.5.

Table 8.5 - Construction Phase Water Quality Objectives for Discharge of Collected Runoff

Parameter	Release Criteria	Criteria Type
pH	6.5 – 9.0	Range
Suspended Solids	<50 mg/L	Maximum
Turbidity	Site discharge during sediment basin dewatering has a turbidity (NTU) less than 10% above receiving waters turbidity	Maximum
Dissolved Oxygen	>6 mg/L	Minimum
Hydrocarbons	No visible sheen on receiving water	Descriptive
Litter	No visible litter washed from site	Descriptive

Note: Conditions relate to flow discharged from a particular construction site

In accordance with Table 2.1 of the *Urban Stormwater Quality Planning Guidelines 2010* (DEHP 2010), sediment control measures in areas that are disturbed and open for less than 12 months will be designed to withstand a design storm with a recurrence interval of 2 years. Although it is not expected that any areas will be left open for longer than 12 months, in areas disturbed and left open for between 12 and 24 months, sediment controls will be designed to withstand a design storm with a recurrence interval of 5 years. Area specific erosion and sediment control plans will be developed for each component of construction, taking into account:

- The time of year and likelihood of wet weather occurring
- Soil and subsoil types
- Slope
- Area of disturbance
- The downstream receiving environment.

Erosion and sediment controls will also be coordinated with the overall stormwater management approach for the project. As some of the stormwater quality improvement devices, such as bioretention swales, may be damaged by high sediment loads from construction areas, these components will not be installed until disturbed areas are stabilised. Erosion and sediment controls will remain in place until the stormwater system, including all stormwater quality improvement devices, are fully functional.

An initial evaluation of erosion risk for each of the proposed precincts is provided in Table 8.6. Table 8.6 also provides indicative information on erosion and sediment control measures to match the erosion risk levels for each precinct and soil type.

Table 8.6 – Preliminary Review of Erosion Risk

Precinct	Soil and Subsoil Susceptibility to Erosion	Slope	Downstream Receiving Environment – Pre-development ([2])	Management of Erosion Risk
Headland Resort	Permian soils (Pzm1-4) are moderately to highly susceptible to sheet, rill and gully erosion, low susceptibility to wind erosion	Slopes less than 5% for most of this precinct	In spite of proximity to the coastline, this area does not drain to open coastal waters. Drainage is to the west into dune swales/ephemeral wetlands or south-west into an ephemeral drainage line that discharges to the mangrove fringe along Boyne Creek.	Due to the high susceptibility of soils to erosion, one or more sediment basins are likely to be required for the duration of construction activities in this precinct. Flocculation may be required if sediment levels at sediment basin outlets exceed 50 mg/L. Overflows from sediment basin will not flow directly to the marine or coastal environment, but via ephemeral waterways into mangrove line inlets, providing further opportunity for sediment attenuation.
Village	Quaternary soils (Qb3) have low susceptibility to sheet, rill and gully erosion and high susceptibility to wind erosion. Permean (Pzm1) soils are highly susceptible to sheet, rill and gully erosion, low susceptibility to wind erosion.	Slopes less than 5% in this precinct	Natural drainage from this precinct is south-west into an ephemeral drainage line that discharges to a mangrove lined inlet that joins Boyne Creek. Quaternary soil areas are low lying and do not have established drainage paths.	Due to the high susceptibility of soils to erosion, one or more sediment basins are likely to be required for the duration of construction activities in this precinct. Flocculation may be required if sediment levels at sediment basin outlets exceed 50 mg/L. Overflows from sediment basin(s) will not flow directly to the marine or coastal environment, but via ephemeral waterways into mangrove line inlets, providing further opportunity for sediment attenuation.
Golf and Beach Resort	Quaternary soils (Qb3) have low susceptibility to sheet, rill and gully erosion and high susceptibility to wind erosion.	This area is very flat and low lying compared to surrounding areas	Drainage from this area is poor due to its flat, low lying nature and permeable soils and there are no clear drainage lines. In high rainfall conditions, areas close to the northern beach drain to an ephemeral channel that runs parallel to the rear of the beach and may periodically open up and discharge to the beach. Much of the area drains south to a mangrove lined inlet that joins Boyne Creek.	Erosion risk in this area is low. Minimisation of exposed areas and deployment of sediment fences should be adequate to manage erosion risk in this area.
Ocean View Resort	Permian soils (Pzm1 and 4) are moderately to highly susceptible to sheet, rill and gully erosion, low susceptibility to wind	This area is flat to sloping with slopes of 5-20%.	Drainage runs downslope to the west and then joins an ephemeral drainage line that passes through the central ridgeline and discharges to a mangrove lined inlet that joins Boyne Creek.	Erosion risk in this area is moderate to high. Diversion drains will be required for all disturbed areas and outlets from diversion drains will need to have energy dissipation to prevent scouring on steeper slopes. One or more sediment ponds will be required to intercept

Precinct	Soil and Subsoil Susceptibility to Erosion	Slope	Downstream Receiving Environment – Pre-development (2)	Management of Erosion Risk
	erosion			all flows from this area and provision for flocculation may be required to maintain sediment levels in discharges below 50 mg/L. . Controls will also be required to control overland flow and dissipate energy on areas with slopes in excess of 5%. Consideration may need to be given to minimising construction activities during the wet season in this precinct. Overflows from sediment basin(s) will not flow directly to the marine or coastal environment, but via ephemeral waterways into mangrove line inlets, providing further opportunity for sediment attenuation.
Bushland	Permian soils (Pzm1-4) are moderately to highly susceptible to sheet, rill and gully erosion, low susceptibility to wind erosion Quaternary soils (Qm) have low susceptibility to erosion. Cainozoic soils (Czs) have moderate to high susceptibility to erosion.	This precinct varies from flat to sloping with slopes up to 20%.	Drainage runs via several ephemeral watercourses to mangrove lined inlets that join Boyne Creek to the south.	Erosion risk in this area is moderate to high. Diversion drains will be required for all disturbed areas. Outlets from diversion drains will need to have energy dissipation to prevent scouring on steeper slopes. One or more sediment ponds will be required to intercept all flows from this area and provision for flocculation may be required to maintain sediment levels in discharges below 50 mg/L. . Controls will also be required to control overland flow and dissipate energy on areas with slopes in excess of 5%. Consideration may need to be given to minimising construction activities during the wet season in the steeper areas of this precinct. Overflows from sediment basin(s) will not flow directly to the marine or coastal environment, but via ephemeral waterways into mangrove lined inlets, providing further opportunity for sediment attenuation.

(1) Soil types are described in more detail in Section 6.3.

(2) Watercourses and hydrological characteristics are described in Section 6.4.

Provided that erosion and sediment control measures are developed and properly implemented, sediment release to the surrounding environment can be adequately controlled. As each component of the proposed development is relatively self-contained, it will be possible to develop dedicated sediment basins for higher erosion risk areas. Sediment basins can be left in place until disturbed surfaces are stabilised and permanent stormwater controls are in place.

Drainage from each precinct can also be controlled such that discharges are directed via existing ephemeral watercourses to mangrove lined inlets.

The proponent will monitor the implementation, maintenance and effectiveness of erosion and sediment controls throughout the construction period.

The proposed coastal and marine water quality monitoring program and stormwater runoff monitoring program will also be used to validate the effectiveness of erosion and sediment controls. The monitoring program will commence on commencement of construction and continue throughout the construction period. Should suspended solids levels in the receiving environment be identified as elevated above water quality objectives, more stringent erosion and sediment control measures can be introduced.

Overall, sediment releases arising from construction activities are not expected to have any significant impact on water quality in the receiving environment due to the relatively small area that will be exposed to erosive forces at any on time and provided that best practice erosion and sediment control is practiced. Following the criteria established in Section 1.7, the severity of impact on the receiving environment is negligible and significant or unacceptable impacts on MNES are not expected.

8.5.5 Groundwater Intercepted During Construction

As discussed in Section 6.4.3 and shown on Figure 6.27, there is a shallow groundwater lens underlying sandy soils in the north-west part of the special lease at depths of 0.5 to 5m below surface.

This shallow groundwater may be intercepted during construction of stormwater ponds and some buildings associated with the proposed golf course. As groundwater levels fluctuate depending on recent rainfall, the quantities of groundwater that might be intercepted will vary from year to year, and seasonally. Groundwater quality varies from fresh in the central area with conductivities less than <1,500 µS/cm to more saline closer to the coastline (AGC Woodward Clyde 2003 in SKM 2007, see also Section 6.4.3). The bulk of excavation will be for stormwater/recycled water storage ponds at the proposed golf course and the footprint of these ponds overlies the area identified as freshwater.

Where low conductivity groundwater is encountered, low impact disposal options are available, including irrigation and storage for later use. The preferred disposal option will depend on the stage of the development. In early stages, when stormwater ponds are not constructed, water from dewatering of excavations (including excavations to construct stormwater ponds) will be disposed of by irrigation on adjacent areas. As soils in this area are quite sandy, irrigation with freshwater is not likely to cause any ponding or waterlogging, provided irrigation rates are managed. The area is quite flat and erosion risk from irrigation water is low. Irrigation may cause a temporary minor raising of the water table, however as the water level in this aquifer fluctuates with rain inputs, this is expected to be well within the tolerance limits for the system.

If irrigation is used to discharge of good quality, groundwater, the following measures will be followed:

- Check salinity of groundwater before and during dewatering and if salinity exceeds <1,500 µS/cm, cease irrigation and utilise a vacuum truck to collect dewatering water
- Identify irrigation areas in adjacent grassed or vegetated areas, with the size to correspond to likely disposal amount, allowing for up to 10 mm to be applied per day
- Monitor irrigation areas to check for waterlogging or ponding and if this occurs reduce the application rate/increase the irrigation area
- Monitor irrigation areas for scouring or erosion and stabilise and repair any scouring within 24 hours
- In later stages of development, dewatering water will be directed to permanent stormwater ponds and then used for irrigation of the golf course and other landscaped areas throughout the development. Irrigation rates may need to be slightly increased to maintain storage capacity in stormwater ponds.

If groundwater salinity exceeds 1,500 µS/cm, an alternative management strategy will be required. Excavation in identified higher salinity areas will be relatively minor, associated with building foundations. If dewatering is required in this area and the salinity of dewatering water exceeds <1,500 µS/cm, it will be collected in a vacuum truck and either input to the propose desalination plant, placed in the evaporation ponds for the desalination plant or removed for disposal at one of the sewage treatment plants in the Gladstone area. The groundwater will not be discharged into tidal or marine waters unless a permit is obtained from the GBRMPA (in respect of the GBRMP) or Queensland Government (in respect of the GBRCMP). If this was to occur, the permit application would need to demonstrate that there was no adverse impact on the marine environment.

In relation to dewatering of excavations, the EMP will contain requirements to:

- Prevent discharge to waters without the appropriate permits
- Test salinity levels before dewatering and develop alternative management plans if levels exceed 1500 µS/cm, with the preferred management approach being removal by a vacuum truck to the evaporation ponds or a suitably authorised landfill (see Section 2.11.1 for discussion of waste management facilities in and around Gladstone).
- Monitor irrigation areas for waterlogging and scouring.

Given the relatively small quantities of groundwater likely to be encountered, and that effective management options are available, the potential for groundwater from dewatering of excavations to cause degradation of coastal and marine water quality is assessed as negligible. Impacts on MNES are not expected.

8.5.6 Wastewater Treatment and Reuse

8.5.6.1 Treatment and Management of Wastewater

All wastewater generated by the project will be treated in a dedicated wastewater treatment plant and recycled within the proposed development. As wastewater from the project is of domestic origin only, other contaminants such as heavy metals will be present at very low concentrations that are not likely to exceed guidelines (National Water Quality Management Strategy 2006).

Routine discharge of wastewater or treated wastewater to surface waters is not proposed as part of the project.

The selected wastewater treatment process will rely on mechanical and chemical treatment methods which has the following benefits:

- Proven use in production of treated water for use in recycled water schemes
- High reliability and low risk of production of “off specification” recycled water. Treatment is largely by physical or chemical processes which are much more reliable compared to biological processes used in conventional wastewater treatment plants. Physical and chemical processes are also more readily able to cater for variable loads which may occur due to tourist fluctuations on the Island
- Tolerance to small amounts of household chemicals, paints and other contaminants without risk of upset of the treatment system. The nature of the wastewater catchment is such that spikes of contaminants are very unlikely; spikes are usually associated with industrial inputs
- Use of zeolite filters which can be regenerated or used as fertiliser
- A crystallisation process that produces struvite crystals which can be reused as high quality fertiliser
- Very effective removal of pathogens
- Low noise and odour potential.

In the event that off-specification water is produced, there is no risk of release to the environment as treated water is directed to a 100 ML water storage before further treatment and reuse within the development. The water storage will be located at the proposed golf course and will be combined with stormwater runoff ponds. The storage will be designed as a series of interconnected ponds rather than a single tank, with access points for fauna.

A more detailed description of wastewater management and of the overall water management cycle at the project is provided in Section 2.7.2. Management of sludge generated from the water management system is discussed in Section 2.11.1. Sludge will not be released to the environment, and will either be reused as a soil conditioner, or removed from PTP by an authorised waste management contractor, for recycling on the mainland, or disposal in an authorised landfill.

8.5.6.2 Management of Emergency Releases

Any sewage collection and treatment system must have an emergency release mechanism in the event that sewage cannot be treated. This is required for public health purposes, to prevent sewage from flowing back into houses or public areas and potentially exposing human populations to untreated sewage (NRMMC 2004). For a new sewerage system such as the project, there are three scenarios that must be considered that may lead to the need for an emergency release:

- A catastrophic failure of the sewage treatment plant and/or transfer network
- A power failure
- An extreme wet weather event where rainwater may infiltrate into the sewerage system (NRMMC 2004).

A number of mechanisms have been built into the design of the sewage collection and treatment system for the project to reduce the likelihood of an emergency release occurring:

- Provision of a minimum of four hours storage at average dry weather flow at each pump station. This will allow for most power failure scenarios as well as some mechanical failures. As the storage capacity is designed for peak daily flows, where mechanical failures occur at night when flows are significantly lower, a longer period of storage is available, compensating for delayed response times during night periods. During detailed design, a risk assessment will be undertaken to determine whether additional storage is required at the pump stations, based on risk of releases to sensitive environments.
- Provision of storage at the sewage treatment plant in the event of a mechanical or other failure. The amount of storage required will be determined during the detailed design process using a risk assessment approach to determine risk to the coastal environment.
- Duplication of key elements of the sewage treatment plant to reduce the likelihood of equipment or mechanical failure. The treatment plant will consist of two parallel modules of equal capacity such that if one malfunctions, the other can continue to treat at least part of the flow.
- Design of the sewage reticulation system to minimise wet weather inflows. This will include use of sealed “smart sewers” that minimise the amount of infiltration into the sewerage network. Smart sewers and other low infiltration sewers (such as pressure sewers) typically reduce inflow such that peaks flow would be reduced to around three to four times the average dry weather flow, which is more consistent with the design criteria for the STP. This substantially eliminates the risks associated with excess flows arriving at the STP.
- Design of the sewerage system and sewage treatment plant to allow for increased flows during wet weather, as this is generally unavoidable even where systems are designed and constructed

to minimise inflows. While design parameters will need to be agreed with the Gladstone Regional Council, typical requirements are that:

  - The sewerage system should be able to convey up to five times the average dry weather flow
  - The sewage treatment plant should be able to treat up to three times the average dry weather flow.

- The ability to pump out sewage from the sewage treatment plant and pump stations with a vacuum truck for disposal at a regional wastewater treatment facility in the event of a prolonged power failure or plant equipment failure that exceeds the storage capacity of the system. All weather access is available and hence, even in severe weather events, sewage will be able to be removed. Several large sewage treatment facilities with adequate capacity exist in the Gladstone area. Several large commercial waste contractors operate fleets of vacuum trucks in Gladstone.
- Provision for back-up power generation at pump stations and the sewage treatment plant
- 100% redundancy at pump stations, such that there is always a back-up pump available in the event of failure of the primary pump.

Regardless of these measures, engineering design standards and public health requirements for sewerage systems and sewage treatment plants require an emergency overflow point to be provided (NMRRC, 2004). An emergency discharge point will therefore be installed in an ephemeral waterway discharging into Boyne Creek. The discharge point will be located above highest astronomical tide, and scour protection will be placed below the discharge point so that erosion of the intertidal zone does not occur in the event that an emergency discharge is required.

With the proposed design measures in place, and a proactive maintenance program, it is highly unlikely that an emergency release of untreated sewage would occur. In the very unlikely event that such a release did occur, the volume and nature of the discharge is such that the overall load of contaminants that might be released would be low.

Allowing for an emergency discharge over a period of 24 hours, and given typical total nitrogen content of domestic sewage of 40 mg/L and total phosphorus content of 10 mg/L, an estimated 35 kg of nitrogen and 9 kg of phosphorus would be discharged into Boyne Creek. This compares with estimates made by OzCoasts of annual catchment inputs into the Colosseum Inlet estuary (including part of Boyne Creek) of:

- From current catchment conditions:
  - 2,200 kg/year of phosphorus
  - 8,400 kg/year of nitrogen

- From undeveloped (pre-European settlement) catchment conditions:
  - 400 kg/year of phosphorus
  - 4,300 kg/year of nitrogen. (http://www.ozcoasts.gov.au/search_data/detail_result.jsp accessed 2/4/2013)

Hence, the nutrient load that might be released from emergency overflows is very small in comparison to natural inputs into the estuary, and would occur on rare occasions, that is, less than one per cent of the time. The release would be short term and a combination of tidal flushing, and the assimilation potential in an estuarine environment would mean that any adverse impact on water quality or on aquatic habitats would not be discernible outside the immediate vicinity of the release and any detectable changes at the release point would be short lived, unlikely to extend beyond two to three days.

The release point is within the GBRWHA but outside the GBRMP. The nature of the release and capacity of the receiving environment is such that impacts on the OUV of the GBRWHA are not expected as such impacts would only occur if water quality was degraded. Threatened and migratory marine fauna known or potentially present in waters around HHI are unlikely to be in close proximity to the release point and as adverse water quality impacts are not predicted, indirect impacts on listed or migratory marine fauna are not expected.

Using the hazard and risk assessment methodology in Section 1.7.5, the likelihood of emergency releases of untreated wastewater is assessed as rare due to design measures incorporated into the system. In the unlikely event of an emergency release, the small quantity of contaminants, short term nature of the release and assimilative capacity of the receiving environment means that the consequence is minor and reversible.

No further assessment of potential impacts of emergency discharges on MNES is required. There is no routine discharge of treated wastewater.

8.5.6.3 Reuse of Treated Water

As part of the integrated water management strategy for the project, it is intended to treat sewage to a high standard and reuse recycled wastewater as follows:

- At a household level, for toilet flushing and garden irrigation
- For irrigation of landscaped areas at hotels and in public areas and sporting facilities
- For irrigation of the proposed golf course
- For fire fighting.

Treated water quality will be as follows:

- Biological oxygen demand <10 mg/L
- Suspended solids <2 mg/L
- Total nitrogen < 5 mg/L
- Total phosphorus <1 mg/L.

Pathogens will also be removed to safe exposure levels that are to be determined using the risk assessment process set out in the National Water Quality Management Strategy guidelines for recycled water use (November 2006). This risk assessment will be undertaken during the detailed design process.

Reuse of recycled water for toilet flushing does not have any potential environmental impacts as the treated wastewater is returned to the sewage system.

Irrigation with recycled water can be beneficial for the environment, both in terms of avoiding the need to discharge treated wastewater to aquatic environments and in provision of nutrients to plants, thus promoting healthy plant growth and effectively removing the nutrients from the water cycle. However, if recycled water is applied at rates greater than the assimilative capacity, which is a combination of the extent to which soils absorb nutrients and the amount of nutrients taken up by plants, adverse environmental impacts can occur as follows (see also National Water Quality Management Strategy, November 2006):

- Nutrient levels, salt or sodium may build up in soils, causing breakdown of the soil structure. This in turn harms plant growth and exposes soils to erosion
- Surface water runoff may mobilise nutrients in dissolved form, or adsorbed onto soil particles, and convey nutrients to the coastal and marine environment. Open coastal and marine environments have very low tolerance to increased nutrient levels and low assimilative capacity. Estuarine environments have a higher assimilative capacity due to higher primary production rates, but are still relatively intolerant to increased nutrient loads. In particular, increased nutrient levels will promote algal growth which can smother other organisms and, with some algal species, cause algal blooms (Department of Premier and Cabinet 2009)
- Nutrients that are not taken up by plants or absorbed onto soil particles may also percolate to groundwater. The extent to which this may have an adverse environmental impact depends on the groundwater systems in the area. As discussed in Section 6.4.3, there are limited groundwater resources underlying most of the proposed development footprint, with a shallow, perched, freshwater lens underlying the quaternary soils of the Golf and Beach Resort Precinct.

Modelling of the potential for irrigation using recycled water to cause environmental impacts was undertaken for the project and results are provided in Appendix D2. The MEDLI model (Modelling Effluent Disposal to Land Irrigation) was used to determine sustainable application rates such that nutrient build up in soils does not occur, stormwater runoff does not mobilise nutrients from irrigated areas and leaching of nutrients to groundwater does not occur.

The following factors were considered in the MEDLI modelling program:

- Soil capability and assimilative capacity
- Depth of groundwater and effect effluent is having on groundwater
- Nutrient loading and nutrient harvesting
- Sustainability of irrigation practices
- Wet weather storage capacity required to ensure minimal site run off and to avoid the need to irrigate in wet weather.

The model outputs looked at two typical soil types found within the development footprint, sandy loam soils (soil type Pzm1 shown on Figure 6.17) and sandy soils (soil type Qb3 shown on Figure 6.16). The modelling identified that:

- For sandy loam soils (Pzm1), average application rates of 14 kL/ha/day of recycled water could be achieved without causing adverse impacts to soils, the quality of surface water runoff and groundwater quality
- For sandy soils (Qb3), average application rates of 22 kL/ha/day of recycled water could be achieved without causing adverse impacts to soils, the quality of surface water runoff and groundwater quality.

Other Permean (P) and Quaternary (Q) soil types found within the development footprint would behave similarly under irrigation with recycled water, however, further modelling will be undertaken during detailed design to confirm application rates for all soil types. Ongoing monitoring of soil nutrient levels, and nutrient levels in rainfall runoff and groundwater will also be carried out to allow optimisation of application rates.

A water balance was also undertaken for the proposed development to demonstrate that the volumes of treated wastewater generated by the proposed development can be reused for irrigation without any need for discharge of treated wastewater. This is presented in Appendix D2.

In practice, the sustainable irrigation rates will also depend on rainfall, and if rainfall has occurred, less recycled water will be required. A large balancing storage will be provided for recycled water to store recycled water when it is not required for irrigation due to rainfall. Preliminary calculations have been undertaken by Cardno and determined a size of 100 ML (refer Appendix D2). This will be reviewed during detailed design.

8.5.6.4 Management of Water Recycling Schemes

The National Water Quality Management Strategy has provided comprehensive guidelines on the management and use of recycled water for domestic uses and irrigation. The Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (National Water Quality Management Strategy, November 2006) sets out a comprehensive risk management framework for identifying, evaluating and managing risk to public health and the environment from reuse of recycled water. This is shown in Figure 8-9.

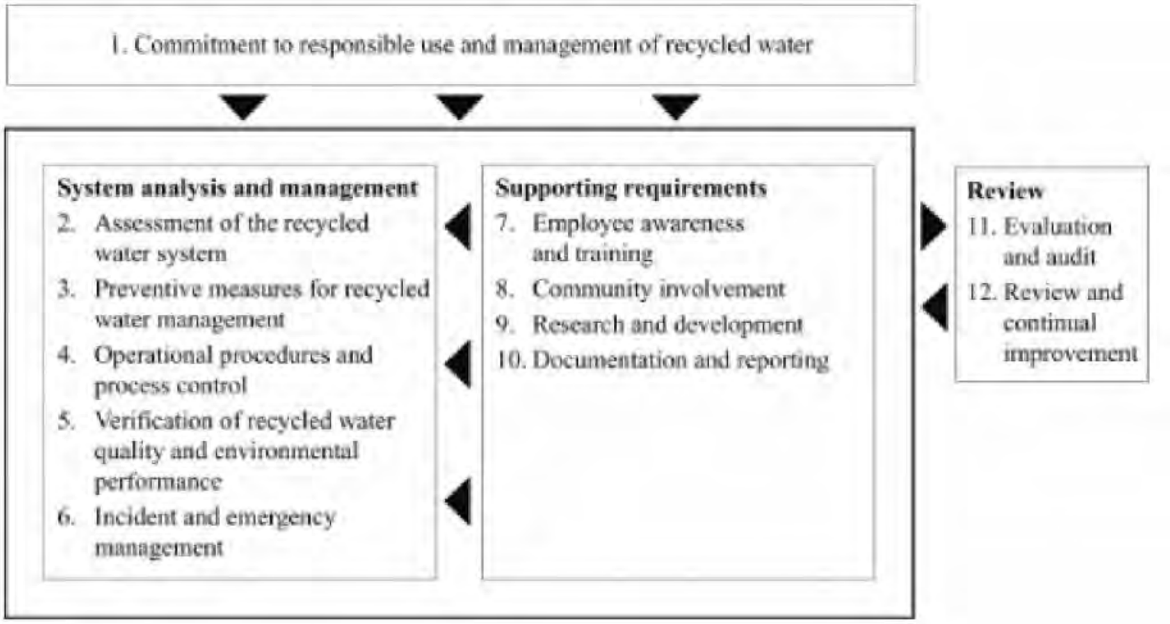

Figure 8-9 – Elements of the Framework for Management of Recycled Water Quality and Use (National Water Quality Management Strategy 2006)

The Queensland Government also regulates recycled water schemes under the *Water Supply (Safety and Reliability) Act 2008*. The operator of the PTP water reuse scheme will be required to be registered as a Recycled Water Provider under this Act, and to have in place an approved Recycled Water Management Plan and Validation Program. This is also a condition of the Queensland Coordinator-General's report.

A Recycled Water Management Plan "must be based on an appropriate risk management methodology and must include:

- A description of the recycled water scheme
- Details of the infrastructure used to produce or supply the recycled water and how it will be maintained
- The water quality criteria for the recycled water for the RWMP
- Identification of hazards and hazardous events that may affect the quality of the recycled water
- An assessment of the risks posed by these hazards and hazardous events
- Details that demonstrate how the risks posed by these hazards and hazardous events are proposed to be managed
- Details of operational and verification monitoring programs to show how the scheme will maintain compliance with water quality criteria

- An incident and emergency response plan for the scheme". (http://www.nrm.qld.gov.au/water/regulation/recycling/management_plan.html)

Where recycled water is provided via a dual reticulation scheme as is proposed for the PTP, the recycled water provider must also provide an education and risk awareness program for users.

The validation program contains the means by which the treatment processes and related plant and equipment to be used for treatment and production of recycled water will be tested to demonstrate that the quality of the recycled water consistently meets the water quality criteria for the scheme. The water quality criteria are determined through the Recycled Water Management Plan based on public health and environmental safeguard requirements.

The recycled water management plan will be reviewed and updated:

- Every five years
- Whenever monitoring indicates that new treatment or management procedures are required to meet required health and environmental exposure standards
- Whenever new legislation or standards are introduced
- Whenever there is a major change in the way that recycled water is managed and used.

The proponent of the project will become the registered recycled water provider for the initial phase of PTP, up until management of infrastructure is handed over to the regional council (see also Section 2.9). At this time, the regional council would become the registered recycled water provider.

8.5.6.5 Monitoring of Irrigation Areas

For the proposed golf course, an automated irrigation management system will be used which monitors soil moisture content using soil probes and automatically adjusts irrigation requirements to maintain an optimal soil moisture content. This is described in Section 2.9.3. This type of system is routinely used at golf courses and is therefore well-established technology with very low risk of malfunction leading to over-irrigation. More information on management of irrigation at the proposed golf course is provided in Section 2.9.3.

Stormwater runoff from the golf course will be directed to stormwater ponds as described in Section 2.7.3 and 2.7.4. This will prevent risk of direct mobilisation of nutrients to coastal waters.

For garden and landscape areas that are to be irrigated, watering will be by hand or by automated irrigation systems which will apply a set rate of recycled water. Maintenance staff associated with the various hotels and apartment/villa facilities will undertake garden and landscape area watering. The irrigation rate for gardens and other landscaped areas will initially be set at a lower rate of 5kL/ha/day as it is intended that the majority of landscape and garden plants will be species native to the central Queensland area which will typically require less water and re adapted to low nutrient conditions. This will also ensure that overwatering does not occur. Maintenance staff responsible for watering gardens and other landscaped areas will be able to override the automated system to increase the irrigation rate during dry weather and stop irrigation altogether during wet weather, based on observations of soil moisture, plant health and weather.

Effective use of recycled water for irrigation also requires ongoing monitoring such that any adverse impacts on soils, surface water quality and groundwater quality are quickly detected and corrected. Monitoring and associated performance indicators and corrective actions are set out in Table 8.7 and will be further developed based on the National Water Quality Management Strategy guidelines for recycled water use (November 2006).

Table 8.7 – Monitoring and Corrective Actions – Irrigation with Recycled Water

Monitoring Activity and Frequency	Corrective Actions in the Event that Performance Indicators are Not Met
Element: Treated effluent Location: Wastewater treatment plant outlet Frequency: Continuous, with monthly laboratory analysis Variables: Nitrogen, phosphorus, biological oxygen demand, pathogens Method: Laboratory analysis of grab samples	Undertake maintenance of wastewater treatment plant and make operational adjustments as required.
Element: Soils Location: All irrigation areas Frequency: Annually Variables: Nitrogen, phosphorus, salinity, sodium/sodicity, dispersivity, pesticides Method: Laboratory analysis of soil samples collected at a rate of 1 sample for every 10 hectares	Reduce rate of irrigation with recycled wastewater (if a permanent reduction in irrigation rate is required, additional irrigation can occur on the airstrip if required to manage volumes of recycled water).
Element: Soils Location: Golf Course Frequency: Continuous Variables: Moisture content, nitrogen and phosphorus Method: In-situ measurements	Reduce rate of irrigation with recycled wastewater (if a permanent reduction in irrigation rate is required, additional irrigation can occur on the airstrip if required to manage volumes of recycled water).
Element: Groundwater Location: Golf Course Frequency: Quarterly (to be reviewed after five years of golf course operation) Variables: Nutrients, major cations and anions, pesticides Method: Dedicated groundwater monitoring bores	Cease or reduce rate of irrigation with recycled wastewater. Continue to monitor until performance indicators are achieved. Recommence (or continue) irrigation at a lower rate (if a permanent reduction in irrigation rate is required, additional irrigation can occur on the airstrip if required to manage volumes of recycled water).
Element: Stormwater retention ponds Location: Golf Course Frequency: Quarterly, after major rain events Variables: Nutrients, pesticides Method: Laboratory analysis of grab samples	Cease or reduce rate of irrigation with recycled wastewater. Continue to monitor until performance indicators are achieved. Recirculate water in ponds over irrigation areas to assist with attenuation of nutrients. Recommence (or continue) irrigation at a lower rate (if a permanent reduction in irrigation rate is required, additional irrigation can occur on the airstrip if required to manage volumes of recycled water).

Monitoring Activity and Frequency	Corrective Actions in the Event that Performance Indicators are Not Met
Element: Coastal waters Location: ~200m offshore from western beach Frequency: As per marine water quality monitoring program Variables: Nutrients, pesticides Method: Laboratory analysis of grab samples	Cease or reduce rate of irrigation with recycled wastewater. Continue to monitor until performance indicators are achieved. Recommence (or continue) irrigation at a lower rate (if a permanent reduction in irrigation rate is required, additional irrigation can occur on the airstrip if required to manage volumes of recycled water).
Element: Soils Location: Landscaped areas and gardens Frequency: When irrigating Variables: Ponding, soil moisture Method: Visual observations	Increase irrigation rate if soils are dry and/or plants appear stressed Reduce irrigation rate or cease irrigation if ponding is occurring.

Monitoring of treated effluent and irrigation impacts will commence as soon as the proposed wastewater treatment plant is commissioned. An initial period of intense monitoring will be required to verify the recycled water quality in accordance with Queensland legislative requirements, and then routine monitoring will commence. Baseline monitoring of soil characteristics and groundwater and surface water quality will commence prior to commencement of irrigation to determine performance indicators and trigger levels for further monitoring and/or corrective action.

Monitoring in relation to the proposed golf course will be carried out by the golf course managers while monitoring of gardens and landscaped areas will be assigned to managers of relevant facilities. Overall (centralised) management of the recycled water system will be as described in Section 2.7. The proponent will be the water supply provider in the development phase of the project and this responsibility will then be handed over to Gladstone Regional Council.

The monitoring program set out in Table 8.7 will allow for early detection of any impacts arising from irrigation with treated wastewater. Provided that potential impacts are detected early and corrective action taken, any increases in nutrient levels in surface waters or groundwaters will be naturally attenuated once the contaminant source is removed. Similarly, for soils, early detection and corrective changes in irrigation practices should allow reversal of adverse effects from nutrient build up or salinity. If soils become sodic, this can be treated with application of a calcium carbonate based soil ameliorant.

8.5.6.6 Summary of Potential Impacts

By recycling treated wastewater, there is no requirement for a routine discharge of treated wastewater. An emergency discharge is required, however a range of design measures and contingency measures have been adopted to reduce the likelihood of a release of treated or untreated wastewater to “rare” (defined as frequency of occurrence less than 1% and in reality, likely to occur less than once every 10 years). In the rare event that a discharge does occur, the load of nutrients that would be released is small in comparison to catchment inputs and would be quickly dispersed and assimilated with negligible impacts on water quality and MNES predicted.

Treated wastewater will be used for toilet flushing and irrigation of the proposed golf course and gardens and landscaped areas. Preliminary modelling has identified sustainable application rates for irrigation and these will be confirmed during detailed design of each precinct. A balancing storage of about 100 ML will be provided to store recycled water when rainfall is sufficient to meet irrigation needs and to ensure sufficient recycled water is available when demands exceed the inflows to the STP.

Recycled water will be produced and supplied by a recycled water provider registered under the Queensland *Water Supply (Safety and Reliability) Act 2008* and this will require the provider to prepare and implement a Recycled Water Management Plan and Validation Program. The proponent will be the water supply provider in the development phase of the project and this responsibility will then be handed over the regional council.

Monitoring of all irrigation areas will be undertaken to determine whether adverse effects on soils have occurred, and if this is the case, irrigation rates will be adjusted and soils treated if necessary to restore damage. For the golf course, surface water and groundwater monitoring will also be undertaken. Prior to commencement of any irrigation, baseline soil, surface water and groundwater conditions will be established and trigger levels for corrective action determined. Monitoring will then detect whether irrigation rates are unsustainable and allow for corrective action, in the form of reducing irrigation rates or ceasing irrigation for a period of time. Impacts on soils, groundwater and surface waters will be reversible provided impacts are detected early and corrective actions implemented. The proposed monitoring program will provide the mechanism for early identification of the need for corrective action.

The assessment presented demonstrates that the recycled water system can be operated and managed with negligible impact on water quality and MNES, and that a robust monitoring program and effective corrective actions are available in the event that impacts do occur. Early detection of impacts via the monitoring program will mean that impacts on the receiving environment are reversible.

8.5.7 Management of Nutrients at the Proposed Golf Course

Use of recycled water will reduce the need for additional fertilisers to be applied to the proposed golf course. Fertiliser application will only be undertaken where in-ground sensors indicate sub-optimal levels of nutrients in the soil. If fertilisers are required, slow release fertilisers will be used in preference to more direct methods, and fertiliser will not be applied if wet weather is forecast in the two to three days after proposed application.

As fertiliser application is linked to irrigation with treated wastewater, a turf management plan will be developed for the proposed golf course and linked closely to the Recycled Water Management Plan (see also Section 2.6.3).

Monitoring of soil nutrients and matching of fertiliser application rates to soil nutrient levels will minimise the amount of nutrients that might be entrained in stormwater.

The ponds at the proposed golf course will serve a dual function as storage for recycled water and collection of stormwater runoff from the golf course for first flush and low flow events. For larger events (beyond the design standard for treatment), runoff will be bypassed to reduce the potential for the ponds to overtop during rainfall events. These ponds will be designed and operated such that there is sufficient capacity to capture and retain stormwater runoff from low flow events in rainfall events up to the one in ten year wet season (that is, on average, one wet season out of every ten). At this event, overflow will occur. As the golf course and surrounding area is flat and low lying, overland flow will be at low velocity and there will be some further attenuation of nutrient levels and some infiltration to soils.

Nutrient levels in the golf course ponds will be dictated by the nutrient levels in treated wastewater, which will be less than a maximum of 5 mg/L of total nitrogen and 1 mg/L of total phosphorus when transferred into the ponds. In the event that the ponds overflow, rainwater will provide significant dilution. The ponds will be lined to prevent loss to groundwater.

As nutrient levels in the ponds may be high enough at times to cause nuisance algal blooms, water will be treated by ultraviolet devices as required to control algae levels.

If water levels in the ponds builds up such that sufficient freeboard is not available, or nutrient levels become excessive, the water will be recirculated through irrigation of the golf course or air strip so that nutrient levels can be further attenuated through plant uptake.

A key aspect of nutrient management for the proposed golf course will be to prevent leaching of nutrients to groundwater, as shallow groundwater underlies the proposed golf course area. As discussed in Section 6.4.3, there is a low salinity groundwater lens underlying the southern part of the proposed golf course (see Figure 6.26). This lens is surrounded by zones of higher salinity groundwater which is presumably influenced by infiltration from marine waters. Recharge of this shallow groundwater would be from rainfall, and hence, in high rainfall years, there is potential for movement of groundwater towards the coastline. It is therefore important to carefully manage groundwater quality so that nutrients and other contaminants are not mobilised in high rainfall years.

MEDLI modelling described in Section 8.5.6 and Appendix D2 has determined initial nutrient application rates for the soil types present, and this will be explored in more detail as part of detailed design to ensure that soil types and nutrient assimilation capacities are well understood and subsurface leaching of nutrients does not occur.

Monitoring of soil nutrient levels at and below the assimilation zone will be used to test for any increase in soil nutrient levels that may in turn leach to underlying groundwater. Groundwater will also be monitored. Pre-construction monitoring of groundwater will determine baseline conditions and trigger levels for action. Trigger levels for protection of surface water and groundwater environmental values will be set conservatively in recognition of the sensitivity of adjacent receiving environments. Should soil or groundwater nutrient levels reach these trigger levels, the irrigation management system will be reviewed and irrigation and/or fertiliser application rates adjusted.

If required, recycled water can be irrigated onto the air strip, which is in the centre of HHI and not underlain by shallow groundwater. This provides an alternative means of disposing of recycled water if nutrients in soils, groundwater or stormwater at the golf course reach pre-determined trigger levels.

Groundwater monitoring will be conducted every six months for the first five years of golf course operation to allow for early detection of nutrient build up in groundwater. This will mean that, if nutrient levels in groundwater do increase, corrective action can be initiated before a significant quantity of nutrients has been released and before mobilisation to coastal and marine environments can occur. The groundwater monitoring frequency will be reviewed after five years to determine whether a lower frequency of monitoring can provide an adequate level of protection.

In summary, monitoring activities relevant to management of nutrient levels from fertiliser include:

- In-ground sensors to measure soil nutrient levels
- Regular validation (annual or more frequently if required) of accuracy of in-ground sensors through laboratory testing of soil nutrient levels
- Monitoring of irrigation rates and nutrient levels in recycled water
- Monitoring of weather forecasts (rain)
- Monitoring of water quality in stormwater detention ponds and stormwater runoff
- Monitoring of nutrient levels in groundwater
- Monitoring of coastal water quality.

The golf course operator will undertake monitoring, however monitoring will also be linked to the Recycled Water Management Plan and overall environmental management plan for the project so that golf course management can be matched with the recycled water management system. The proponent will ensure that adequate funding and resources is available for this. The proposed marine water quality management program will also provide a means to check the effectiveness of nutrient management at the golf course (see also Section 8.5.18.1).

With the proposed management approach, and early detection of the need for corrective action through a comprehensive monitoring program, mobilisation of nutrients from fertilisers and/or irrigation with recycled water to sensitive coastal and marine environments is unlikely to occur. Impacts on water quality and subsequent indirect impacts on MNES can therefore be avoided. Significant impacts are not expected, provided that ongoing vigilance in management and monitoring is maintained.

8.5.8 Contamination of Stormwater

8.5.8.1 Overview

Cardno (2013b Appendix D2) prepared a design for the project stormwater system based on the WSUD principles (Water by Design 2007) and the Queensland Urban Drainage Manual (DNRW 2008). The stormwater management system is described in Section 2.7.3 and Appendix D2.

Adopted stormwater quality and quantity objectives are described in Table 8.8.

Table 8.8 - Adopted Stormwater Quality and Quantity Objectives- Hummock Hill, Operational Phase

Criteria	Design Objective
Water Quality Design Objective	Treatment to provide median concentrations of sediment and nutrients similar to those predicted for existing (undeveloped) situation, and providing a load reduction in comparison to urban development without controls in place in excess of the following: • 85% reduction in total suspended sediment • 70% reduction in total phosphorus • 45% reduction in total nitrogen • 90% reduction in gross pollutants.
Frequent Flow Management	Capture and manage rainfall from all impervious surfaces of the proposed development as follows: a. Where the fraction of the catchment that is impervious is less than or equal to 40%, capture at least the first 10 mm of run-off from impervious surfaces b. Where the fraction of the catchment that is impervious is greater than40%, capture at least the first 15 mm of run-off from impervious surfaces c. Run-off capture capacity replenished within 24 hours of the run-off event.
Waterway Stability Management	Limit the post-development peak one-year average recurrence interval event discharge within the receiving waterway to the pre-development peak one-year ARI event discharge.
Peak Flow Management	No increase in the peak flow discharged from any part of the site for events with recurrence intervals up to 100 years.
Flow Management	No runoff from developed areas shall be allowed to discharge to the Open Coastal areas on the northern side of the island.
Golf Course Recycled Water Storages	Overtopping allowed only once every 10 wet seasons on average.

Note: Design objectives based on Table 2.2 and Table 2.4 of Urban Stormwater Quality Planning Guidelines 2010

A range of stormwater quality improvement devices are proposed as summarised in Table 8.9.

Table 8.9 - Summary of Proposed Stormwater Treatment

Precinct	Existing Drainage	Proposed Development	Proposed Stormwater Treatment
Golf and Beach Resort Precinct	Flat to undulating sand ridges, sandy soil with high infiltration rate. Few defined drainage lines, no wetlands. Defined drainage line parallel to northern beach, drains to west but no defined outlet (would wash out in rain events).	Beachfront tourist hotel Beachfront villas and apartments Golf course villas, cottages and apartments Golf clubhouse Golf course Lifesaving club	Bioretention swales/basins within the road reserve where possible. Rainwater tanks and reuse adopted for all Class 1 and 3 buildings. Lake/pond system through golf course providing irrigation and lined to prevent infiltration.
Headland Resort Precinct	Flat to gently sloping sandy soils with high infiltration rate. No defined drainage lines, no wetlands. Rises to steeper headland in West with rockier soils and lower infiltration rates. Minor drainage to west beach (west of headland). Existing (dry) drainage channel parallel to northern beach conveys some flows west, remainder discharges overland to northern western beach or via southern drainage path towards airstrip and ultimately Boyne Channel.	Resort hotel Holiday homes, apartments and cottages Foreshore homes Motel Village apartments Caravan park and camping Village retail and commercial Community services centre Public Parking	Bioretention swales/basins within the road reserve where possible. End-of-line bioretention / detention basins elsewhere, including areas where lots drain directly offsite, directed via a diversion swale. Rainwater tanks and reuse adopted for all Class 1 and 3 buildings, in addition to the Caravan Park (with additional apartment roof catchment).
Ocean View Resort Precinct	North-south ridge with relatively steep slopes Several significant gullies to the west, with more consistent topography grading to the east Small dam on the lower eastern region	Spa retreat Ocean view villas	Spa and western catchment directed to end-of-line bioretention / detention basins. Eastern catchment treated by swale/basins within the main access road reserve. Southern catchment draining to downstream apartments for treatment.
Colosseum Precinct	Significant ridge to the south-west of precinct, draining directly to Boyne Channel. Other moderate hilly features throughout precinct draining to lower lying areas and south to estuary. Large dam within ridge 'saddle'	Bushland holiday villas Colosseum apartments and villas Colosseum village Research centre Boat ramp and storage Airstrip Island services	Bioretention swales/basins within the road reserve where possible. End-of-line bioretention / detention basins elsewhere, including areas where lots drain directly offsite, directed via a diversion swale. Rainwater tanks and reuse adopted for all Class 1 and 3 buildings

8.5.8.2 Stormwater Treatment Effectiveness

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 5.1.16) by eWater was used to test the effectiveness of the proposed stormwater control measures against the water quality objectives for reduction in contaminants compared to the “no treatment” scenario.

The assessment identified that the load percentage reduction targets were achieved and in most cases exceeded for each precinct and for each area within each precinct

Total suspended solids concentrations in stormwater released from the stormwater treatment devices were estimated to be less than 2 mg/L for all areas except for the caravan park, where sediment concentrations of 2.3 mg/L were predicted. This compares to water quality guidelines for total suspended solids of 15 mg/L for enclosed coastal waters, where the stormwater runoff is directed, and 2 mg/L for open coastal waters. This also compares to the predicted concentration of suspended solids in runoff from natural parts of the island which was calculated as being of the order of 3.5 mg/L.

The total phosphorus concentration in stormwater released from the stormwater treatment devices was predicted to be less than 0.01 mg/L for all precincts. This compares to water quality guidelines of 0.02 mg/L for enclosed and open coastal waters. It also compares to a predicted total phosphorus concentration of the order of 0.014 to 0.018 mg/L for runoff from undeveloped areas. Note that, as is the requirement throughout Queensland, dog owners will be required to collect and dispose of their dog’s faeces.

The total nitrogen concentration in stormwater released from the stormwater treatment devices was predicted to be between 0.15 mg/L and 0.28 mg/L. This compares to water quality guidelines of 0.2 mg/L for enclosed coastal waters and 0.14 mg/L for open coastal waters. This also compares to the predicted concentration of total nitrogen in runoff from natural parts of the island in the order of 0.21 to 0.26 mg/L.

The proposed stormwater system includes litter traps which are expected to remove over 90 per cent of litter and other gross pollutants. The bio-retention systems proposed as part of the stormwater management system trap litter and the resultant visual impact is a strong driver for maintenance. The litter removal afforded by the bio-retention systems will be enhanced by litter baskets located at the points of discharge from each system.

As it is important to avoid plastics entering the marine environment (see also Section 8.7.4), there will also be an ongoing awareness raising program regarding littering and litter receptacles will be provided in all public places.

Grass swales will be placed along roadways to trap and biodegrade hydrocarbons in road runoff. Hydrocarbons in runoff from other areas will generally be absorbed to sediments and sediment removal will also remove most hydrocarbon load. In small quantities, hydrocarbons can be expected to break down within days through physical, chemical and biological degradation processes. Oil/water separation devices will be placed in car parking areas wherever these are exposed to incident rainfall.

8.5.8.3 Monitoring and Management

The proposed stormwater management system will require regular maintenance to remain effective. This will be carried out by the proponent in the first 16 years of the proposed development and then handed over to local government as described in Section 2.11.4. Funding for ongoing management will be raised through rates. A detailed management plan will be prepared detailing the standard maintenance measures and the rectification measures to be employed with respect to each stormwater treatment asset. The plan will be based on best practice publications such as the Healthy Waterways, Water by Design *Maintaining Vegetated Stormwater Assets* (2012).

The proponent proposes a coastal and marine water quality monitoring program and stormwater runoff monitoring program which will be used to validate the effectiveness of the stormwater system and provide for early identification of any unpredicted impacts. The monitoring program will commence on commencement of construction. Should suspended solids or nutrient levels in the receiving environment be identified as elevated above water quality objectives, the stormwater management system will be reviewed and augmented as necessary to improve pollutant removal rates. Impacts will be reversible provided early detection occurs.

The proposed stormwater management system and management plan will also be reviewed when guidelines such as the Water Sensitive Urban Design guidelines are updated.

8.5.8.4 Summary

Given the modelled effectiveness of the stormwater in removing sediment and nutrient inputs, and that litter and hydrocarbons will also generally be removed, contamination of adjacent coastal waters due to stormwater runoff is not expected. With the proposed treatment measures in place, the development will exceed current best practice requirements with respect to load reduction and achieve discharge concentrations that match the existing environment.

8.5.9 Changes in Overland (freshwater) Flow Characteristics

Apart from potential contamination of stormwater, development can also impact flows of stormwater.

In an undeveloped catchment, rainfall initially infiltrates soils and leaf litter, with runoff commencing once soils have reached saturation in terms of moisture content (the amount of rainfall that is required to saturate soils depends on the soil type). Development converts vegetated surfaces into hard surfaces such as pavements and roofs. This has the effect of reducing infiltration rates and increasing the volume and velocity at which incident rainfall runs off into the environment. This in turn can increase scouring and erosion along overland flow paths and watercourses.

Earthworks can also change local topography, resulting in changes in the area of land draining to a particular drainage line and discharge point. Where the area of land gets larger the volume of runoff increases and this can cause erosion in drainage lines, as well as overtopping of banks on watercourses. By contrast, where the catchment gets smaller, the volume of runoff may reduce and downstream ecosystems that depend on freshwater may be deprived.

Increases in slope can also increase the velocity of rainfall runoff and reductions in slope may reduce runoff, causing waterlogging.

The stormwater system proposed for the project has taken these factors into consideration, setting objectives for frequent flow management and waterway stability management as shown in Table 8.8. The key design consideration is incorporation of detention basins that temporarily store runoff and provide peak flow rates that match existing conditions. This matching of peak flow rates will occur for a range of events to ensure that development does not result in increased flows and velocities for both smaller more frequent events and larger less frequent events, thereby maintaining waterway stability. The control of the peak flow discharged from developed areas will be accompanied by measures aimed at managing the frequency at which runoff occurs, thereby replicating existing conditions to as great an extent as possible. This will be achieved by the use of rainwater tanks, bio-retention systems and other measures which collect and then slowly release runoff, mimicking existing systems. The targets established with respect to frequent flow management are as follows:

- Where the fraction of the catchment that is impervious is less than or equal to 40%, capture at least the first 10 mm of run-off from impervious surfaces
- Where the fraction of the catchment that is impervious is greater than 40%, capture at least the first 15 mm of run-off from impervious surfaces

These initial capture rates account for reduced infiltration due to pavements, buildings and other hard surfaces. The bio-retention basins, in combination with other measures then gradually releases these flows, and any flows over and above the initial amount captured so that the runoff characteristics downstream do not change. In this way, aquatic and riparian ecosystems that are reliant on freshwater input are protected and scouring and erosion of downstream drainage lines and watercourses is avoided.

The master plan for the project has also been developed to minimise changes in topography. In steep areas, roadways follow contours, to minimise earthworks required. Development codes included in the Plan of Development minimise the amount of landform change that can occur on individual lots.

Visual monitoring of stormwater drainage paths and watercourses will be undertaken until the stormwater system in each precinct is fully established and has been operational for five years. Pre-development conditions will be recorded using physical stream characteristics defined in the Australian River Assessment System (AUSRIVAS). If scouring, erosion of destabilisation of drainage pathways and watercourses is identified, the proponent will:

- Review and augment the stormwater detention system such that the required flow objectives are achieved
- Reinstate and stabilise the damaged area.

With these design measures in place, and with monitoring of the effectiveness of the measures in mimicking pre-development flow conditions, minimal changes to pre-development quantities of rainfall runoff are expected. Impacts on water quality, marine habitats and associated MNES values from changes in hydrological characteristics are negligible and unacceptable impacts are not expected.

8.5.10 Saline (brine) waste

A desalination plant will be used to provide potable water supply for the PTP. This is described further in Section 2.4.2.

It is not proposed to discharge brine from the proposed desalination plant. As discussed in Section 2.7.2 and 2.11.2, brine will be directed to a lined evaporation pond, and crystalized material removed for reuse or disposal as required to maintain capacity in the pond.

Evaporation exceeds rainfall in the Gladstone area, with average annual evaporation at the Gladstone weather station being 1,752 mm, against an average annual rainfall of 894 mm.

Preliminary analysis of desalination pond requirements indicates that four ponds, each 65 m x 65 m would be required to manage the brine stream (see Appendix D). Evaporation ponds would be lined with either clay or a geotextile, typically with permeability less than 0.01 mm/day.

The evaporation ponds will be designed so that they do not capture any overland flow and can contain incidental rainfall in up to a 1 in 100 year storm event, in which case a controlled overflow would be provided via the proposed stormwater system. In such a weather event, dilution of brine would be more than adequate to ensure that salt levels did not exceed those of the receiving waters. In any case, the salt is derived from the receiving waters and does not contain any constituents not already present in the receiving environment.

Saline waste is not expected to cause any change to coastal or marine water quality, even when an overflow occurs, and impacts on the MNES values present are not expected.

8.5.11 Hydrocarbon Contamination of Surface Water and Groundwater

Contamination of groundwater may arise from spills and leaks of hydrocarbons from a number of sources. While locations and quantities of hydrocarbons that may be stored and used at the PTP will be a matter for detailed design, the following may potentially be required:

- Petrol, diesel and/or outboard fuel may be stored at service station which would be located at the Colosseum precinct (Colosseum Village)
- Construction contractors may have temporary diesel storages for refuelling construction vehicles and equipment, or may use mobile tanker trucks
- Small quantities of diesel would be stored at the sewage treatment plant and sewage pump station(s) to power generators. Quantity stored would be less than 5,000 litres.

In Queensland, fuel storages greater than 500m^3 (~400 kL) require approval under the *Sustainable Planning Act 2009/Environment Protection Act 1994*. All fuel storages and related activities such as fuel dispensing and operating a service station must also comply with the requirements of the *Work Health and Safety Act 2011*.

These approvals will require fuel storage, handling and dispensing facilities to be designed, constructed and operated to meet Australian Standard 1940: *Storage and Handling of Flammable and Combustible Liquids*. This Australian Standard requires a range of environmental protection measures to prevent spills, leaks, fire or explosion including:

- Specifications for storage tank design and operation
- Secondary containment in the event that the main storage vessel should fail
- Automatic shut-off valves
- Inspection and maintenance procedures.

The following additional codes and standards are relevant to storage of hydrocarbons, and to selling fuel and must be complied with to meet requirements under the *Work Health and Safety Act 2011*:

- Model Code of Practice Managing risks of hazardous chemicals in the workplace 2012, Safe Work Australia
- AS 4897: The design, installation and operation of underground petroleum storage systems
- AS 4977: Petroleum products-Pipeline, road tanker compartment and underground tank identification
- AS 4976: The removal and disposal of underground petroleum storage tanks.

These standards include a range of measures to prevent and contain spills and leaks of hydrocarbons from storages or during refuelling operations (Workplace Health and Safety Queensland 2012).

Mobile refuelling tankers must also comply with requirements of the *Transport Operations (Road Use Management) Act 1995*, and by reference, the Australian Code for Transport of Dangerous

Goods by Road and Rail. This includes requirements for design and operation of the tanker, training of the operator and preparedness to deal with spills and other potential emergency events.

These mandatory requirements significantly reduce the likelihood of a spill or leak of hydrocarbon. Given this low likelihood, and the relatively small quantities of fuels and other hydrocarbons that may be stored and used at the project, mean that the overall risk to the environment generally, and to MNES specifically is very low, and impacts arising from this aspect are considered negligible. Further assessment of impacts on specific MNES is not required.

Individuals may also have personal supplies of small quantities of fuel in storage containers, with typical volumes in the order of 10-20 L. Requirements under the Queensland *Environmental Protection Act 1994* require individuals to generally avoid causing environmental harm, and Section 440ZG prohibits release of contaminants such as fuels and oils to waters.

The *Transport Operations (Road Use Management) Act 1995* and associated regulations prohibit filling of containers with fuel that do not meet requirements of the Australian Code for Transport of Dangerous Goods by Road and Rail. This means that only properly designed containers can be used for storage of small quantities of fuel. This further reduces the risk of spills or leaks due to failure of the container.

Even if spilt, the small volumes of fuels that would be stored in personal storage containers would be insufficient to cause groundwater contamination. If released directly to surface waters, a small area of water may be affected, however natural processes of mixing, volatilisation, photo/chemical breakdown and biodegradation would reduce hydrocarbon concentrations to levels where toxic effects on marine organisms would not be expected within hours of any spill. If released to soils, volatilisation, chemical breakdown and biodegradation processes would also act to remove small quantities of hydrocarbons quickly.

Given the small quantities involved, legislative controls and mandatory measures to minimise risk of spills or leaks of hydrocarbons from personal fuel containers, the risk to the environment generally, and to MNES specifically is very low, and impacts arising from this aspect are considered negligible. Further assessment of impacts on specific MNES values is not required.

Potential hydrocarbon contamination arising from recreational boat use is discussed in Section 8.5.16.

8.5.12 Contamination of Surface Water and Groundwater by Pesticides

8.5.12.1 Overview

Pesticides may be required as part of turf management at the proposed golf course. Pesticides may also be required for weed and insect control in landscaped and garden areas of the project and also for weed control programs in the proposed conservation area. Pesticides may also be applied as a pre-treatment and for ongoing protection of buildings against termites.

While pesticides have an important role in managing weeds and insects that can have harmful effects on humans and the environment, the chemical constituents of some pesticides can be toxic to other organisms than the target organisms. Toxic effects may occur at the application site if spray application techniques result in overspray onto adjacent areas. Pesticides may also be conveyed to aquatic environments by stormwater flows, either in dissolved form, or adhered to particulates.

If poorly managed, pesticide use within the project has the potential to impact on sensitive coastal and marine environments surrounding HHI. Pesticides in catchment runoff is identified as a very high risk to the GBR, with the Great Barrier Reef Outlook Report noting that "*there are traces of pesticides in the Great Barrier Reef environment, the impacts of which are largely unknown*" (GBRMPA 2009).

A wide range of chemicals are used as pesticides and each has different properties both in terms of biodegradability and persistence in the environment and toxicity to non-target organisms. Increased awareness of the potentially harmful effects of pesticides has led to development of pesticides that are rapidly biodegradable, and of lower toxicity to non-target organisms. GBRMPA has identified seven herbicides (diuron, atrazine, ametryn, simazine, hexazinone, 2,4-D, and tebuthiuron) that are in widespread use in catchments draining to the Great Barrier Reef ecosystem (GBRMPA 2009).

The toxicity of potential herbicides, pesticides and fungicides will vary depending on the receptor, with toxic responses often varying considerable between mammals, birds fish or crustaceans. Typical acute toxicities are presented in Table 8.10. The relative toxicity varies considerably between species, with mammals and birds generally being more resistant to toxic effects than fish and crustaceans. Toxicity associated with aquatic plants varies over a range of compounds presented in Table 8.10.

Table 8.10 – Toxicity Ranges for Common Herbicides, Pesticides and Fungicides (after Radcliffe, 2002)

Type	Name	Mammals Acute LD50	Birds Acute LD50	Fish 48-96h LC50	Crustaceans 48-96h LC50	Aquatic plants LC50
Herbicides	2,4-D	<320 – 1,000	270 – 1,000	0.0014 - 4.8	0.0016 – 0.144	0.104 - 0.485
	Glyphosate (Roundup®)	750 – 5,600	>3,800	0.011 – 9.217	0.003 – 0.062	>380
	Metsulfuron methyl	>5,000	>5,000	>150	>150	1.56
	Atrazine	750 – 3,090	>2,000	0.5 - 71	5.7 - 540	0.021 - 0.377
Insecticides	Chlorpyrifos	32 – 1,000	8 - 112	1.3 - 542	0.00006 – 0.001	0.01 – 0.33
	Diazinon	300 - 400	3 - 41	0.022 - 24	0.0002 – 0.14	2.5 - 20
Fungicides	Chlorothalonil	>6,000	5,000	0.25 – 0.43	0.07 – 1,000	0.17 – 0.27
	Captan	250 – 15,000	2,000 – 5,000	0.056 – 0.072	7 - 10	1 - 74

Notes:
Toxicity for mammals, birds and bees = acute toxicity (mg/kg)
Toxicity for fish, crustaceans, and aquatic plants = acute toxicity (µg/L)

8.5.12.2 Legislative Controls

A range of legislative controls are in place at both Federal and State government levels to manage the potentially harmful impacts of pesticide use.

The Australian Government administers the National Industrial Chemicals Notification and Assessment Scheme. This scheme requires assessment of human health and environmental impacts of all chemicals prior to registration for use in Australia. Assessment includes review of ecological toxicity data. Under the Commonwealth *Industrial Chemicals (Notification and Assessment) Act 1989*, it is illegal to use chemicals, including pesticides that are not registered under this Act.

The Australian Pesticides and Veterinary Medicines Authority provide a centralised registration of agricultural and veterinary chemicals for use in Australia under the requirements of the *Agricultural and Veterinary Chemicals Act 1994* and related legislation. One of the roles of this authority is to evaluate potential health and environmental impacts of pesticides and ban those that may have harmful effects.

Under the Queensland *Pest Management Act 2001*, a person must hold a licence to undertake pest management activities. Licenced pest management technicians must demonstrate competency in selection of appropriate pesticides for a particular situation, safe application techniques for pesticides, safe storage and handling of pesticides and safe disposal of materials contaminated with pesticides.

All chemicals and chemical formulations used in Australia are required to follow labelling requirements which includes information on hazards and safe disposal. Material safety data sheets are also required to be prepared by manufacturers and/or retailers and these data sheets must contain information on environmental hazards, safe storage and handling requirements and disposal of the chemical itself and any contaminated packaging or other material contaminated with the chemical. This means that information on safe handling, use and disposal of all pesticides is readily available to users.

8.5.12.3 Gardens and Landscaped Areas

As it is proposed to use plant species native to central Queensland for the majority of landscaping and garden planting, the need for use of pesticides in gardens and landscaped areas is expected to be minimal.

Where weed control is required, weeding will be undertaken by hand wherever practicable, however maintenance staff may need to use weedicides on gardens and landscaped areas associated with hotels, units and villas and other facilities within the development from time to time.

The most commonly used pesticide for weed control in landscaped areas and gardens is glyphosate, a broad spectrum weed killer that targets broad-leafed plants (http://www.apvma.gov.au/products/review/completed/glyphosate.php). A material safety data sheet for the commercial glyphosate formulation Roundup ® concentrate reports the following ecological toxicity results:

- Fish: LC50 (96 hr) (rainbow trout) 1080 mg/L
- Invertebrates: EC 50 (48 hr) (*Daphnia magna*) 488 mg/L (http://www.termidor.com.au/brochures-and-labels/msds/, accessed 2/04/2013).

These test results indicate low ecological toxicity for glyphosate (see also Duke and Powles, 2008).

The MSDS also reports that glyphosate absorbs strongly to soil, thus minimising potential for residue to dissolve in stormwater runoff. If soil particles with adhered glyphosate are entrained in stormwater, this could result in mobilisation of glyphosate. However, the proposed stormwater management system is designed to capture sediment and minimise sediment release to coastal waters and hence, there is low likelihood of glyphosate being mobilised (see also Section 8.5.8).

In terms of environmental fate, glyphosate is microbially degraded with half-life in soils estimated at 12-91 days and half-life in water estimated at 3-174 days. Glyphosate remains strongly bound to soils and has minimal potential to leach to groundwater and presents minimal opportunity for marine organisms to be exposed to toxic effects (Duke and Powles 2008).

Use of glyphosate for weed control is therefore not expected to present any environmental risk to terrestrial or aquatic habitats or organisms.

8.5.12.4 Managed Conservation Area

As part of the establishment of a managed conservation area across the balance of HHI (see also Section 8.3.8) a weed control program will be conducted. Hand removal of weeds will be preferred in sensitive locations, however is not likely to be practical across the entire area and some use of chemical weedicides is expected to required. Glyphosate is effective against some of the weeds present on HHI, including lantana.

The weed control program will be developed as part of the management plan for the conservation area and will include selection of appropriate weedicides and weed control methods using the following considerations:

- A risk based assessment of weed levels, and whether chemical weed control is warranted to improve conservation outcomes
- Identification of sensitive areas where use of chemical weedicides is not appropriate
- Selection of weedicides that are targeted to weed species present
- Selection of weedicides on the basis of:
    - Eco-toxicity
    - Potential for mobilisation to the wider environment
    - Biodegradability
    - Overall environmental fate.
- Development of application methods that ensure that:
    - the minimal amount of weedicide required for effective weed control is used
    - weedicide is carefully applied to avoid overspray and over-application.

This management approach will allow safe use of weedicides in the conservation area such that weed levels are reduced or controlled without causing harm to the surrounding coastal and marine environment.

8.5.12.5 Biting Insect Control

Midges and mosquitoes are common in the central Queensland area, particularly in coastal areas. A relatively small proportion of the development footprint is located in an area which could receive insect pests during ideal conditions for dispersal from wetland habitats. Prevailing south-easterly winds could move insect pests into the Colosseum Precinct of the PTP. Physical modification of biting insect habitat or chemical control is not considered necessary or appropriate, given the sensitivity of receiving environments.

The proponent will develop and implement a vector management plan in accordance with the Queensland Health *Guidelines to minimise mosquito and biting midge problems in new development areas* (2002) and in consultation with Queensland Health and the Gladstone Regional Council as part of the construction and operation of the project. The vector management plan will examine non-chemical means to control biting insects including:

- Breaks in any continuous vegetation lines leading to residential areas
- Design of stormwater systems, including road drainage, to eliminate standing water except in designated retention ponds
- Insect screens on buildings.

With regard to artificial waterbodies that will be created as part of the development, the colonisation by mosquitoes and biting midges can be managed by design measures set out in the Queensland Health *Guidelines to minimise mosquito and biting midge problems in new development areas* and the *Australian Mosquito Control Manual* (Mosquito Control Association of Australia 2002).

Chemical control of biting insects is therefore not expected to be required.

8.5.12.6 Termite Control

Termites are active throughout central Queensland and measures are required to protect wooden components of buildings from termite damage. As all buildings associated with the project will be constructed new, termite control, in the form of physical barriers, will be incorporated into all designs. However, if infestations occur, chemical termite control may be required.

Where chemical treatments are required for termites, these must be applied by licenced pest management technicians and application is very specific to the building components requiring protection, with very limited opportunity for release from the application site to the environment. Australian Standard 3660 Protection of Buildings from Subterranean Termites - Prevention, Detection and Treatment of Infestation governs the prevention and control of termites including design controls and chemical treatment.

Low toxicity chemicals are available for use in termite treatment. For example Termidor ® is a commonly used pesticide in Australia. Ecotoxicity data obtained from a material safety data sheet for Termidor indicates low toxicity to standard test organisms as follows:

- Toxicity to fish:
  - LC50 (96 h) 0.25 mg/l, *Oncorhynchus mykiss*
  - LC50 (96 h) 0.0852 mg/l, *Lepomis macrochirus*
  - LC50 (96 h) 0.43 mg/l, *Cyprinus carpio.*
- Toxicity to Aquatic invertebrates:
  - EC50 (48 h) 0.19 mg/l, Daphnia magna.

- Aquatic plants:
  - EC50 (96 h) 0.068 mg/l (biomass), Scenedesmus subspicatus (http://www.termidor.com.au/brochures-and-labels/msds/,accessed 2/04/2013).

Given the standards and controls in place in relation to prevention and treatment of termite infestation, and that low ecotoxity termite treatment chemicals are available, it is very unlikely that terrestrial or coastal habitats, or plants and animals, will be exposed to toxic chemicals as a result of termite control.

8.5.12.7 Golf Course Management

Pesticides are likely to be required at the golf course to address weed and insect infestations in turf areas. As discussed in Section 2.9.3, the proposed golf course will be managed in accordance with the Australian Golf Environmental Initiative of the Australian Golf Course Superintendents Association (http://environment.agcsa.com.au/). This will include implementation of the e-par® environmental management system for the golf course. In relation to pest management, an integrated pest management plan will be developed.

Methods to minimise the use of chemical pest management methods and manage chemical pesticides where these are required are described in Section 2.9.3. Chemical pesticides will only be used where non-chemical methods are not available or practicable, and application methods will minimise potential for residue to contaminate surface waters or groundwater. Pest resistant turf species will be selected.

As a wide range of pesticides (weedicides and insecticides) may be used on the proposed golf course at various times and in response to various pest issues that may arise, it is not practical to present toxicity information for potential pesticides. The approach to selecting pesticides for use will be based on determining:

- Whether there is a non-chemical means that can be used to address the pest problem
- Selection of an appropriate pesticide based on:
  - Eco-toxicity
  - Potential for mobilisation to the wider environment
  - Bioaccumulation potential
  - Biodegradability
  - Overall environmental fate, including toxicity and fate of breakdown products.

Where chemicals are required for pest control, consideration will also be given to rates and methods of application such that:

- The minimal application rate is used
- Pesticides are not applied if rain is forecast in the next 24 hours
- Application methods target only areas of actual pest infestation
- Application methods avoid overspray or over-application
- A buffer strip of at least 2 metres is maintained around water bodies and up-slope of sensitive native habitat (http://environment.agcsa.com.au/resources/pesticide_storage_and_application accessed 2/04/2013, Branham et al, 2005).

As discussed above, any residual pesticides that remain after application will also be entrained in stormwater and conveyed to stormwater bioretention ponds. Pesticide levels in ponds will be monitored quarterly (see also Table 8.7) and if pesticide contamination is detected in stormwater bioretention ponds, corrective actions can be applied as follows:

- Adjust pesticide application rates and methods to reduce pesticide residues
- Consider whether alternative pesticides are available if biodegradation is not occurring quickly enough
- Reapply water from the bioretention ponds as irrigation water. This will allow more time for pesticides to biodegrade before any release to the stormwater system.

The stormwater/recycled water ponds have been designed not to overflow in nine out of ten wet seasons; that is, on a statistical basis, overflow is only expected every ten wet seasons. In this event, stormwater ponds will overflow to the environment, following existing drainage lines and ephemeral watercourses. Rainfall in a large event will provide for a high level of dilution and if there is any residual pesticide contamination in the stormwater ponds, this will be diluted. Toxic effects are therefore not expected.

Ongoing monitoring of levels of pesticides in receiving waters and groundwater beneath the proposed golf course will be undertaken as set out below.

Although most pesticides available for use in Australia are biodegradable, grass clippings may contain residual pesticides. The preferential waste management approach for grass clippings is to use these as a soil enhancer, however testing of grass clippings will be required before determining where clippings can be placed. If low levels of pesticide residue remain, it may be appropriate to compost grass clippings for reuse in turf management. If higher levels of pesticides remain and are not broken down by the composting process, disposal to an authorised waste disposal facility will be required. There are a number of commercial waste management contractors operating in central Queensland that will be able to take this waste if necessary.

Containers and equipment that have been used in the application of pesticides will contain residual pesticides and may require cleaning from time to time. The correct procedure for disposal of any pesticide contaminated rinsate will depend on the pesticide used and requirements set out in the relevant material safety data sheet will be followed.

Pesticides will be stored and handled in accordance with the requirements of the material safety data sheet. A dedicated storage area will be provided at the proposed golf course including secondary containment and protection from accidental damage.

While use of pesticides at the golf course could be potentially harmful to the surrounding environment, adequate controls are in place to minimise the extent to which pesticides used at the proposed golf course may be mobilised to the surrounding environment. A high level of information is available on the safe use and management of commercially available pesticides and adequate information is available to assess the environmental risks and fate associated with selected pesticides and put appropriate management measures in place.

Management of pesticide use at the proposed golf course will take place within the framework of a specially adapted environmental management system e-par® that has been developed for the Australian Golf Course Superintendents Association's Australian Golf Environmental Initiative.

Regular monitoring will detect whether pesticides are being mobilised to the coastal and marine environment and allow corrective action to be taken in the event that aquatic ecosystem guideline limits for pesticides established under the Water Quality Guidelines for the Great Barrier Reef marine Park (GBRMPA 2010) and Australian Water Quality Guidelines (ANZECC/NHMRC 2000) are reached. Pesticide selection will consider the potential for bioaccumulation and persistence in soils and aquatic environments and avoid pesticides that may bioaccumulate or persist for long periods of time. Hence, if guideline values for pesticides are exceeded, pesticide residues will be removed from the environment through physical or biodegradation provided that corrective actions are applied at the source to prevent further inputs.

With these measures in place, adverse impacts on surface water and groundwater quality and associated impacts on aquatic organisms are not expected. Water quality in the GBRWHA/NHP and GBRMP will not be degraded such that ecological functions are affected and listed threatened or migratory species known or potentially present in the waters surrounding HHI will not be affected.

8.5.12.8 Management of Pesticide Contaminated Packaging

Pesticide contaminated packaging will be generated wherever pesticides are used.

For the golf course, where larger volumes of pesticides will be required, the golf course manager will either:

- Negotiate with suppliers to take packaging back
- Dispose of packaging through an authorised commercial waste contractor.

For other areas where pesticides are used, disposal of packaging will be as per the relevant material safety data sheet for that pesticide. The proponent will ensure that managers of all facilities where pesticides are used are aware of correct disposal procedures and will provide safe storage facilities for pesticide containers and residues used in facility maintenance until these can be removed for disposal.

8.5.12.9 Monitoring

Monitoring for pesticide residue will be conducted as follows:

- Water samples will be collected from stormwater detention basins and stormwater outlets. Sampling will occur at least annually, as early as possible in the wet season when catchment runoff is likely to contain highest levels of contaminants
- At the same time, water samples will be collected from the coastal and marine environment around HHI to test for pesticides
- Sediment samples will be collected from areas adjacent to stormwater outlets every two years
- Samples of grass clippings will be tested for pesticide residue on an annual basis.

Should testing indicate pesticide levels in excess of guidelines set in the Water Quality Guidelines for the GBRMP (GBRMPA 2010) or Australian Water Quality Guidelines (ANZECC/NHMRC 2000), an investigation will be conducted into the source of pesticides and pesticide management approaches reviewed and revised to prevent pesticide releases.

As some pesticide contamination may have already occurred from catchment runoff and use of pesticides in former grazing activities, pre-construction testing of soil, sediment and water quality will be undertaken to establish a baseline.

Information collected will be made available to the GBRMPA and Queensland Department of Premier and Cabinet, which administers the ReefPlan.

The proponent will conduct monitoring until management is handed over the local government, at which point, local government will continue the monitoring program.

8.5.12.10 Summary

While pesticides can present a high risk to aquatic environments, it has been demonstrated that, through a combination of careful selection of appropriate pesticides and established management practices, the potential for mobilisation of pesticides to the coastal and marine environment is minimal.

Regular monitoring will detect any build-up of pesticides in the coastal and marine environment and allow correct actions to be applied before guideline levels are exceeded.

Impacts on water quality and aquatic habitats are considered negligible and no further assessment of potential impacts on specific MNES is required.

8.5.13 Contamination of Surface Water and Groundwater by Other Hazardous Materials

8.5.13.1 Paints

During construction, acrylic or oil based paints will be utilised. Quantities may be in the order of several hundred litres, however, individual packages will generally not exceed 20 L. Paints are low in toxicity and given the location of use, there is no likelihood of spillage directly to surface waters. If spillages do occur, the quantity would be less than 20 L and would generally be within or in close proximity to a construction site. Paint is slightly viscous and easily contained and cleaned up if spilt. Overall, the potential for paint to cause contamination of surface waters and groundwater is negligible.

8.5.13.2 Cleaning Chemicals

Cleaning chemicals may be used during construction or operation. These may include various types of detergents, solvents and bleach. In high concentrations, these materials can be toxic to organisms in fresh and marine ecosystems and, if spilt on land in large quantities, may inhibit plant growth within the area of spill. The quantities to be stored and used will be small, in the order of several hundred litres, and package sizes will be less than 20 L. When in use, cleaning chemicals are typically diluted with water.

If spills of undiluted or diluted cleaning chemicals occur to land, quantities released would be small and readily assimilated into the environment.

If cleaning chemicals are released to stormwater systems, there is potential for chemicals to enter the marine environment. Stormwater quality improvement devices will provide opportunity for attenuation of cleaning chemicals through evaporation, photo/chemical degradation and settlement, however it is also considered appropriate to prevent release of cleaning chemicals to the stormwater system through worker training and general awareness raising.

The sewage system will be able to treat and remove cleaning chemicals from treated wastewater.

The risk of environmental harm arising from storage and use of paints and cleaning chemicals is considered very low, and associated impacts are therefore considered negligible.

Nevertheless, the following requirements will be included in the environmental management plan:

- All spills of paints and cleaning chemicals to be cleaned up immediately, with contaminated soils placed in a plastic bag or secure container for disposal
- Requirement for cleaning chemicals and solutions not to be disposed of in stormwater to be included in awareness raising information given to visitors and residents and covered in training for workers
- Stormwater inlets will be marked with signs noting that hazardous materials are not to be disposed of to the stormwater system.

8.5.13.3 Solid and Hazardous Waste

Solid and hazardous waste will be generated by the project. These are identified in Section 2.9.1, together with appropriate management approaches. While all solid and hazardous wastes can cause environmental impacts if not managed properly, with proper collection, storage and disposal systems, environmental impacts will be minimal.

All wastes anticipated to be generated as a result of the project can be readily managed through existing waste management services and infrastructure, such that improper storage and disposal, and associated impacts, will be avoided.

Impacts on MNES may arise if there is an accidental spill of a hazardous waste, and this spill enters surface water or groundwater systems. However, given the small quantities of hazardous wastes that might be generated, and that contracting services are available in the region to provide low-risk management services for these wastes, impacts on MNES are not expected.

8.5.14 Removal of the Causeway - Water Quality Impacts

As discussed in Section 8.3.6, the opportunity to partially remove the artificial causeway structure has been identified.

Partial breaching of the causeway would involve removal of the rocks and logs that make up the causeway from within Boyne Creek using an excavator at low tide. The excavator would access from the causeway itself, and hence would not track across the intertidal or subtidal surfaces. It would take two to three days to perform this work.

During this time, there would be some minor disturbance to the bed of Boyne Creek and release of sediments from the bed of the creek and also any sediments entrained in the causeway structure. Quantities released to the water column would be less than about 50 kg and the effect is likely to be negligible within several hundred metres of the causeway. The duration of any effect would be very short and sediment levels within tens of metres of the location of disturbance would be comparable to, or lower than, the effect of stormwater runoff from a minor rain event.

Excavation is not required as the rocks and logs sit on top of the bed of the channel, and hence potential acid sulfate soils would not be disturbed or displaced. Note that there are no other materials that make up the causeway apart from rocks and logs. As the causeway is located in a dynamic tidal environment, any fine material has been washed away in the 100 years since the causeway was first placed across Boyne Creek.

Seagrass monitoring identified patches of *Zostera capricorni* with *Halophila ovalis* along the north and south banks of Boyne Creek to the west of the causeway in 2002, however, these beds were not present in monitoring undertaken in 2009 (see also Section 6.6.2). Seagrass beds along the banks of Boyne Creek are not likely to be affected by the restoration of flows as only the middle section of the causeway is to be breached and hence any changes in flows are expected to be restricted to the centre of the channel. Sediment plumes may float across the area where seagrass beds have been observed, but would be similar in duration and turbidity levels to those experienced during a minor rain event and not likely to have any impact on primary productivity. Measurable change sin turbidity levels are not expected to extend to the more persistent seagrass beds in Seven Mile Creek as these are five kilometres from the causeway.

While minor, short term degradation of water quality will occur within the GBRWHA/NHP, effects will be localised to within several hundred metres of the causeway, with duration in the order of two to three days. The effect on water quality would be similar to sediment levels that arise from surface runoff from a minor rainfall event. However, sediment released will be through re-suspension rather than additional sediment load.

The causeway is over 8 km by sea from the GBRMP and no impact is expected given the small quantity of sediment mobilised and the distance by sea.

8.5.15 Human Waste Discharges from Recreational Boats

It is expected that 50-150 recreational boats may launch from the proposed boat ramp at PTP each weekend, with peaks coinciding with long weekends and school holiday weekends (see Section 8.8.4.2). It is not illegal to discharge sewage/human wastes from a small recreational boat of the type that would be operating in waters around HHI and these boats are not required to have holding tanks for sewage. A survey of recreational boating undertaken in 2006 indicated that, for the Central Queensland area, 60% of recreational boat trips were less than 5 hours, and 12% more than 11 hours (Maritime Safety Queensland 2007). Boat occupancy was three or less persons for 83% of trips (Maritime Safety Queensland 2007).

Given the short duration of trips and low passenger numbers per boat, the amount of human waste that might be released to the marine environment is expected to be low and likely to be well within the assimilative capacity of the marine and estuarine environment. Using the impact assessment methodology set out in Section 1.7.4, the severity of the impact is negligible and therefore the impact is assessed as not significant in terms of impacts on MNES values.

GBRMPA has identified that there is a lack of data regarding impacts of recreational boating on water quality and hence, while impacts are expected to be negligible, the proponent will monitor water quality to detect any degradation that might occur.

As the proposed water quality monitoring program will include monitoring for nutrients and microbial contaminants in waters around HHI, any degradation of water quality will be detected. If significant increases in nutrient concentrations occur, or faecal coliform contamination is detected above water quality objectives, this will trigger investigation into the source (see also Section 8.5.18). If human waste from recreational boats is identified a significant source, the proponent can investigate mitigation measures such as providing a specialised tank for human waste disposal at the proposed boat ramp. However, this measure would only be implemented if it was clear that human wastes from recreational boats were causing water quality impacts.

If water quality and marine ecosystem monitoring indicates adverse impacts on water quality from recreational boats, the proponent will seek to work with GBRMPA, Queensland DNPRSR and other stakeholders to determine additional controls that may be required. The proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

8.5.16 Hydrocarbon Discharges from Recreational Boats

As discussed in Section 8.8.4.2, it is expected that 50-150 recreational boats may launch from the proposed boat ramp at PTP each weekend, with peals coinciding with long weekends and school holiday weekends. Based on profiles of registered boats available from Queensland Department of Transport and Main Roads, most of these will be trailerable boats with outboard motors.

Outboard motors discharge cooling water and this cooling water can contain small amounts of hydrocarbons through contact of cooling water with parts of the engine and incomplete combustion of fuels in 2-stroke engines.

A review of water quality impacts of recreational boating by Milliken and Lee (1990) for the US National Oceanic and Atmospheric Administration concluded that “normal” levels of recreational boating did not appear to be having a toxic effect on aquatic communities. In the marine environment, hydrocarbons are generally not persistent as vaporisation, biodegradation and physical and chemical weathering processes act relatively quickly to convert hydrocarbons into component molecules (PGM Environment 2012). Diesel fuel will generally break down within about 24 hours (PGM Environment 2012).

Hence, low concentration releases of hydrocarbons will generally not accumulate in the water column. Hydrocarbons that settle on sediment may persist for longer but in shallower, well oxygenated waters, will still be subject to reasonably rapid biodegradation. Figure 8-10 shows a graphic representation of natural degradation and weathering processes on hydrocarbons released to the marine environment.

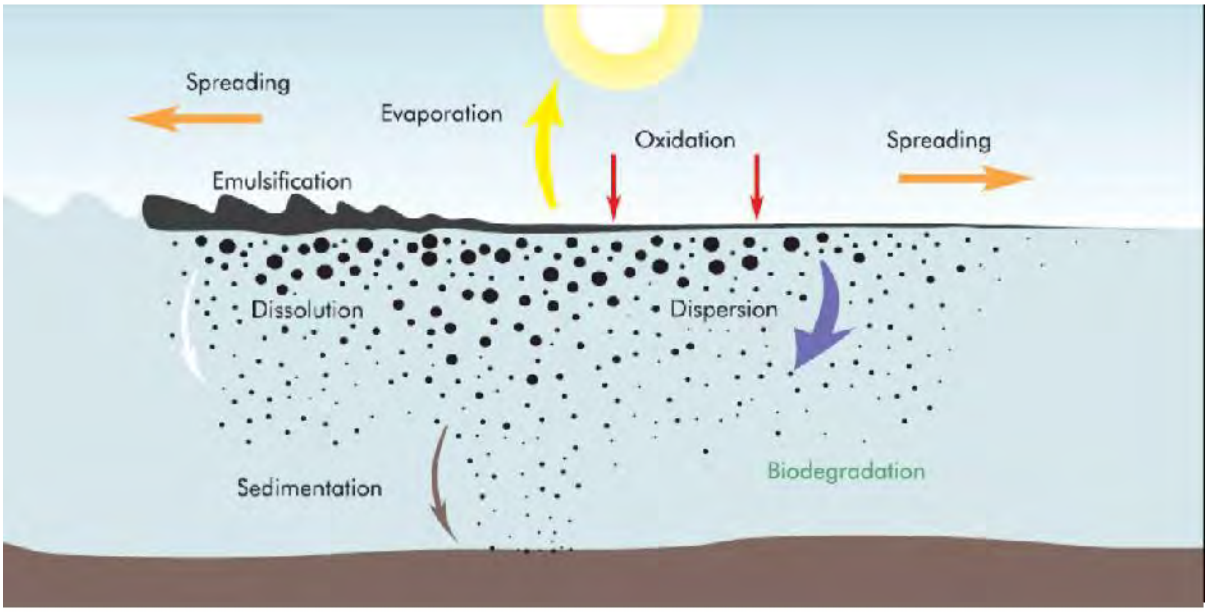

Figure 8-10 – Biodegradation and Weathering Processes Acting on Spilled Oil (ITOPF 2002)

The Australian Government does not currently regulate air and water emissions from outboard engines (http://www.environment.gov.au/atmosphere/airquality/publications/marine-outboard-engine.html accessed 3/3/2013). Overseas schemes to regulate emissions from engines on small recreational boats have focussed on noise and air emissions rather than emissions to water.

Given the low boating numbers, the short persistence of hydrocarbons in the marine environment and the flushing flows within the estuary, release of hydrocarbons from recreational boat engines is not considered likely to cause any measurable impact and is not considered further in terms of impacts on MNES (see also Milliken and Lee 1990, PGM Environment, 2012). However, the EMP will include monitoring of hydrocarbon levels in estuarine waters and sediments.

Requirements under the Queensland *Environmental Protection Act 1994* require individuals to generally avoid causing environmental harm, and Section 440ZG prohibits release of contaminants such as fuels and oils to waters. However, it is recognised that spills of outboard fuel may occur from time to time. The type of small trailerable recreational boats that would be utilised in the area are typically not refuelled in the water, but rather, fuel tanks are filled at land based service stations. Typical fuel quantities carried on trailerable recreational boats undertaking day trips are in the order or 20-50 L, and there are regulations in place regarding the types of containers used to carry fuel such that failure of containment is not expected. Spills would only occur in the event of a burst fuel line or other engine malfunction, and then the amount of fuel that might be released would be in the order of several litres.

Waterfront refuelling facilities for larger (non-trailerable) boats will not be available at the PTP.

As with releases of hydrocarbons in engine cooling water, the small quantity involved, the short persistence of hydrocarbons in the marine environment and the available tidal flushing would mean that impacts on water quality would be negligible and this aspect is not assessed further in terms of impacts on MNES.

GBRMPA has identified that there is a lack of data regarding impacts of recreational boating on water quality and hence, while impacts are expected to be negligible, the proponent will monitor water quality to detect any degradation that might occur (see Section 8.5.18).

If water quality and marine ecosystem monitoring indicates adverse impacts on water quality from recreational boats, the proponent will seek to work with GBRMPA, Queensland DNPRSR and other stakeholders to determine additional controls that may be required. The proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

8.5.17 Removal of Existing Contamination

As discussed in Section 6.3.8, there is an abandoned cattle dip near the headland. The location is shown in Figure 8.11 and a photo of the cattle dip is shown in Figure 8-12. Previous investigations have found that the cattle dip and immediate environs are contaminated with arsenic and some pesticides. There are also several sites near the old homestead that may potentially be contaminated with hydrocarbons.

Figure 8-11 - Aerial View of Headland Showing Cattle Dip Location

Figure 8-12 – Abandoned Cattle Dip

The homestead and associated buildings contain asbestos, however this does not present any risk to MNES.

The scale of soil and groundwater contamination is not widespread due to the limited volumes of hazardous contaminants used. Potential areas of impact are may be limited to areas of initial contamination. Potential hazardous contaminants that may be associated with historical activities are outlined in Table 8.11.

Table 8.11 – Historical Activities, Potential Hazardous Contaminants and Exposure Pathways

Activity	Hazardous Contaminant	Information
Cattle Dip	Arsenic	Detected by Woodward Clyde (1993) in soils surrounding the cattle dip (range 2.5 – 337 mg/kg). Water solubility of 0.13 mg/L. May be present in a number oxidation states with As(V) predominant in oxidising conditions and As(III) reducing conditions. Can be toxic in high concentrations (an essential mineral in small concentrations). Relatively immobile and remains near the source of contamination both laterally and vertically. Mode of toxicity = various but mostly from inorganic arsenic forms.
Cattle Dip	Ethion	Detected by Woodward Clyde (1993) in residual water at the bottom of the dip. Water solubility 0.6 mg/l and a K_{OC} of 4.19. Relatively immobile and remains near the source of contamination both laterally and vertically. Mode of toxicity = acetylcholinetserase inhibitor (acts on the central nervous system).
Fuel Storage	Diesel	A number of fuel drums remain in a storage shed in the former homestead with some minor staining of soil. Water solubility = 5 mg/L. Combination of various hydrocarbons (aliphatic and aromatic). Can be mobile in larger quantities. Mode of toxicity = various.
Buildings	Asbestos Cement	Former homestead outbuildings constructed with asbestos/cement sheet. Immobile unless in small (approx less than 1 mm) fibrous form. Mode of toxicity – carcinogen if fibres are inhaled.

In order to prevent ongoing environmental harm and to make the land suitable for its intended use, remediation of identified contamination of soils will be conducted in accordance with the *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (1998)*. A suitably qualified contaminated land consultant will undertake this work in accordance with the Queensland DEHP requirements.

The first step in this process will be a Stage 2 Contaminated Land Investigation which will further delineate the lateral and vertical extent of contamination, including an assessment of the potential for contaminants to have leached to groundwater. As groundwater in the headland area is relatively deep, it is unlikely that groundwater testing will be required, but this can be determined once depth profiles of potentially affected soils have been undertaken.

The main outcome of the Stage 2 Contaminated Land Investigation Report will be to determine the appropriate remediation approach which, in this instance, is most likely to involve removal of contaminated soils. If this is the case, the Stage 2 report will delineate the area and depth of soils that need to be removed. The Stage 2 report will be submitted to Queensland DEHP which administers contaminated land through the EP Act. Once Queensland DEHP has agreed to the remediation approach, remediation can commence.

As earthmoving equipment is required, remediation will not be commenced until the bridge is in place. In the interim, an exclusion zone will be established around the cattle dip area and any other contaminated areas to prevent accidental disturbance.

If the contaminated material is to be removed for disposal at another location, a permit will be required under the EP Act to move contaminated soil. The most likely disposal location will be a suitable authorised landfill in the area, such as the Benaraby landfill.

Following completion of any remediation, validation testing will be undertaken to check that the full extent of contamination has been removed. A Validation Report will be submitted to Qld EPA to demonstrate that the site has been remediated and is now suitable for its intended use. The volume, mode of transport and destination of any contaminated soils removed from the site will also be recorded as part of the Validation Report.

The Queensland DEHP will review the validation report and, if satisfied, inform Gladstone Regional Council, as assessment manager for material change of use applications in relation to PTP, that the land is suitable for the proposed use.

As the quantity of soil that needs to be removed is small, and the site is located inland and away from watercourses, there is very little likelihood that contaminants will be released to the environment during the remediation process. Once remediation is complete, there will be an overall benefit in terms of reduced leaching of contaminants to the environment.

8.5.18 Monitoring Programs

8.5.18.1 Marine Water Quality Monitoring Program

The proponent is committed to, and it is a condition of the Coordinator-General's report for the project that a marine water quality monitoring program be developed and implemented in waters around HHI. This program will allow early detection of any changes in water quality that might in turn cause degradation of habitat for marine threatened and migratory animals, impacts on those features in waters around HHI that contribute to the OUV of the GBRWHA or degradation of habitats of the GBRMP. A range of contingency mitigation measures have already been described in Section 8.5 in the event that degradation of water quality is attributable to PTP and are summarised in Section 8.5.18.3.

The water quality monitoring program will be designed in accordance with:

- Queensland Water Quality Guidelines (DEHP 2009a)
- Urban Stormwater Quality Planning Guidelines (DEHP 2010)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)
- Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA 2009)
- The Queensland Government Monitoring and Sampling Manual, Version 2, (DHEP 2009b).

An initial review of baseline data available from other regional monitoring programs (PCIMP and Gladstone Ports Corporation) will be completed and additional baseline sampling will be undertaken as required to establish water quality objectives prior to commencement of any construction activity. Location specific water quality objectives will then be developed. Monitoring locations will be selected based on:

- Proximity to locations where existing water quality monitoring data is available, to allow direct comparison
- Proximity to sensitive habitats such as seagrass beds in Seven Mile Creek and Creek Rocks, to the north of HHI
- Proximity to impact areas such as stormwater discharge points and the boat ramp
- Distance from impact locations (control sites).

The parameters to be monitored, relevant guideline values and laboratory levels of reporting (LORs) are shown in Table 8.12. Additional parameters may be added during development of the detailed WQMP.

Table 8.12 – 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
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 8.12 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. WQOs 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 EPA Water Quality Sampling Manual (currently 2009). 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. Each monthly water sampling event will also include profiling of temperature, salinity, dissolved oxygen, pH, and turbidity at each monitoring location.

Sub-regional 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.

8.5.18.2 Marine Ecological Monitoring Program

The proponent is committed to, and it is a condition of the Queensland Coordinator-General's report that a Marine Ecological Monitoring Program be developed and implemented for the waters surrounding HHI. The Marine Ecological Monitoring Plan will 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 MEMP will target those features of the area that contribute to the OUV of the GBRWHA such as habitat for marine turtles, dugong, fish and other animals recognised in the statement of OUV (see Section 7.2 and Appendix C.2).

The MEMP will include baseline monitoring including at least two seasonal monitoring events (winter and summer) over at least 12 months prior to commencement of construction activities.

The key objectives of this program will be to:

- Test the effectiveness of proposed measures to manage surface water runoff in maintaining marine water quality. Results from this will in turn inform management of surface water runoff in new and existing developments
- Examine effects of recreational boating on habitats for listed threatened and migratory species and habitats that are part of the GBRMP
- Explore links between ecological and water quality trends, particularly in relation to relationships between catchment runoff issues and impacts on marine ecosystems

- Provide information on marine ecosystem characteristics of the Rodds Bay area of the GBRWHA. This area, south of Port Curtis, remains one of the least studied areas of the GBRWHA. The information gathered through characterisation of the marine ecosystem will be made publicly available for use in broader studies on the diversity and ecological transition characteristics of the Great Barrier Reef
- Provide information to support GBRMPA and DotE research on vulnerability of the GBR ecosystem to climate change. Climate change is identified as the most significant risk to reef ecosystem health and the Commonwealth and Queensland governments have committed to an extensive research program in their Interim Response to the Great Barrier Reef Outlook Report 2009.

8.5.18.3 Corrective Actions

Although no significant water quality impacts have been identified in this assessment, should the marine water quality and marine ecological monitoring programs identify degradation of water quality or marine habitats, the proponent will undertake an investigation into the causes of this degradation and identify appropriate corrective actions.

While there may be a wide range of causes and a correspondingly wide range of suitable corrective actions, some key potential issues and corrective actions are identified in Table 8.13. This demonstrates that, in a worst case scenario where impacts are worse than predicted, corrective actions are available.

Table 8.13 – Corrective Actions – Water Quality Issues

Potential Cause of Degradation	Corrective Action
Stormwater runoff –general	Review effectiveness of stormwater system in removing contaminants Upgrade or otherwise augment stormwater system to increase removal of pollutants.
Stormwater runoff – golf course and other recycled water irrigation areas	Reduce irrigation intensity immediately by diverting some irrigation water to the air strip Review irrigation rates and adjust as necessary to reduce nutrient application Review wastewater treatment processes and provide additional treatment or improve existing treatment to increase level of contaminant removal
Stormwater runoff from construction areas	Review erosion and sediment control measures and apply additional measures or treatment as required to reduce sediment levels
Contamination with pesticides – any source	Review pesticide use across the PTP and restrict or change the type of pesticides used and/or pesticide application methods Cease pesticide use until review is complete
Contaminants arising from recreational boating	Work with GBRMPA, Queensland DNPRSR and other stakeholders to determine additional controls that may be required. The proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

8.5.18.4 Consistency with Existing Monitoring Programs

The proponent will seek to collaborate with the PCIMP, GBRMPA and GPC to ensure that data collected is compatible and consistent with monitoring activities undertaken by these organisations. The proponent will seek to become a contributing member of the PCIMP program.

This consistency will mean that results from the programs are comparable and will strengthen overall body of knowledge on water quality and ecosystem health in the Port Curtis and Rodds Bay areas. This in turn will assist future proponents as well as guide ongoing management of environmental values.

8.5.19 Summary of Potentially Significant Impacts

Potentially significant impacts on EPBC Act listed threatened ecological communities and species and migratory species associated with direct impacts on terrestrial, intertidal and marine habitat are identified in Table 8.14.

Table 8.14 – Summary of Potentially Significant Impacts – Water Quality

Potential Impact	Threatened Plants, Animals and Ecological Communities	Migratory Species
Disturbance and subsequent oxidation of acid 8-94ulphate soils	Negligible impact	Negligible impact
Releases of sediment from bridge and boat ramp construction	Negligible impact	Negligible impact
Terrigenous sediment arising from erosion	Negligible impact	Negligible impact
Disposal of groundwater intercepted during construction	Negligible impact	Negligible impact
Wastewater treatment and reuse	Negligible impact	Negligible impact
Use of fertilisers on the proposed golf course	No impact	No impact
Changes in overland flow characteristics	Negligible impact	Negligible impact
Contamination of stormwater	No impact	No impact
Saline (brine) waste	No impact	No impact
Hydrocarbon contamination of surface water and groundwater	Negligible impact	Negligible impact
Contamination of surface water and groundwater by pesticides	Negligible impact	Negligible impact
Contamination of surface water and groundwater by other hazardous chemicals	Negligible impact	Negligible impact
Removal of the causeway (water quality impacts)	Negligible impact	Negligible impact

Potential Impact	Threatened Plants, Animals and Ecological Communities	Migratory Species
Sewage discharges from recreational boats	Negligible impact	Negligible impact
Hydrocarbon discharges from recreational boats	Negligible impact	Negligible impact
Remediation of contaminated sites	Potential benefit	Potential benefit

With the proposed design of the stormwater and wastewater management systems, and proposed controls and monitoring programs, adverse impacts on water quality in the GBRWHA/NHP and GBRMP are not expected. Hence, habitats of the GBRMP and features of the marine environment that contribute to the OUV of the GBRWHA/NHP are not expected to be degraded.

Using the methodology for assessing significance of impacts set out in Section 1.7.4, water quality related impacts are not significant and unacceptable impacts are not expected.

8.6 Impacts on Individual Terrestrial Threatened and Migratory Species

8.6.1 Overview

Direct impacts on terrestrial threatened and migratory animals, and native terrestrial animals generally may arise from:

- Injury or mortality during vegetation clearing activities
- Injury or mortality from vehicle strike
- Injury or mortality from aircraft strike
- Increased predation.

Direct impacts on threatened plants may also occur as a result of vegetation clearing.

8.6.2 Mortality or Injury of Animals from Vegetation Clearing

During vegetation clearing, arboreal animals and ground dwelling animals are vulnerable to injury or mortality. Nests and burrows will also be lost.

Of the listed threatened or migratory animals potentially occurring on HHI, impacts may occur as follows:

- Black-breasted button quail (if present) will not be affected as clearing will not take place within or immediately adjacent to potential habitat
- The vulnerable grey-headed flying fox as this species is not known to roost on HHI and forages at night when clearing will not be taking place
- While yakka skink, collared delma and brigalow scaly-foot are not known to occur, suitable habitat exists and if these animals are present, vegetation clearing would potentially kill these animals. This is discussed further in Section 9.2.2.

- The migratory terrestrial bird white-bellied sea-eagle has not been observed nesting on HHI, but may potentially nest in trees affected by clearing. Potential impacts of vegetation clearing on the white-bellied sea-eagle are further discussed in Section 10.3.2.
- The migratory terrestrial bird rainbow bee-eater, which has been observed on HHI nests in burrows and may be affected by clearing. This is discussed further in Section 10.3.2.
- Other terrestrial migratory bird species present or likely to be present forage aerially and rarely roost or perch. These birds would be readily able to move away from clearing activities. Further assessment of impacts of vegetation clearing on these birds is not required
- Of the marine migratory birds known or potentially present, tern species will not utilise habitat within the development footprint and egrets which may use shallow wetland, pond and dam areas will be able to move away from clearing activities. Further assessment of impacts of vegetation clearing on these birds is not required
- Migratory shorebird roosting and foraging habitat does not generally feature vegetation, and in any case, with the exception of a small area of saltmarsh at the bridge and boat ramp, no construction activity will take place within migratory shorebird habitat. The habitat at the bridge and boat ramp location has been identified as only supporting single birds.
- Only very limited clearing will take place in potential water mouse foraging and nesting habitat. During the day time, when clearing would take place, these animals may be sheltering in mangrove areas but are quite mobile and would be able to move into immediately adjacent habitat if disturbed. Only 0.1 ha of mangrove is to be cleared, and a previous survey did not identify water mouse in this area.

While impacts on listed threatened and migratory species are not expected, impacts on smaller ground dwelling native animals and arboreal mammals may occur, and this in turn may affect overall fauna abundance on HHI. As 50% of mature habitat trees are to be retained across the development footprint this will reduce impacts on arboreal animals. A spotter-catcher will be utilised during clearing in areas likely to provide habitat for native animals.

Impacts are not likely to be such that fauna diversity is impacted (for example, through local extinction of a particular species) and hence, biodiversity values of the GBRWHA/NHP are not expected to be affected.

While EPBC Act listed threatened plants have not been identified in surveys to date, a pre-clearing survey will be undertaken and if any plants listed as threatened under EPBC Act or Queensland NC Act are identified, the plants will be avoided or relocated where practicable. Relocation or destruction of plants will require a permit under the NC Act.

As this impact would only impact on terrestrial species, there is no potential for impact on the GBRMP. As terrestrial biodiversity is identified as a component of the OUV of the GBRWHA, impact on terrestrial animals and biodiversity generally could diminish the OUV. As discussed in Section 7.2, the contribution that terrestrial fauna diversity of HHI makes to the OUV of the GBRWHA is minor and as impacts on fauna diversity are not expected, impact on the contribution that HHI makes to the OUV of the GBRWHA in this regard is not significant. However, further discussion is provided in Section 11.5 on overall potential for the contribution that HHI makes to the biodiversity component of the OUV to be diminished.

8.6.3 Mortality or Injury from Vehicle Strike

As development of the PTP progresses, a road network will be developed, including a main arterial road running north-south across HHI (see Figure 2.3). This road will bisect habitat areas that are to be retained to the east and west.

Traffic volumes on the main arterial road will be around 10,000-15,000 vehicles per day once the development has reached full capacity, with the majority of vehicles being private cars and small commercial vehicles. For a development of this type, over 80 % of traffic will occur in daylight hours. The road will be single lane dual carriageway, that is, there will be a single lane in each direction with a median strip in between. The width of the road reserve will be an estimated 25 m. The speed limit on the main arterial road will be set at 60 km/hour or less if required to minimise impacts on fauna or for safety reasons in urban areas.

Smaller collector and local roads will be required to provide access throughout the proposed development. These will be one way or two way roads, depending on location and purpose. Speed limit will be 40 km/hour.

Road design for all roads will follow Queensland and local government design standards, including the requirements of the Queensland Department of Transport and Main Roads Fauna Sensitive Road Design Manual (DMR 2000, DTMR 2010).

In terms of potential impacts on listed species of national environmental significance there will be no roads through the vine thicket that provides potential habitat for the black-breasted button quail.

If water mouse is utilising mangrove and intertidal habitat in the vicinity of the bridge and boat ramp, water mouse will be able to move from east to west under the bridge, but may be affected by traffic at the boat ramp. As the water mouse is nocturnal, and the majority of boat ramp activities will be undertaken during daylight hours, impacts on water mouse are considered negligible.

If yakka skink, collared delma and brigalow scaly-foot are present, habitat would be fragmented. Although these species are thought to have relatively small foraging ranges, fragmentation is of concern in relation to inter-generational dispersal movements between any breeding populations that may be present. Although movements would generally be at night when traffic volumes are lower, these small reptiles would be vulnerable to vehicle strike. Mitigation measures for fauna crossing of the main arterial road are discussed below and, should pre-clearing surveys identify presence of either yakka skink, collared delma or brigalow scaly-foot, these would become priority target species in relation to selection of road crossing methods.

The potential for migratory shorebird species to come into proximity with vehicles is likely only at the bridge crossing where birds may fly over or under the bridge while commuting east-west along the waterway. However, the relatively slow vehicle speeds (60 kph speed limit) combined with the protective railings on the bridge, and the high visual acuity and flight manoeuvrability of shorebirds, including at night, will mean that the risk of vehicle strike to migratory shorebirds is negligible. While there is evidence in the international scientific literature to demonstrate such collisions occur (Bard et. al., 2002, Jacobson, 2005), they are anticipated to be rare for the species likely to occur in the study area. In the event that collisions of birds and vehicles are observed on the bridge, mitigation measures in the form of additional railings or other deterrents are available such as that shown in Figure 8-13. However, these measures will only be applied if bird strike is observed on the bridge.

Figure 8-13 – Contingency Measures to Mitigate Bird Strike Risk on the Bridge (Bard et al 2002)

While impacts on other listed threatened and migratory species are not expected, impacts on smaller ground dwelling native animals and some arboreal mammals may occur. Abundance of individuals may be affected and, if a particular species is particularly vulnerable to the effects of vehicle related mortality, this in turn may lead to localised extinction in the long term. The most significant impact can be expected to occur on the main arterial road due to higher traffic volumes. Impacts on native fauna from collector roads and local roads are expected to be minimal.

The use of a single lane, dual carriageway road for the main arterial road will assist with fauna movement across the road as small animals will be able to take shelter in the median strip. As mentioned above, main arterial road design will be in accordance with the Queensland Department of Transport and Main Roads Fauna Sensitive Road Design Manual (DMR 2000, DTMR 2010).

Consideration will also be given to whether collector and local roads require fauna passage based on the processes set out in the Fauna Sensitive Road Design Manual.

The Fauna Sensitive Road Design does not provide prescriptive solutions but rather, sets out a process of assessment and design based on:

- Forming an understanding of the degree to which fauna move through habitat prior to development. This will include review of fauna species identified and the local context of movement needs of each to access water resources, foraging resources and for breeding
- Identifying high priority species and species at higher risk
- Setting objectives for fauna passage and determining whether facilitated fauna passage or other mitigation measures in relation to vehicle strike are warranted
- Considering local landscape, topography and habitat types, selecting fauna crossing techniques and locations to best maintain required movement patterns and access to resources. This may also include selection of methods to restrict access to roadways in some locations.

Once fauna crossing structures and other mitigation measures are in place, ongoing monitoring will be required to test the effectiveness of the mitigation measures and make adjustments as necessary. Monitoring will commence as soon as the road is in place and will include and initial program of:

- Monitoring of the species and number of animals that may be killed while crossing roads using direct observations
- Monitoring of fauna movements through fauna crossing structures, most likely using motion activated cameras.

Monitoring will be repeated over a period of 2-4 weeks annually until the proposed development reaches full capacity and then the frequency will be reduced to bi-annually or less if mitigation measures appear to be effective.

If mitigation measures are not operating effectively, further modifications will be made, using the DTMR manual and other national and international best practice guidelines.

It is not anticipated that fauna crossing structures will be required on collector roads and local roads, however, this can be reviewed as part of the regular monitoring of effectiveness of fauna crossing measures on the main arterial road.

Condition 14, Schedule 1 of the Queensland Coordinator-General's report requires the proponent to address management of road impacts on fauna in the Wildlife and Habitat Management Plan (see also Section 8.3.9). Condition 2 of Schedule 2 of the Coordinator-General's Report also contains requirements in relation to fauna road crossings that are to be imposed on the Proponent by Gladstone Regional Council.

With these measures in place, the severity of vehicle strike impacts on individual fauna species such as the yakka skink, collared delma and brigalow scaly-foot (if present) and on overall fauna diversity is considered to be low and overall impacts on terrestrial biodiversity are not considered significant. No further evaluation is required.

As this impact would only impact on terrestrial fauna, there is no potential for impact on the GBRMP. As terrestrial biodiversity is identified as a component of the OUV of the GBRWHA, impact on terrestrial animals and biodiversity generally could diminish the OUV. As discussed in Section 7.2, the contribution that terrestrial fauna diversity of HHI makes to the OUV of the GBRWHA is minor and as impacts on fauna diversity are not expected, impact on the contribution that HHI makes to the OUV of the GBRWHA in this regard is not significant. However, further discussion is provided in Section 11.5 on overall potential for the contribution that HHI makes to the biodiversity component of the OUV to be diminished.

8.6.4 Mortality or Injury from Aircraft Strike

As described in Section 2.11.2, the existing airstrip will be reinstated and used as a private facility for small aircraft undertaking scenic joy flights as a tourism activity or charter flights bringing visitors to the island. The airstrip will not be suitable for use by jet aircraft, and it will not be equipped for night time operation. The number of flights per day is not known, but is not likely to exceed about 10-20 aircraft per day at peak periods and on most days will be less than 10 flights per day.

Brisbane Airport Corporation examined aircraft-strike of birds in an EIS prepared for a new parallel runway (BAC 2007). Data on bird strike at major commercial airports in Australia was presented for the period 2000-2005. One of the highest rates of airstrike was at Cairns airport which is located near the coast and adjacent to coastal wetlands. Recorded or suspected bird strikes for Cairns ranged from 8.2 strikes per 10,000 aircraft in 2000 to 23.8 strikes per 10,000 aircraft in 2005. While bird strike rates at a major commercial airport such as Cairns are likely to be significantly higher than for the airstrip at PTP, this does indicate that the magnitude of bird strikes associated with airports is relatively low. It is unlikely that there would be 10,000 aircraft using the PTP airstrip in one year.

While aircraft strike is not expected to significantly impact on birds, a conglomerate of nationally and internationally important foraging and roosting habitat for migratory shorebirds has been identified at HHI and other sites in Colosseum Inlet and Rodds Bay. Direct mortality of migratory shorebirds from aircraft strike has been identified as a threat (DEWHA 2009b (Draft)). Given the importance of migratory shorebird habitat in this area, a further detailed assessment is provided in Section 10.2.5.

Apart from birds, the only other listed threatened or migratory species that might be affected by aircraft strike is the grey-headed flying fox which occasionally forage on HHI. Recent research by the Australian Transport Safety Bureau identified the average number of flying fox and bat strikes on aircraft between 2002 and 2011 to be about 80 per year. A large proportion of these occur in Queensland reflecting relatively large flying fox numbers in the State. The vast majority of flying fox/bat strikes occurred in the evening and night time periods (Australian Transport Safety Bureau (ATSB), 2012). The airstrip at PTP will not be equipped to operate at night.

Given the low numbers of flying fox/bat strikes that generally occur, the absence of any permanent camps on HHI, the seasonality of available foraging resources on HHI, the small number of flights per day, and that the airstrip at PTP is not intended for night time use, it is considered unlikely that airstrike issues will arise.

Aircraft approaching the airstrip from the north will overfly the GBRMP, however as there are no inshore coastal habitats for birds or other flying animals, any impact on fauna values of the GBRMP is negligible. Migratory shorebird roosting and foraging habitat on HHI has been identified as making a major contribution to the OUV of the GBRWHA and the detailed assessment in Section 10.2.5 is therefore also relevant to impacts on the OUV of the GBRWHA. Further discussion is then also provided in Section 11.5 in terms of the potential for the contribution of HHI to the OUV of the GBRWHA to be diminished.

8.6.5 Predation

Feral dogs and cats have been identified on HHI (see Section 6.7).

The proponent has committed to banning pet cats from HHI, and to imposing strict controls on pet dogs such that the proposed development will not contribute to the current level of predation risk on HHI. This is a condition of the Queensland Coordinator-General's report (Schedule 1, Condition 14) (February 2011) and can be imposed through the plan of development.

The proponent also intends to implement a feral animal control program as part of the management approach for the proposed conservation area (see also 8.3.8). This will reduce predation risk for native animals on HHI, including migratory shorebirds. As the bridge will make it easier for feral animals to reach HHI from the mainland, the proponent will install devices on the bridge to minimise entry by foxes, dogs and cats. These devices are likely to consist of cattle grids and self-closing gates. If necessary, closed circuit cameras can be installed to check effectiveness of these measures.

8.6.6 Loss of Threatened Plants During Vegetation Clearing

Section 7.4.3.15 identified that the vulnerable plant *Germainia capitata* may possibly occur within the development footprint due to the presence of suitable habitat in *Eucalyptus spp* and *Melaleuca spp* woodlands. *Cycas megacarpa* may also occur within the development footprint in *Eucalyptus tereticornis* and *E. crebra* dominated forests (Queensland regional ecosystem 12.12.12) within the development footprint. Neither species has been identified in surveys to date, however, particularly with *Germainia capitata*, it is possible that the species may have either not been detected in earlier surveys or that seeds have since been spread to the island. This is less likely with *Cycas megacarpa* as seeds are not generally spread far from mature plants.

Regardless, pre-clearing surveys will be undertaken to identify any threatened plants including *Germainia capitata* and *Cycas megacarpa*. This is also a condition of the Queensland CoG's report (condition 16, CoG 2011).

In the event that *Germainia capitata*, *Cycas megacarpa* or any other threatened plant is identified mitigation will be as follows:

- Review the development footprint and determine whether the area can be avoided through relocation of buildings and infrastructure. If this can occur, ongoing management of threatened plants within the development footprint will occur through the Wildlife and Habitat Management Plan (see also Section 8.3.8).
- Prepare an implement a translocation plan. As the bulk of HHI is to be converted to a managed conservation area and examples of all habitat types within the development footprint are also found in the managed conservation area, translocation can occur immediately which will significantly enhance the likelihood of success.
- If appropriate, seeds will also be collected and further plants propagated for planting in the managed conservation area
- Management of areas where threatened plants have been translocated or propagated plants have been planted will be included in the conservation area management plan (see also Section 8.3.8).

8.6.7 Summary of Potentially Significant Impacts

Potentially significant impacts on EPBC Act listed threatened species and migratory species associated with injury or mortality to terrestrial fauna species and loss of threatened plants are identified in Table 8.15.

Table 8.15 – Summary of Potentially Significant Impacts – Mortality or Injury to Terrestrial Fauna and Flora

Potential Impact	Threatened Plants and Animals	Migratory Species
Mortality or injury from vegetation clearing activities	Negligible impact	Negligible impact
Mortality or injury from vehicle strike	Negligible impact	Negligible impact
Mortality or injury from aircraft strike	Negligible impact	Potentially significant, refer 10.2.5
Reduced predation risk	Potential benefit	Potential benefit
Loss of threatened plants	Low or negligible (depending on whether plants are found in pre-clearing surveys)	Not applicable

In combination, impacts of injury and mortality of terrestrial native fauna may affect biodiversity in the GBRWHA/NHP, hence potentially reducing the contribution that HHI makes to the OUV of the GBRWHA. This is discussed further in Section 11.5.2.

There are no impacts in this regard within the GBRMP.

8.7 Impacts on Individual Marine Threatened and Migratory Animals

8.7.1 Overview

Direct impacts on marine threatened and migratory animals, and marine animals generally may arise from:

- Injury or mortality from impingement or entrainment in the desalination plant intake
- Injury or mortality from boat strike
- Entanglement with litter and debris
- Noise from boat ramp and bridge construction
- Increased recreational fishing effort
- Upgrade of zoning of Rodds Bay Dugong Protection Area.

8.7.2 Mortality or Injury from Impingement or Entrainment on Desalination Plant Intake

The proposed desalination plant intake will be placed on the bridge and will draw water from the middle of the Boyne Creek. The intake pipeline will be a pipeline of up to 250mm diameter, equating to a maximum surface area of 0.05 m^2. The intake rate is 600 kL per day and the pump will be programmed to operate during the upper half of the tidal cycle to ensure a consistent quality of water.

Intake pipelines can impact on marine fauna and flora through entrainment, whereby organisms are sucked into the intake pipeline or, where there is a screen across the mouth of the intake, by impingement whereby the intake current causes organisms to become trapped against the screen. While actual flows into the intake will be determined in detailed design, flows are not expected to exceed a 15 L per second pumping rate which will have no impact on flows in Boyne Creek. This pumping rate and the 1m diameter inlet screen around the pipe inlet will also ensure that marine organisms and sediment to be sucked into the inlet. A backwash system will be incorporated into the inlet to allow a small volume of water to be pumped out of the intake to clean the screens if they become clogged with particulate matter. It is not expected that mobile marine animals will be entrained by current generated by the intake. In any case, the small size of the intake and low intake current will mean that mobile marine animals will easily be able to avoid or escape entrainment. Listed threatened and migratory marine animals are therefore not expected to be affected.

Indirect impacts on listed threatened and migratory marine animals could occur if the intake removed a measurable proportion of larvae and other food sources such that the food chain in the area of the intake was disrupted. Larvae and other non-mobile marine organisms are unlikely to be trapped against the screen due to the intake current being lower than tidally induced currents in surrounding waters. In any case, the intake area is very small, less than 0.05 m^2, and impingement of marine organisms will have negligible impact on ecosystem productivity, even at a localised scale.

Direct and indirect impacts from impingement and entrainment on listed threatened and migratory marine species are considered negligible, as are overall impacts on biodiversity.

The proposed desalination plant intake is over eight kilometres by sea from the GBRMP and therefore no impact will occur. Impacts on the OUV of the GBRWHA are not expected as the desalination plant intake will not reduce the contribution that the waters and marine habitats surrounding HHI make to the GBRWHA.

8.7.3 Mortality or Injury from Boat Strike and Disturbance by Boat Traffic

Boat strike, from both recreational and commercial boats, has been identified as a threatening process to marine turtles (Environment Australia 2003). Boat strike is also recognised as a potential threat for dugong, particularly in shallow inshore areas (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 11/03/2013). Boat strike is not considered a threat for Indo-Pacific humpback dolphin (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=50 accessed 14/03/2013).

The waters around HHI have been identified as being of moderate importance in relation to marine turtles and dugong. As discussed in Section 8.8.4.2, recreational boating activity in waters surrounding HHI is anticipated to increase as a result of the installation of a formal boat ramp as part of the project. Impacts on listed threatened species (marine turtles) and migratory species (marine turtles and dugong) may potentially occur and are further assessed in Sections 9.3.4 10.4.

As marine megafauna also contribute to the biodiversity values of the GBRWHA, potentially significant impacts on the OUV of the GBRWHA are discussed in Section 11.5. As marine megafauna in waters around HHI move in and out of the GBRMP, potentially significant impacts on the GBRMP are discussed in Section 12.2.

Increased boating activity is not expected to directly affect any other marine fauna. There is the potential for increased recreational fishing effort to affect estuarine food webs.

8.7.4 Litter and Debris

The Great Barrier Reef Outlook Report (GBRMPA 2009) identifies entanglement with marine debris, including litter and debris from commercial and recreational fishing activities as a high risk overall to the ecosystem.

Littering from recreational boats is identified by GBRMPA as a potential threat to marine megafauna such as turtles and also migratory shorebirds and other birds that feed on fish as these which can become entangled in rubbish, or mistake items of rubbish for food. Litter may also enter the marine environment through stormwater systems.

In relation to littering from recreational boats, under the Queensland *Transport Operations (Marine Pollution) Act 1995*, it is an offence to throw any rubbish or garbage overboard.

While the proponent is not in a position to directly enforce these laws, the proponent will make information on compliance requirements available at the proposed boat ramp, including visible signs. Consequences of non-compliance will also be explained, both in terms of fines and environmental impacts. Even with these laws in place, the proponent acknowledges that some recreational boat operators do not comply, and that some littering may occur.

In relation to litter from land based activities, litter may be mobilised to the marine environment through entrainment in stormwater and blown by the wind. The proposed stormwater system includes gross pollutant traps to trap litter and debris (see Section 2.7.3). This is expected to capture all litter and debris mobilised via the stormwater system. Wind blown litter is most likely to occur from those parts of the project that are within several hundred metres of the coastline, and this effect will be minimised by the retention of trees and other vegetation in the coastal zone, which will tend to trap wind blown litter. It is illegal under Queensland *Waste Reduction and Recycling Act 2011* to drop litter.

Ongoing management actions to be documented in the EMP will also include:

- Provision of rubbish bins in public areas where litter is likely to be generated
- Regular removal of litter from public areas
- Awareness raising information on the potential impacts of littering on marine fauna.

The proponent will also encourage tourism and commercial activities at the project to incorporate waste minimisation into procurement strategies, and choose packaging that poses less of a threat to marine animals, for example avoiding plastic bags and encouraging biodegradable bait packaging.

With these measures in place, the quantity of litter and other debris that will enter the marine environment from land-based activities is considered to be negligible.

In relation to potential impacts of litter and debris on MNES, while the impact of this alone may be low, in combination with other aspects such as boat strike, there may be an additive effect on turtles and hence this is discussed further in Section 9.3.6. Additive effects on dugong are not expected as ingestion or entanglement of litter is not identified as a cause of mortality for dugong. Entanglement of dugong is noted to arise from entanglement with shark nets and large mesh fishing nets used by commercial fishers, however there are restrictions on use of mesh nets in waters around HHI as HHI is located within a Dugong Protection Area.

Migratory shorebirds feed on invertebrates in intertidal mud flats and may become entangled in litter that washes up in the wrack zone. This can be managed by monitoring build-up of litter in this area and removal if necessary. This monitoring and management will be undertaken by the proponent as part of the managed conservation area, and will commence with commencement of the development and continue on at least an annual basis, more frequently if monitoring indicates litter build up in the wrack zone.

As marine turtles are identified as a particular value of the GBRWHA, potentially significant impacts on biodiversity values which might in turn affect the OUV of the GBRWHA are discussed in Section 11.5. As marine turtles present in waters around HHI move in and out of the GBRMP, potentially significant impacts on the GBRMP are discussed in Section 12.2.

8.7.5 Underwater Noise from Bridge and Boat Ramp Construction

Construction of the proposed bridge and boat ramp will generate some underwater noise, however blasting and pile driving will not be required.

Noise may be generated from equipment used to construct the bridge and boat ramp, however this will be at low levels, and episodic, and will only occur over a short period of time. Again, only the immediate environs of Boyne Creek would be affected. Levels from works taking place out of the water are not likely to be such that dugongs and turtles are deterred from using the area (GHD 2009).

Adverse impacts on dugong and marine turtles are not expected due to the short duration of works and low noise levels from most aspects of the works.

Overall, there is very limited opportunity for impact of noise from bridge construction activities on marine animals due to the short term and episodic nature of the works and the narrow configuration of the location.

8.7.6 Increased Recreational Fishing Effort

Increased access to waters around HHI will increase recreational fishing effort, since the main activity undertaken by recreational boaters is fishing. An estimate of increased recreational boating activity is provided in Section 8.8.4. The proposed boat ramp will be constructed in years one to two of the proposed development and hence, any local increase in recreational boating and associated fishing effort will commence early in the development phase. Section 6.5.5 provides information on current levels of access for recreational fishing to the waters around HHI.

In 2010, the then Queensland Department of Employment, Economic Development and Innovation undertook a recreational fishing survey (Taylor et al 2012). Findings of the survey in relation to fishing effort included:

- An estimated 350,000 households or 21% of all households in Queensland contained one or more recreational fishers
- Nearly 90% of boat owners in the Fitzroy region, which includes HHI, use their boats for fishing while an average of 85% of boat owners in Queensland use their boats for fishing
- The average number of days fished by individuals in the survey year was four days
- 45% of fishing effort in the survey period was in estuarine waters while 41% was in open ocean
- In Rockhampton coastal waters, which include HHI, approximately half of the fishing effort was from boats, with the remainder from the shore

- In Rockhampton coastal waters, which includes HHI, the number of fisher days in 2010 was estimated at around 100,000.

Based on fishing effort and the total number of fish caught, an average of about five fish are caught for each fishing day. This would appear to be within bag limits set under the GBRMP zoning plans (GBRMPA 2003).

The 2010 survey also noted that, while boat ownership has increased:

- Fishing effort declined by about one third between 2000 and 2010
- Fish catch declined by about 50% between 2000 and 2010
- Participation rate in recreational fishing in the Fitzroy residential region where HHI is located reduced from 34% of the population to 21% of the population between 2000 and 2010.

The top ten species taken, including fish harvested and released, by recreational fishers in Rockhampton coastal waters, which include HHI, is shown in Figure 8-14. More detail is provided in Section 6.6.8.

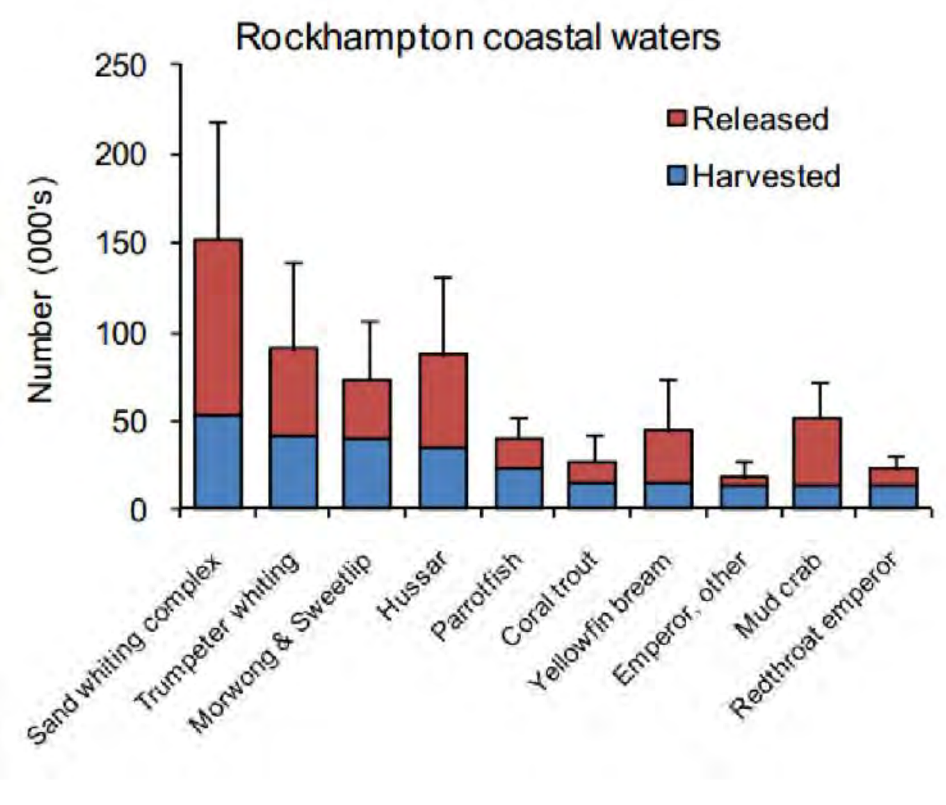

Figure 8-14 – 2010 Recreational Fishing Survey – Catch in Rockhampton Coastal Waters Region (Taylor *et al.* 2012)

Fishing effort and recreational fish catch has declined from 2000 to 2010 at a state and regional level, indicating that pressure on fish stocks from recreational fishing has reduced. The survey report does not speculate on whether reduced fishing effort and catch may also be due to declining fish stocks.

Mundoolin Rocks, Colosseum Inlet and Boyne Creek are noted as good fishing areas in several fishing guides and websites (http://www.gladstoneregion.info/Portals/3/DOCUMENTS/Brochures%20etc/GAPDL%20Gladstone%20Region%20Fishing%20Guide.pdf, http://www.fishingmonthly.com.au/Articles/Display/3011-Gladstone-planner, http://www.banana.qld.gov.au/docs/local_government/Gladstone%20Region%20Fishing%20Guide.pdf) which indicates that these areas are already utilised by recreational fishing. Seal Rocks, offshore from HHI, is also identified as an important fishing location although access by small boats would be limited to fine weather conditions.

While waters around HHI are already accessed by recreational fishers, an increase in recreational fishing effort is expected in the Colosseum inlet/Boyne Creek/Seven Mile Creek estuary due to the provision of the proposed boat ramp. Recreational fishing effort in offshore coastal waters will increase to a lesser extent as the size of boats that can be launched at the proposed boat ramp will only be able to access the open coastal waters in fine weather and, due to navigational restrictions at the mouth of Colosseum Inlet and Seven Mile Creek, under certain tidal conditions (see Section 8.8.4).

The GBRMPA Recreation Management Strategy notes that:

> *The ecosystem effects and cumulative impacts of fishing are poorly understood, but are likely to be concentrated in inshore areas close to major population centres. Local depletion, particularly of some inshore species, is of concern in some areas. In contrast, the fishing practices of recreational users are unlikely to result in significant physical impacts on the habitats of the Great Barrier Reef. (GBRMPA 2012)*

This indicates that there will be some uncertainty in predicting impacts of any increase in recreational fishing associated with PTP.

There has also been considerable focus on the health of fish in Gladstone Harbour in the past two to three years, with concerns raised that water quality impacts from dredging and construction of industrial facilities at the Port of Gladstone were having detrimental impacts on fish health (http://www.ehp.qld.gov.au/gladstone/fish-health-panel.html, accessed 6/04/2013). Gladstone Harbour is located 30 kilometres to the north-west of HHI (See Figure 1.1). In inquiry by the Queensland Government was inconclusive and an “Integrated Aquatic Investigation Program” was recommended.

Results of the first 12 months of this program (September 2011 to September 2012) were published in 2013 and indicated that fish health appeared to be improving and that contaminant levels remained within guidelines for the duration of the program (Gladstone Harbour Fish Health Interdepartmental Committee 2013). However, the program has focussed on fish health and has not presented any data on fish population numbers.

If fishing levels in water around HHI exceed the ability of fish stocks to replenish, this may affect the food chain in the waters around HHI. While the listed threatened and migratory species present or likely to be present in waters around HHI do not generally feed on fish, a major reduction in fish stocks might still change the productivity balance in the local waters, particularly if reduced consumption of algae by fish leads to a proliferation of algae. However, this would require a major perturbation in fish stocks.

Adequate data is not available to estimate the number of fish that might be taken by recreational fishers in the waters around HHI. Recreational boating estimates (Section 8.8.4.2) indicate up to 150 boats might utilise the proposed boat ramp on a peak weekend. This might occur five to six times per year. At other times, the number of boats using the boat ramp would be considerably less.

While an increase in local recreational fishing effort is predicted, recreational fishing effort at a regional level is not expected to increase as a result of the project as the overall population increase from the project is very small at a regional scale, and the proposed boat ramp is likely to result in redistribution of recreational boating activity and fishing effort rather than an overall increase. Hence, while GBRMPA has noted concerns about impacts of recreational fishing in proximity to major regional centres such as Gladstone, fish populations at a regional level should not be further affected by the project.

Through its zoning plans, GBRMPA has designed approximately one third of the GBRMP/GBRCMP as "no take" zones (GBRMPA 2012). The closest such zone to HHI is a marine national park zone on the east coast of Rodds Peninsula, about 20 km east of HHI. This area is not readily accessible from the project boat ramp. Under the zoning requirements for the GBRMP/GBRCMP, the following restrictions are placed on fishing activities in the general use zone and habitat protection zones, which are the zones accessible from the project:

- Fishing must be by hand and hand held implement
- Generally no more than 5 of a species may be taken
- Maximum of 3 lines/rods per person and with a combined total of 6 hooks per person.

The Queensland Government also has controls in place to manage sustainable utilisation of fisheries including seasonal restrictions, size limits and bag limits. The 2010 recreational fishing survey indicated that fishers are generally aware of these requirements, based on the number of fish that were released and the reasons given for releasing. There are also restrictions on use of mesh nets within the Rodds Bay Dugong Protection Area which surrounds HHI.

The proponent will ensure that signs and written information on fishing restrictions are available at the boat ramp and tourist information centre. Education and awareness is identified by GBRMPA as a key management tool in managing impacts of recreational activities (GBRMPA 2012).

Given that the overall number of recreational boats likely to engage in fishing activities in water around HHI remains low at most times, and the legislative controls in place on recreational fish catch, it is not considered likely that unsustainable levels of fishing will occur in the local area.

MNES present are not likely to be affected directly by reduced fish populations, and any reduction in fish populations is not likely to be significant enough to upset the balance of the food chain in the area.

Impacts on MNES, including impacts on diversity of marine species within the GBRWHA/NHP and GBRMP are not expected to be significant or unacceptable. However, there is some uncertainty as to the overall effects of recreational fishing on fish stocks, and the proponent will ensure that if any additional controls are imposed by either GBRMPA or the Queensland Government that recreational boaters using the boat ramp are made aware of these. Education and awareness is identified by GBRMPA as a key management tool in managing impacts of recreational activities (GBRMPA 2012).

If a proposal by the Queensland Government to upgrade the zoning of the Rodds Bay Dugong Protection Area goes ahead, the proponent has committed to purchasing up to four commercial fishing licences so that the local and regional commercial fishing industry is not disadvantaged by the rezoning (see also Section 8.7.7). This would reduce fishing pressure in the region.

8.7.7 Upgrade of Zoning of Rodds Bay Dugong Protection Area

Dugong protection areas are declared under the Queensland *Fisheries Act 1994* and are areas where certain fishing methods are prohibited or restricted. The principal restrictions relate to use of mesh nets. There are two zones, Zone A and Zone B, with the restrictions being more strict in Zone A compared to Zone B.

The Rodds Bay Dugong Protection Area is currently designated as Zone B in relation to the types of fishing methods that may be undertaken. The proponent has committed to working with the Queensland Government to contribute to a proposal to upgrade the zoning of the Rodds Bay Dugong Protection Area from Zone B to Zone A. This would further restrict the types of fishing methods and activities that can take place in the dugong protection area.

In order for this to occur without disadvantaging local and regional commercial fishing interests, an estimated four commercial fishing licences would need to be purchased. The proponent's contribution would be to provide the funding to purchase these fishing licences. This would then reduce the fishing activity in the area, and also reduce the risk to dugong from mesh nets. Reduced commercial fishing effort may benefit fish stocks in relation to values of the GBRMP.

8.7.8 Summary of Potentially Significant Impacts

Potentially significant impacts on EPBC Act listed threatened and migratory species associated with mortality or injury of marine fauna are identified in Table 8.16.

Table 8.16 – Summary of Potentially Significant Impacts – Mortality or Injury to Marine Fauna

Potential Impact	Threatened Plants, Animals and Ecological Communities	Migratory Species
Impingement or entrainment on desalination plant intake	Negligible impact	Negligible impact
Boat strike	Potentially significant impact Refer Section 9.3.4	Potentially significant impact Refer Section 10.4.4
Litter and debris	Potentially significant impact Refer Section 9.3.5	Potentially significant impact
Recreational fishing	No impact	No impact
Noise from Bridge and Boat Ramp Construction	No impact	No impact
Upgrade of Zoning of Rodds Bay Dugong Protection Area	No impact	Potential benefit Refer Section 10.4.7

In combination, impacts of injury and mortality of marine native fauna may affect biodiversity in the GBRWHA/NHP which in turn may reduce the contribution that waters around HHI make to the OUV of the GBRWHA. This is discussed further in Section 11.5.

Impacts related to recreational boating and fishing may also impact the values and objectives of the GBRMP. This is analysed further in Section 12.2.

8.8 Increased Levels of Activity in GBRWHA/NHP and GBRMP

8.8.1 Overview

The project is expected to result in increased visitation to the GBRWHA/NHP and GBRMP. This will include boat based, air based and, in the case of the GBRWHA/NHP, land based activities. Increased access to the GBRWHA/NHP and GBRMP may also increase research activity in the area. Increased activity levels may increase associated activity-related impacts but may also facilitate access to and enjoyment of the GBRWHA/NHP and GBRMP as well as a better understanding of the importance of these areas, including the concept of OUV of the GBRWHA and the things that contribute to OUV.

8.8.2 Visitor Levels

The project will increase visitor levels to the Central Queensland Region and to the Mackay-Capricorn management area of the GBRMP/GBRWHA/NHP. As shown in Section 2.3.3, the capacity of the project is expected to be around 3,900 persons, made up of around 2,300 tourists and 1,600 residents. Actual occupancy levels will generally be less than this and visitor levels can also be expected to fluctuate throughout the year, depending on seasons, school holidays and other factors.

In terms of the extent to which visitors to the project will access the marine park, most visitors can be expected to use commercial tourism facilities although, as discussed in Section 8.8.3.1, some may bring their own boats.

This section uses the convention established by GBRMPA which distinguishes between tourists and visitors that utilise commercial tourism operators and activities to access the GBRMP compared to those who enter the GBRMP independently.

8.8.3 Increase in Commercial Tourism Activities

8.8.3.1 Boat Based

As discussed in Section 7.6.3, the Mackay-Capricorn management area of the GBRMP currently has low visitation levels. There were approximately 120,000 visitor days in the region associated with commercial tourism operators in the year ending June 21012, accounting for around seven per cent of total commercial tourism visitor days in the GBRMP. The highest visitor numbers were to offshore locations such as Lady Eliot Island, Lady Musgrave Island, Heron Island and the reefs and atolls of the Capricorn Bunker reef group and Swain Reef group. A search of Yellow Pages® indicates that there are five boat charter operations in Gladstone, mostly offering deep sea fishing trips and trips to Swain Reef and Capricorn Bunker reef systems.

PTP is a tourism-focussed development and given its coastal location, it would be expected that some tourism operators may establish boat-based tourism operations which would involve taking visitors into the GBRMP for various activities. As the project does not include any marina or mooring activities, boat based tourism operating directly from HHI would only be able to utilise smaller, trailerable boats or alternative vessels such as kayaks. Larger boats could be based at Gladstone, potentially with a booking agent at PTP and tourists transported to Gladstone to board.

If tourism operators establish boat based tourism operations at PTP or in response to demand from generated by the project, they will require a permit to access the GBRMP whether or not they use the proposed boat ramp. This permit system allows GBRMPA to evaluate consistency of the proposed activity with the zoning objectives and the overall sustainability of tourism activities, having regard to levels of use at the time. GBRMPA has developed a range of sustainable use guidelines for tour operators and tourists, and conditions of individual permits may place further restrictions on particular activities. Given the range of controls in place, GBRMPA considers impacts of commercial tourism to be minor (GBRMPA 2009).

As current tourism levels in the Mackay-Capricorn management region generally, and specifically in the Gladstone area are low (GBRMPA 2009), it is unlikely that growth in tourism activities associated with the project will result in demand for unsustainable usage of the GBRMP. With this in mind, it is not considered likely that unacceptable impacts would arise from tourism operations that may become established at the PTP or are established elsewhere arising from demand generated by the project.

8.8.3.2 Aircraft Based

The project will include an airstrip as described in Section 2.7.6. As for all other commercial tourism activities, operation of commercial scenic flight tours across the GBRMP requires a permit from the GBRMPA. As for boat based tourism, when deciding to grant a permit for scenic flights, GBRMPA will have regard to the sustainability of the activity and potential impacts of the activity on ecological values and also on use and enjoyment of the GBRMP.

In terms of existing aircraft based tourism, a company “Australia by Seaplane” operates scenic flights from Gladstone along the coastline and hinterland between Gladstone, Agnes Waters and Curtis Island. Charter flights are also available from Gladstone, including flights to Lady Eliot Island and Lady Musgrave Island.

In recognition of potential impacts of aircraft based tourism on enjoyment of the GBRMP, GBRMPA issued a position statement on tourist flights in the vicinity of Magnetic Island in April 2009 (http://www.gbrmpa.gov.au/__data/assets/pdf_file/0004/3892/gbrmpa_ManagementOfTouristFlightsInTheVicinityOfMagneticIsland_2009.pdf, accessed 10/04/2013). This position statement included the following management strategies which could also be applied to the Mackay-Capricorn management area if necessary:

- Aircraft are to operate only between the hours of 9.00 am and 5.00 pm each day
- Aircraft activities are to be limited to six days out of every seven day period
- Aircraft activities are to be limited to a maximum of eight flights on any one day
- Aircraft are not to operate at a vertical height of less than 1500 feet in the vicinity of Magnetic Island unless, notwithstanding the fact that it is aware of this condition, but for emergency or other extraordinary reasons, air traffic control requires the aircraft to fly within the 1000 metre zone or for the purposes of landing and/or take-off at permitted locations.

Note also that the proponent has committed to maintaining an aircraft exclusion zone around important migratory shorebird habitat as discussed in Section 10.2.4.4.

Given GBRMPA’s ability to regulate commercial scenic flights through its permit system, significant or unacceptable impacts on the GBRMP are not expected. Similarly, impacts on the GBRWHA/NHP are not expected.

8.8.4 Recreational and Independent Visitors

8.8.4.1 Increase in Recreational and Independent Visits

In line with GBRMPA terminology, visitors who access the marine park independently (as compared to utilising a commercial tourism operator) are referred to as “recreational visitors”. In terms of data collection, GBRMPA assumes that most recreational visitors are residents in the catchments of the GBRMP. However, the term may also apply to visitors to a facility such as PTP who then independently access the marine park.

The GBRMP Recreation Management Strategy notes that residents in the catchment of the marine park made 14.6 million visits to the GBRMP in 2008, at an average of 15.5 visits per year, and four out of five visits were for a day or less (GBRMPA 2012). This equates to 966,000 visits per annum from residents of the Gladstone Regional Council area, which includes HHI. Allowing for a resident population of 1,200 persons at PTP, this equates to an additional 18,600 visits to the GBRMP per annum, with 14,880 of those being for a day or less. Some tourists visiting the PTP may also make "recreational visits" to the GBRMP in the form of swimming and beach fishing from the beach to the west of the headland, as this beach borders the GBRMP.

The majority of visits by recreational visitors are for swimming and boating (GBRMPA 2012).

The population increase associated with the project is small when compared to the regional population and at a regional level, the increase in visits to the GBRMP is not significant.

There will however be a significant local increase in recreational visits in the immediate vicinity of HHI as this area has limited public access at present. This will include increases in land based visits and also increases in recreational boating activities induced by the availability of a boat ramp. Estimates of recreational boat traffic generated by PTP are provided in Section 8.8.4.2.Further assessment of potential impacts of increased visitor levels to HHI and surrounding waters on the GBRWHA are discussed in Section 11.4.4 and impacts of increased visitor levels to the GBRMP are discussed in Section 12.2.

8.8.4.2 Estimates of Recreational Boat Traffic

Development of the PTP and provision of a boat ramp on HHI is expected to increase current levels of recreational boat usage of the Colosseum Inlet, Boyne Creek and Seven Mile Creek estuaries. The proposed boat ramp will be constructed in years one to two of the proposed development and hence, any local increase in recreational boating and associated fishing effort will commence early in the development phase.

Existing boat launching facilities (formal and informal) in the vicinity of HHI are described in Section 6.5.5. There is one all-tide ramp (Turkey Beach) and several part tide boat ramps that provide access to waters around HHI. While formal boat counts of current usage in waters around HHI are not available, usage is assumed to be proportionally lower than for the Port Curtis/Gladstone Harbour area due to navigational restrictions which make it harder for boats to enter Colosseum Inlet and Seven Mile Creek from the seaward direction except at high tide and under fair weather conditions. Similarly boaters wanting to access offshore waters are potentially less likely to use boat ramps that access the sheltered waters around HHI as direct access to offshore waters is not available.

There are two considerations in relation to likely increases in recreational boat numbers due to the proposed development.

Firstly, population growth associated with the project may increase the overall number of trailerable boats in the region.

The Gladstone Region, which extends from Hervey Bay to Rockhampton / Yeppoon has the second highest level of boat ownership of the six regions administered by Maritime Safety Queensland. Recreational boat numbers are shown in Table 8.17. In January 2013, there were 46,169 registered vessels in the Gladstone Region, representing 19 % of total boat ownership in Queensland. Approximately 8-9% of the regional population owns a boat.

Table 8.17 – Boat Registrations in Gladstone Region (1)

Boat Length	31 January 2013	31 January 2012	31 January 2011	31 January 2010	31 January 2009
< 3.0m	1264	1248	1286	1342	1304
3.01 - 4.0m	17,853	17,326	17,005	16,836	16,151
4.01 - 4.5m	11,610	11,258	40,937	10,804	10,274
4.51 - 5.0m	5,177	5,049	5,008	4,981	4,767
5.01 - 6.0m	5,710	5,484	5,335	5,174	4,861
6.01 - 8.0m	2,775	2,614	2,457	2,372	2,223
8.01 - 10.0m	735	729	713	708	666
10.01 - 12.0m	563	555	536	525	501
12.01 - 15.0m	394	368	357	361	370
15.01 - 18.0m	68	63	66	62	51
18.01 - 20.0m	21	11	8	10	10
20.01 - 25.0m	12	5	4	6	6
Over 25.0m	3	4	3	5	4
Total Boats	46,169	44,714	43,715	43,186	41,188
Trailerable boats (< 12m)	45,671	44,263	43,277	42,742	40,747
Population (2)			496,362	494,092	491,180
Proportion of boat ownership			8.8%	8.7%	8.4%

([1]) Maritime Safety Queensland
http://www.msq.qld.gov.au/~/media/msqinternet/msqfiles/home/about%20us/right%20to%20information/published%20information/lists%20and%20registers/recreational_registration.pdf accessed 3 March 2013
([2]) OESR population estimates, Central Queensland and Wide Bay Burnett Regions

Allowing for an estimated permanent resident population of about 1,200 people, and based on around 8-9% boat ownership, around 120 new recreational boats might be expected in the region as a result of the project. This is a very small number of boats in the context of total boat ownership in the Gladstone area. Only 15 % of boat owners utilise their boats more than once per week, with 40 per cent using their boats 2-3 times per month and 45 % of boat owners using their boats less frequently then “once every 2-3 months” (Maritime Safety Queensland 2007). The increase in the number of recreational boat trips in the local area and region as a result of population increase associated with the proposed development is conservatively over-estimated as 25 per week. This increase must be viewed in the context of a significant existing population and forecast population increase in Gladstone region (see also Section 14).

The second factor is that the presence of a formal boat ramp, as compared to the current more informal launching facilities, will increase access to the Colosseum Inlet/Boyne Creek/Seven Mile Creek area.

A Recreational Boating Facilities Demand Forecasting Study was undertaken by Maritime Safety Queensland (GHD and Economic Associates 2011) for the whole of Queensland. For the Gladstone subregion (which does not correspond to the Gladstone operation region reported in Table 8.17), the Recreational Boating Facilities Demand Forecasting Study projected growth in trailerable boat registrations as follows:

- 2010 – 8,188
- 2011 – 8,381
- 2016 – 9,206
- 2021 – 10,072
- 2026 – 11,051
- 2031 – 12,101.

The recreational demand study used off-peak, average and peak demand scenarios, and estimated for:

- Off-peak demand - 8% of boats demand a boat lane on any given weekend
- Average demand - 14 % of boats demand a boat lane on any given weekend
- Peak demand – 20% of boats demand a boat lane on any given weekend.

In 2011 there were 28 lanes available at boat ramps through the Gladstone subregion, and using 2011 boat registrations, usage on weekends is estimated to as:

- Approximately 24 boats per lane, during an off-peak weekend
- Approximately 42 boats per lane, during an average weekend
- Approximately 60 boats per lane during a peak weekend.

While significant caution must be used in extrapolating these numbers, the numbers provide an order of magnitude indication of likely numbers of boats that might access the proposed two lane boat ramp at PTP. Allowing for likely growth in boat ownership, and assuming an even distribution of usage across all boat ramps in the Gladstone area, a broad estimation of between 50-150 boats per weekend will be assumed for analysis of potential impacts of recreational boating activity. Tourists visiting PTP may bring their own trailerable boats, however, this is probably offset by trailerable boat owners in Gladstone taking their boats to other locations while on holiday.

As this calculation is based on boat ramp usage, it can be considered to include the estimated 30 additional trips per week arising from the resident population at the PTP.

This estimate of 50-150 boats per weekend represents an increase in recreational boating levels in the vicinity of HHI, but does not necessarily represent an increase in boating levels in the Gladstone area. It is expected that there would be some redistribution or transfer of recreational boats from other locations due to the improved access to waters around HHI.

There are some existing informal boat launching facilities in the Colosseum Inlet/Seven Mile Creek/Boyne Creek area, including from the mainland side of the existing causeway, across tidal flats accessed from Foreshores Road and at Mundoolin Rocks. It is assumed that, if a formal boat launching facility is provided at the project, users of these facilities will then use the boat ramp at HHI.

It should also be noted that the Recreational Boating Facilities Demand Forecasting Study indicated a shortfall in boat ramp facilities by at least three ramps in the Gladstone subregion by 2021. Additional boat ramps would be expected to be developed in the region, and the proposed boat ramp at PTP would be one of the three boat ramps meeting this demand. This demand arises even if PTP does not proceed.

8.8.4.3 Potential Impacts Associated with Recreational Boating

At a regional level, predicted increases in recreation al boat ownership and activity arising from the proposed PTP are small, with an estimated additional 120 boats to be added to an estimated 8,300 boats in the Gladstone region and 46,000 boats in the larger region from Hervey Bay to Rockhampton. A very minor increase in boating activity at a regional level is therefore predicted due to the PTP.

The provision of a formal boat ramp will increase local levels of recreational boating activity in the Colosseum Inlet/Boyne Creek/Seven Mile Creek area from a current unknown number to an estimated 50-150 boats each weekend, peaking on holiday weekends. Shallow waters and sand bars at the entrance to both Colosseum Inlet and Seven Mile Creek will generally restrict the type of trailerable boats that would be launched at the PTP boat ramp from moving into the more open waters of the GBRMP except in fine weather conditions.

A range of potential impacts may arise from recreational boating activity:

- Water quality impacts from human wastes and hydrocarbons are discussed in Section 8.5.16 and 8.5.15 respectively
- Impacts on marine megafauna from boat strike are discussed in Section 8.7.3 and Sections 9.3.4 (marine turtles) and 10.4 (dugong)
- Impacts on marine megafauna of littering from boats are discussed in Section 8.7.4 and Sections 9.3.5 (marine turtles) and 10.4 (dugong)
- Potential for migratory shorebirds to be disturbed by boat traffic is discussed in Section 8.4.6 and Section 10.2.4.

Potential impacts of increased boating activity in the GBRWHA are also discussed in Section 11 and in the GBRMP in Section 12.2.

8.8.5 Research Activities

The availability of a boat ramp and accommodation at the development may allow marine science researchers and other researchers additional access to the GBRMP/GBRWHA. While marine science and other research activities will generally improve knowledge of values and systems of the marine park and WHA, some research activities can have impacts on these values and systems, particularly where sample collection is required.

Research activities known to have taken place in the waters around HHI in the past decade include:

- Water quality and sediment monitoring undertaken for the Port Curtis Integrated Monitoring Program (Section 6.1.6)
- Seagrass surveys undertaken by the Queensland Government and also in relation to development at the Port of Gladstone (Section 6.6.2.5)
- Wader bird and marine megafauna surveys undertaken by GPC (GPC 2009, 2011)
- Baseline studies for environmental impact assessment of proposed tourism and residential development on HHI (SKM 2007).

Some ongoing monitoring is proposed as part of the project to validate impact predictions and check effectiveness of management mitigation measures. This will include water quality and sediment samples as well as some marine habitat surveys.

An environmental education facility is proposed to encourage community awareness, appreciation and understanding of native wildlife and to present and promote the GBRWHA values to visitors. Discussions are underway with leading Queensland universities to enable the centre to contribute to academic and scientific research in relation to development in the region. Extension programs will be implemented to support the management of the conservation areas and the interaction of residents within those areas. The programs will promote an understanding of the environmental values of the GBRWHA and the GBRMP and will include both voluntary conservation works and environmental education.

Depending on the focus of any associated research programs, this facility may also involve some research activities in the local or regional area.

A permit is required for all research activities in the GBRMP, except for limited impact activities. While research permits are not required for research in that part of the GBRWHA that is outside the GBRMP, a research permit system is also applied to the GBRCMP and administered by the Queensland DNPRSR. As all marine areas of the GBRWHA surrounding HHI that are not within the GBRMP are within the GBRCMP, this means that, effectively, research activities in the WHA are also managed through a permit system.

The permit system allows GBRMPA and Queensland DNPRSR to manage research activities such that impacts from research remain sustainable.

For land based research activities, the Queensland Government also administers a permit system under the *Nature Conservation Act 1992* for protection of flora and fauna.

On this basis, if an increase in research activities associated with the project does occur, adequate measures are in place to ensure that this remains within sustainable levels and hence, is not expected to have any impact on either the GBRMP or GBRWHA.

8.8.6 Environmental Awareness and Appreciation

The location of the PTP in the Mackay-Capricorn Region of the GBRMP/GBRCMP and GBRWHA presents a range of opportunities in relation to raising environmental awareness and appreciation. There is limited tourism development in this southernmost part of the GBRWHA and marine park and a consequential reduced appreciation and awareness of the features of the area that contribute to the OUV of the GBRWHA and the values of the GBRMP/GBRCMP.

The proposed environmental education facility will encourage community awareness, appreciation and understanding of native plants and animals, both marine and terrestrial and provide an opportunity to present and promote the GBRWHA to visitors.

Tourism attractions to be developed on the island will be required to have natural and cultural heritage themes, taking advantage of the natural setting. These will also provide an important opportunity to present the heritage values of the area and raise awareness of the need to protect natural and cultural heritage values. Proposed themes include an Indigenous Cultural Centre and an Ecological Design and Display Centre.

The proponent, Eaton Place is a gold member of Ecotourism Australia, providing the proponent access to information and support material on ecotourism activities and certification of those activities.

Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI.

Other specific opportunities to contribute to environmental awareness, appreciation and protection include:

- Signage at boat ramps providing information on:
  - Legislative requirements regarding litter and hydrocarbon discharge, and environmental impacts arising from these aspects
  - Marine park zones and activities allowed in zones
  - Minimising risk of boat strike, particularly through speed limits
- Provision of environmental awareness displays and information at the tourism information centre. This will include brochures and displays explaining and reinforcing:
  - Particular rules and regulations including control of dogs and prohibited access areas

- Other special areas in the marine environment that warrant protection, such as the seagrass beds in Seven Mile Creek and migratory shorebird roosting and foraging sites
- The environmental design features of the PTP, including water and wastewater management, stormwater management waste management and sustainable building design
- Tips for visitors to minimise their environmental impact while visiting the PTP. These tips will raise general public awareness of environmental issues, as well as reinforce aspects such as proper waste and wastewater disposal and energy efficiency
- Responsible use of the GBRMP/GBRCMP, including reducing impacts of recreational boating on water quality and marine megafauna
- Those features of HHI and surrounding waters that contribute to the OUV of the GBRWHA, the steps taken by the proponent to protect these features and additional actions that visitors can take to protect these features.

- Walking paths which provide controlled access to areas of HHI that can support access. These paths will include interpretive signs and information on plants and animals of the area. Care will be taken that walking paths do not fragment habitat.

Owners and operators of the various hotels, other accommodation facilities and other facilities on HHI will be required to comply with a range of building sustainability measures including sustainable building design and energy and water management systems. This will enhance understanding of sustainable building design and management, and the associated benefits.

While the benefits of these features are difficult to quantify, benefits are expected to be accrued on two levels:

- Presentation of and opportunity to enhance appreciation of the OUV of the GBRWHA
- Increased awareness of the potential impacts of tourism and recreation activities and how individuals can contribute to avoiding or minimising these impacts.

Benefits in relation to the GBRWHA/NHP and GBRMP are discussed further in Sections 11.7 and 12.2.

8.8.7 Summary of Potentially Significant Impacts

The potential for increased activity levels to impact on amenity of the GBRWHA/NHP are discussed in Section 11.4.4. Benefits in relation to presentation of and enhanced awareness and appreciation of the values of the GBRWHA/NHP are also discussed in Section 11.4.5.

Potential impacts of recreational visitor levels on the GBRMP are discussed in Section 12.2. Impacts of commercial tourism activities are not discussed further as these are managed through a permit system administered by the GBRMPA.

Impacts of increases in various types of activity on individual EPBC Act listed threatened species and ecological communities and migratory species are discussed in Sections 8.3 to 8.7.

8.9 Changes in Landscape Character and Visual Amenity

8.9.1 Changes to Landscape Character

The project will result in the following changes to the existing landscape character of HHI:

- Vegetation will be cleared from within the development footprint. Clearing will not occur within the coastal zone and in the Golf Course and Beach Precinct, Ocean View Precinct and Colosseum Precinct, 50 per cent of trees will be retained. Vegetation clearing envelopes will be specified in the Plan of Development (see also Section 2.5)
- Some minor changes to landform will occur as a result of levelling land for building, however, the proposed development has been specifically designed with existing topographic features in mind and only minor earthworks are required to create flat building pads in some locations.
- Buildings and other structures will be constructed within the proposed development footprint. As discussed in Section 2.2.4, there will be strict controls on building heights, built form, building materials and colours
- While it is illegal to drop litter in Queensland, humans may still drop litter. Section 8.7.4 discusses management and mitigation measures in relation to litter
- Lighting from buildings and street lights will be visible at night. Measures to minimise light spill are discussed in Section 2.2.4 and 8.4.10. Measures to minimise impacts of light spill on fauna habitat areas will also reduce impact on visual amenity.

An updated assessment of visual impacts of the project was undertaken and is presented in Appendix F.

8.9.2 Viewer Groups and Viewshed Significance

Cardno (2013a) identified key viewer locations and analysed the significance of viewsheds on HHI, based on an earlier assessment undertaken by SKM (2007).

Viewshed significance zones were then determined based on these factors and are shown in Figure 8-15. This assessment is discussed in more detail in Appendix F.

Table 8.18 analyses the importance of viewer locations based on the number of viewers, the scenic expectations of these viewers and the distance between the viewer and the project. Viewpoints are shown on Figure 8-15. Viewshed significance zones were then determined based on these factors and are shown in Figure 8-15. This assessment is discussed in more detail in Appendix F.

Table 8.18 – Viewer Groups and Viewpoint Significance Levels

Viewer Groups		Viewpoints (Figure 8-14)	Relative Annual Numbers	Likely Relative Scenic Expectations	Distance Range	Viewpoint Significance
1	Residents of and visitors to Tannum Sands	R1 , R2	High	High	>10 km (Background)	High
2	Small Communities Residents: Bangalee, Squatters and Mundoolin Rocks	R3, R4 & R6	Low	High	1km-8km (Foreground to Midground)	Moderate
3	Recreational fishers, divers and other boat and beach users	R5,R10	Low	Medium	1 km-13 km (Foreground to Background)	Moderate
4	GBRWHA/NHP /GBRMP Tourists	R7, R8 & R9	Medium	High	1 km-13 km (Foreground to Background)	Moderate
5	Crew members on ships in the Gladstone Harbour channel	R11	Medium	Low	>13 km (Background)	Low
6	Viewers from the air	Not assessed	High	Medium	2 - 8 km (Midground)	Moderate

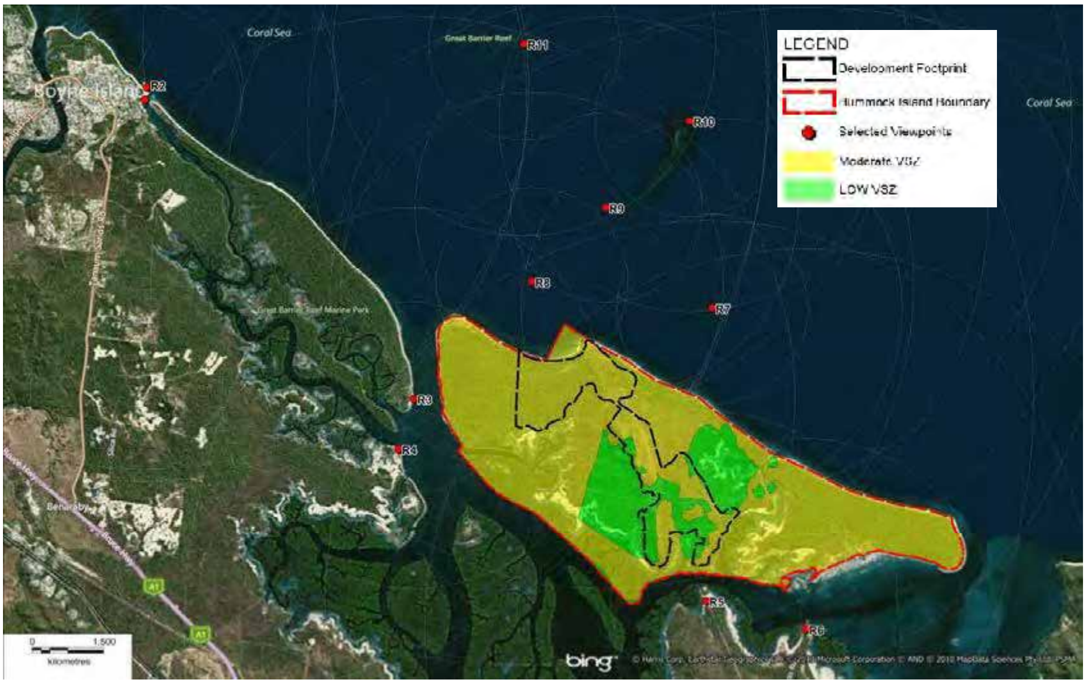

Figure 8-15 – Viewer Locations and Viewshed Significance Zones

HHI has no zones of high viewshed significance as those parts which are visible from external viewpoints are seen by viewer groups with moderate or low scenic demand and/or at mid-ground and background viewing distances. Most of HHI is considered of moderate viewshed significance, including most of the proposed development footprint. The central parts of HHI, including some of the development footprint, are mapped as low visual significance. This is consistent with the generally low visibility of the island to tourists and highway travellers, its distance from towns and the relatively low numbers of boat-based viewers.

The whole of HHI is visible from commercial aircraft flying into and out of Gladstone.

8.9.3 Desired Visual Outcomes

Cardno (2013a, Appendix F) identified five desired visual outcomes in relation to impacts of the project on visual amenity. These desired visual outcomes, together with an assessment of the extent to which each is achieved is provided in Table 8.19.

Desired visual outcome 1 relates specifically to impacts on world heritage values relating to criterion (vii). A more detailed analysis of this desired visual outcome is provided in Section 11.2. For desired visual outcomes 2 to 5, the assessment indicates that the outcomes can be met and there is minimal impact on existing viewers. This outcome is dependent on the building design and development requirements set out in Section 2.2.4 and the proposed Plan of Development. The requirements of the Plan of Development will be imposed on all development at the PTP through Gladstone Regional Council planning scheme requirements.

Table 8.19 – Desired Visual Outcomes

Visual Outcomes	Assessments
1. World Heritage Values relating to aesthetic Criterion (vii), and attributes which contribute to these, are not affected	The only World Heritage aesthetic attribute which is well represented on HHI (the intertidal mangroves) will not be affected by the proposed development. A more detailed assessment of potential impacts on views of HHI from offshore locations is provided in Section 11.2.2.
2. The existing natural setting of HHI remains visually dominant	This outcome will be achieved for viewer groups 1-5 (Table 8.18). HHI will remain predominantly natural. As seen from most external viewpoints (at viewing distances greater than 2 km), the proposed development is largely screened by existing vegetation and has low visibility. The small proportion of visible built form will not change the dominant vegetated look of the Island. Built form will be mainly low rise (to 13.5 m height), and even where visible will be below tree canopy height, retaining the wooded skyline. Building design and materials will minimise the intrusiveness of built structures. As viewed from the air (viewer group 6), the development will change the existing character of HHI. Although most of the island will remain in natural condition, the developed areas and the golf course will be visually prominent, in contrast to the surrounding bush and coastline.

Visual Outcomes	Assessments
3. In areas of moderate VSZ, new built forms, vegetation clearance, operations, night time lighting and earthworks have limited visibility or are hidden from observers at high and moderate viewpoint significance (viewer groups 1 - 4 and 6)	This outcome will be achieved for most of the proposed development, mainly as a result of vegetation retention in the wide coastal management setbacks from the coastline. Light sources will generally be below this tree canopy and screened from external land and sea based observers (viewer groups 1 – 4, and also 5). Hillside buildings and lighting from these buildings will be visible from offshore viewpoints, but at a distance and seen by relatively few observers. However this relatively minor visual impact (in terms of viewer numbers and distance) is capable of further mitigation at detailed design stage by design, colour, building material and height controls on built form, controls on external lighting in elevated positions, and by landscape planting of street trees and other vegetation. With respect to viewer group 6 (aircraft passengers flying overhead), the PTP cleared areas, buildings, golf course and a glow from night-time lighting will be a visual contrast as discussed above for desired visual outcome 2.
4. In areas of moderate VSZ, new development does not detract from views of tourists and residents (viewer groups 1, 2 and 4)	This outcome will be achieved, Views of mainland residents will include distant glimpses of a limited number of hillside buildings over and behind existing vegetation, and will see some distant lights at night, but this is not expected to detract from their existing coastal views. There are limited tourists in the area at present. Numbers of tourists will increase as a result of the project, however, these visitors will not have scenic expectations of an undeveloped island. Some boat and boat ramp users (viewer group 3), plus motorists driving to HHI will see the bridge and some built form on the hillside.
5. In areas of low VSZ, new built form, vegetation clearance, operations, night time lighting and earthworks are hidden from external views or visible to only a minor degree, remaining visually subordinate to the natural setting of HHI.	This outcome will be achieved. Proposed development in zones of low viewshed significance is well screened by the existing vegetation and landform.

8.9.4 Summary of Potentially Significant Impacts

The assessment undertaken by Cardno (2013a, Appendix F) and the earlier assessment undertaken by SKM (2007) indicates that minimal visual impact is expected from the project. As the attributes of HHI are assessed as lower importance in relation to contribution to the values specified in criterion vii and the associated contribution that HHI makes to the OUV of the GBRWHA, and minor impact is predicted, impacts in relation to visual amenity are not considered significant.

Visual impacts will also be controlled through the Plan of Development, to be agreed with GRC, which will specify:

- building envelopes that generally require at 50% of habitat trees to be retained on each lot building
- height controls such that building heights are consistent with tree height and the height of the ridgeline which bisects HHI and do not protrude significantly above these natural features

- contemporary architecture with a tropical character, utilising a blend of masonry and timber, low pitch roofs, avoidance of “blocky” structures and selection of light, natural colours and non-reflective building materials
- controls to minimise light spillage to habitat areas.

Condition 34 of Schedule 2 of the Coordinator-General’s report also contains conditions in relation to minimising visual intrusiveness of various elements of the proposed development. In recognition of the potential significance of views of HHI by viewers located within the GBRWHA/NHP, a more detailed assessment of potential impacts on views of HHI from offshore locations is provided in Section 11.2.2.

8.10 Impacts on Geological and Geomorphological Features and Processes

8.10.1 Overview

Geological and geomorphological features and processes are recognised as part of the OUV of the GBRWHA/NHP. Coastal and estuarine geomorphological processes are also important because these processes create and maintain habitats for a range of species and also influence water quality.

Impacts on geological and geomorphological features and processes may arise from

- Destruction or modification of landform features
- Obscurement of features
- Changes in geomorphological processes.

Analysis of the contribution of HHI to the OUV of the GBRWHA in relation to criterion “o*utstanding example representing major stages of the earth’s history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features*” is presented in Section 7.2.3. This analysis indicates that HHI and surrounding waters make on a minor contribution to the OUV of the GBRWHA as there is only minor expression of features of OUV present at HHI and in surrounding estuarine waters, consisting of:

- Minor expression of coastal geological and geomorphological changes and estuary formation
- Minor expression of geological and geomorphological processes in formation of coastal beaches and sand dunes, intertidal mud flats and tidal creeks
- Minor expression as an example of a continental island.

HHI does not feature any unique or unusual landscape or geomorphological features at either a regional or WHA-wide scale.

HHI is however located close to the mainland coast and forms the outer barrier of an estuary which in turn provides mangrove, seagrass, salt flat, mud flat and soft substrate habitats. Tidal flows, surface runoff and related sediment mobilisation are all important components of this estuary and interference with these could affect habitat values of the estuary.

8.10.2 Destruction, Modification or Obscurement of Landform Features

The footprint and development precincts of the project have been specifically designed with existing topographic features in mind and only minor earthworks are required to create flat building pads in some locations. As basement carparks are also proposed in some precincts, some excavation will be required to provide for this.

The headland, which is a prominent feature, is not altered at all, and the natural landform is taken advantage of in terms of being a focal point for the proposed development.

Development on the steeper slopes of the central ridge and Hummock Hill (Ocean View and Colosseum Precincts) is restricted to villas and houses that follow the contours. Building design is required to minimise earthworks in these precincts with use of multi-level designs and foundations that avoid or minimise excavations.

Roads connecting villas and houses in these precincts also follow contours to minimise the need for excavation.

Sand dune formations at the west of the island are largely outside the special lease area but will be protected within the proposed managed conservation area. Within the special lease, the development footprint avoids the coastal areas and active beach and dune systems. Assessment of these sand dunes has identified that these sand dunes are not unique at a local or regional level. Similar and better examples of sand dune systems are present in the area, both inside and out of the protected estate. Examples that are included in the protected estate include Wild Cattle Island which is protected in its entirety as a national park and Curtis Island which is within the GBRWHA/NHP and parts of which are also protected as national park. Sand dunes on Curtis Island are identified as representative examples of geological and geological features with OUV in the GBRWHA in a report undertaken for the GBR Strategic Assessment (Whiteway et al, 2013).

Controlled access points to the beach west of the headland will be provided from the development across dune formations and erosion prone areas. The number of access points has not yet been determined but will be based on a balance between providing sufficient access that visitors do not feel tempted to create their own access points and minimising damage. Likewise, the design of access points has not yet been determined but will consist of boardwalk and stair structures similar to the examples shown in Figure 8-16. Provision for wheelchair access will be made in at least one location.

The access points will be clearly marked, and signs will also be used to inform visitors not to access the beach by informal routes. As the coastal vegetation is reasonably dense, warning signs, coupled with controlled access is likely to be effective in preventing informal access. Rangers will be able to monitor beach access and quickly detect any informal access point and close them.

Stormwater management and drainage has also been designed so that existing subcatchments are retained with minimal alteration and runoff is managed such that increased erosion or destabilisation of ephemeral watercourses is avoided. This is described in detail in Section 2.7.3, Section 8.5.9 and Appendix D2.

All landform features, including the headland, Hummock Hill and coastal dune systems will therefore remain visible with negligible modification.

Analysis of landform features of HHI indicates that landform features are not unique and make only a local, minor contribution to the geomorphological values of the WHA. In any case, apart from development in some areas of relic sand dunes, no change to landform features will occur. A further assessment of the potential for landform-related values of the GBRWHA/NHP to be affected is provided in Section 11. No other impacts to MNES are expected in relation to impacts on landform.

Figure 8-16 – Examples of Controlled Beach Access via Boardwalk and Staircase

8.10.3 Changes in Geomorphological Processes

There are two key geomorphological processes evident at HHI:

- Sand dune and beach systems are somewhat active, and probably accreting rather than eroding (see also Section 6.3.2 and Section 7.2.3)
- Typical estuarine processes of sediment delivery and deposition are occurring in the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary system. Tidal flushing and catchment runoff both influences these processes.

In relation to sand dunes, the development footprint avoids active dune and beach areas. Structures are not proposed in these areas and access to the beach will be carefully controlled to prevent any destabilisation of the frontal dune.

A bridge is proposed across Boyne Creek at the location of the existing causeway. While the bridge has not been designed yet, design criteria will address impacts on tidal flows such that there is no retardation of tidal flows, and no local eddying effects around pylons.

A boat ramp is also proposed adjacent to the bridge, at the location of the existing causeway. The boat ramp is a low profile structure, laid directly onto the bank substrate. As tidal flows in this area are parallel to the shore, and occur in both directions, the boat ramp is unlikely to contribute to upstream deposition and downstream scouring processes that might occur if flows were only in one direction.

As discussed in Section 8.3, the opportunity to partially remove the artificial causeway structure has been identified.

As the causeway has the effect of a weir, retarding tidal flows slightly, breaching of the causeway would lead to restoration of slightly faster flows, at least in the centre of the channel. This may cause initial scouring of the channel and suspension of fine sediments in the vicinity of the breached causeway. However, it is expected that the soft sediments in the system would quickly equilibrate and any scouring would be in-filled.

While the intention in removing the causeway is to restore flows, the causeway has been in place for a long period of time, possibly over 100 years, and hence the altered flows may be considered natural in the context of benthic ecosystems in the immediate vicinity of the causeway. Boyne Creek is a dynamic tidal watercourse with a wide range of tidal conditions and flows, and hence, benthic ecosystems are expected to be tolerant of a range of flows. It is unlikely that changes in flows arising from removal of the causeway will cause any significant difference in these naturally dynamic benthic ecosystems.

There are no significant watercourses within or adjacent to the project, with surface runoff via overland flow and ephemeral drainage lines. Hence, fluvial geomorphological processes are not important in terms of the geomorphology of the area. In any case, as discussed in Section 8.5.9, the stormwater management system for the proposed PTP is based on maintaining subcatchment areas and managing runoff such that flows in ephemeral watercourses are not altered.

Significant erosion might result in large quantities of sediment being deposited into ephemeral waterways and coastal waters, causing changes to coastal sediment mobilisation processes. Erosion and sediment control measures discussed in Section 8.5.4 will prevent this from occurring.

Given that there are no unusual or unique geomorphological processes present on or around HHI, and given the very minor nature of changes to geomorphological processes, further assessment of the significance of impacts on geological and geomorphological values of the GBRWHA is not warranted.

8.10.4 Destruction or Modification of an Example of a Continental Island

The proposed development takes place on a continental island and will result in connection of this island to the mainland via a bridge.

However, no aspect of the proposed development will make HHI unrecognisable as an ex ample of a continental island, or change any of the features associated with its classification as a continental island.

As such, no impact is predicted in relation to this impact.

8.10.5 Exacerbation of Existing Threats

The review of geological and geomorphological features of the GBRWHA identifies threats to particular geological and geomorphological features. While HHI and surrounding waters do not provide representative examples of any of the identified geological and geomorphological features, the following general threats are noted in relation to continental islands, mangrove islands and seagrass beds:

- Threats to geological and geomorphological values and attributes of mangrove shorelines and mangrove islands are identified as climate change, catchment runoff and coastal and marine development. PTP is not expected to contribute to any of these threats as:
    - Clearing of mangroves is limited to 0.1ha in an already disturbed area (see also Section 8.3.2)
    - It is been demonstrated that stormwater runoff can be contained and treated such that there is no significant change to catchment runoff patterns or contaminant levels in stormwater (see also Section 8.5.7 and 8.5.8)
    - Introduced pests are not expected and control programs will be developed to address existing pests (see also Section 8.3.8 and 8.3.9)
    - The proposal will be required to comply with relevant aspects of Federal and State government policy in relation to climate change.

- Threats to geological and geomorphological values and attributes of seagrass beds are also identified as climate change, catchment runoff, coastal and marine development and direct use. An assessment of potential impacts of anchor damage to seagrasses associated with increased recreational boating activity is provided in Section 9.3.2 and monitoring and contingency mitigation measures proposed. Water quality degradation is not expected (see Section 8.3) and no other impacts to seagrass beds have been identified.
- Threats to geological and geomorphological values and attributes of continental islands are identified as climate change and coastal and marine development. PTP has been designed to avoid modification to geomorphological features and processes (see also Section 8.10) and in relation to climate change, the proposal will be required to comply with relevant aspects of Federal and State government policy in relation to climate change.

Degradation of water quality is also identified as a threat to a range of coral reef geomorphological features, however there are no such features within 50km of HHI and as discussed in Section 8.5, degradation of water quality is not expected, largely due to design features of the PTP.

8.10.6 Summary of Potentially Significant Impacts

Significant impacts on geological and geomorphological features have not been identified. A summary of the impact evaluation and associated measures to avoid and mitigate impacts on geological and geomorphological processes and features of the GBRWHA/NHP is provided in Section 11.3.

There are no impacts relating to geological and geomorphological values on other MNES.

8.11 Compliance with Objectives of EPBC Act

Section 3 of the EPBC Act contains the objectives of the Act. The guidelines for the EIS require discussion of compliance with these objectives. This is provided in Table 8.20.

Table 8.20 – Evaluation of Compliance with Objectives of the EPBC Act

Objective	Response
(a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance	Potential impacts on the environment generally, and on MNES, are evaluated In sections 8-13 of the EIS, using a robust methodological framework. The conclusion of the assessment is that no significant or unacceptable impacts on MNES are expected. A range of mitigation measures have been built into the project design and configuration to avoid direct and indirect impacts on MNES and in addition, effective mitigation measures are available to manage significant and potentially significant impacts. In relation to impacts on the environment generally, the project is also subject to a wide range of environmental protection requirements contained as conditions in the Coordinator General's report for the HHID (Queensland Government 2011) and will also be required to obtain detailed approvals under a range of environmental protection and resource management legislation.

Objective	Response
(b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources	The project does not draw on or utilise natural resources in an unsustainable manner. Water supply will be from desalination, and a comprehensive wastewater treatment and reuse system and stormwater management system has been developed so that there will be no adverse impacts on water resources. Vegetation clearing arising from the project will be offset in accordance with Queensland Government requirements. The proponent is required by the Coordinator-General's report to establish a conservation area on the balance of HHI outside the proposed footprint and to actively manage this area for conservation values. Households and commercial buildings will have solar power, which will be supplemented by electricity sourced from existing power supply generators and networks. Power generators are subject to carbon emissions trading requirements which are intended to limit carbon emissions to sustainable levels.
(c) to promote the conservation of biodiversity	The proponent is required by the Coordinator-General's report to establish a conservation area on the balance of HHI outside the proposed footprint and to actively manage this area for conservation values.
(ca) to provide for the protection and conservation of heritage	The principle heritage values present at HHI relate to its location within the GBRWHA and national heritage place. Assessment of potential impacts on the GBRWHA and national heritage place has not identified any significant or unacceptable impacts. The project will provide an opportunity to present the Mackay-Capricorn region of the GBRWHA and raise awareness of the WHA/NHP and associated outstanding universal values.
(d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples;	The proponent of the project has already entered into discussions with local government regarding sustainable development controls and management of the proposed conservation area, indicating a cooperative approach to land management and management development. Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI. The proponent will also seek to work with Maritime Safety Queensland and the Queensland Department of National Parks, Recreation, Sports, and racing in relation management of boating activities in the waters around HHI, which include the GBRCMP.
(e) to assist in the co-operative implementation of Australia's international environmental responsibilities; and	The project provides an opportunity to present the OUV of the GBRWHA. This will assist Australia in meeting its obligations in relation to presentation of world heritage values. As noted above, the project will not detract from any of the MNES values that Australia is obliged to protect under its treaty obligations.
(f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity;	Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI. HHI is located within the PCCC TUMRA and this may also present opportunities to partner on traditional knowledge and management approaches.

Objective	Response
(g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.	Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI. HHI is located within the PCCC TUMRA and this may also present opportunities to partner on traditional knowledge and management approaches.

8.12 Compliance with Principles of Ecologically Sustainable Development

Section 3A of the EPBC Act sets out the principles of ecologically sustainable development. Section 136 2(a) of the EPBC Act requires the Minister to consider principles of ecologically sustainable development when making decisions regarding approvals of actions. These principles are drawn from the National Strategy for Ecologically Sustainable Development (Australian Government 1992).

The PTPis designed from the ground up on ESD principles. Triple bottom line factors of economic, social and environmental issues have been considered and incorporated into the master planned project from the design stage. The guidelines for this EIS require discussion of compliance with the principles of ecologically sustainable development. This discussion is presented in Table 8.21.

Table 8.21 – Evaluation of Compliance with Principles of Ecologically Sustainable Development

Objective	Response
(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equity considerations	The material presented in this EIS supports decision making processes that integrate economic, environmental and social dimensions of sustainability. The proponent has also already undertaken formal and informal community consultation including formal public review of an EIS prepared under the Queensland SDPWOA. Comments made on the EIS were responded to by the proponent in a Supplementary EIS (SKM 2010) and taken into consideration by the Queensland Coordinator-General in preparation of a Coordinator-General's report recommending that the project proceed (Queensland Coordinator-General 2011). The impact assessment has not identified any significant or unacceptable impacts on MNES or on the environment generally. In particular, the proposed development footprint and design avoids impacts on sensitive features of HHI and surrounding waters. The proposal will provide economic and social benefits including: • Regional expenditure. An estimated $956 million will be spent on infrastructure, buildings and other facilities during the development phase, a period of about 16 years. Expenditure by international, interstate and domestic visitors is estimated at $55 million by 2022 and over $95 million by 2030. • Employment opportunities, particularly in the construction, hospitality and tourism sectors. This will help to diversify the labour force in central Queensland. An average of 190 direct construction jobs is expected to be generated over the 16 year development period and at full capacity, the development is expected to provide 700 direct jobs in tourism, hospitality and related areas. • Expenditure and employment opportunities will lead to

Objective	Response
	diversification of the local and regional economy which is currently heavily reliant on agriculture, resource extraction and manufacturing • New holiday and recreational opportunities will be created for residents in the central Queensland area. This will contribute to improved quality of life. • The project will include a wide range of accommodation and housing options to provide varying levels of affordability, from camping ground to a hotel-style resort. This will allow the recreational and leisure benefits of the proposal to be available to a wide social demographic. • Increased access to the GBRWHA and GBRMP/GBRCMP for enjoyment of the features and values of these by both residents in the region and visitors to the region. There are limited opportunities to access and enjoy the Mackay-Capricorn region of the GBRWHA/GBRMP. The proposal is consistent with and contributes to State and regional policies and plans, including in relation to regional tourism development (see also Section 3). The Central Queensland Tourism Opportunity Plan (2009-2019) identifies a lack of tourism and recreational opportunity in the region.
(b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;	The impact assessment of the project has not identified any serious or irreversible threats to the environment. Vegetation clearing required for the proposed development is effectively irreversible however the loss of this vegetation has not been identified as causing any significant impacts on MNES or overall biodiversity values. Further, clearing of vegetation must be offset in accordance with Queensland Government offset policies such that there is no net loss in biodiversity.
(c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;	The project is not expected to have any adverse impacts on the health, diversity and productivity of the environment such that adverse impacts on current or future generations might occur. There are no particular elements of the community that will adversely affected by the project. The proposed development will provide a valuable holiday destination and recreational opportunity for current and future generations, meeting a shortfall in such facilities in the region. Accommodation options and facilities have been selected to provide for and appeal to a wide social demographic.
(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	This EIS has not identified any adverse impacts on biological diversity or ecological integrity. The proposed development footprint and design avoids impacts on sensitive features of HHI and surrounding waters and includes features to avoid degradation of water resources. Vegetation clearing is required however the loss of this vegetation has not been identified as causing any significant impacts on MNES or overall biodiversity values. Further, clearing of vegetation must be offset in accordance with Queensland Government offset policies such that there is no net loss in biodiversity. The proponent also proposes, and is required as a condition of the Queensland Coordinator-General's report, to make the balance of HHI a conservation area. The Queensland Coordinator-General has recommended to the Queensland Minister for Nature Conservation that the balance of HHI be given conservation area status under the Queensland *Nature Conservation Act 1993*.

Objective	Response
(e) improved valuation, pricing and incentive mechanisms should be promoted.	As the project does not involve ongoing exploitation of natural resources, this principle is not directly relevant to the proposal. The project includes a comprehensive water cycle management approach that promotes sustainable use of water through provision of potable and non-potable water to buildings and facilities. Pricing of water and the availability of a range of water supply options will encourage residents and businesses to utilise the appropriate water stream, however design requirements will also make it mandatory to utilise non-potable (recycled) water for suitable uses. Incentives to utilise electricity sustainably are provided through the Australian government's carbon tax.

SECTION 9

Evaluation of Potentially Significant Impacts on EPBC Act Listed Threatened Species and Ecological Communities

Contents

9. Evaluation of Potentially Significant Impacts on EPBC Act Listed Threatened Species and Ecological Communities

9.1 Introduction

MNES values associated with listed threatened species and ecological communities at HHI are summarised in Table 9.1. These values were discussed in detail in Section 7.4. Only those species that are known to be present or considered potentially present on the basis of habitat suitability and local/regional presence are covered in this section. Note that the brigalow scaly-foot has been covered in this section although it was removed from the list of threatened species listed under EPBC Act in May 2013 as this species is listed in the guidelines as a species that must be addressed in the EIS.

Table 9.1 – Summary of MNES Values – Listed Threatened Species and Ecological Communities

Value	Description	Importance [1]
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia Endangered ecological community	This ecological community is present as a mosaic within a broader coastal vegetation community of area approximately 190ha (see Figure 7.1). Some previous disturbance and weed invasion has occurred however the patches are in generally good condition. While these patches were not identified in an inventory of this ecological community prepared by the threatened species scientific committee (TSSC 2008a), the patches are nevertheless potentially important.	Highest importance
Black-breasted button quail *Turnix melanogaster* vulnerable	Considered likely to occur due to suitable habitat and sighting of "platelets" and scats characteristic of quail species including the black-breasted button quail. No confirmed sightings.	Lower importance
Grey-headed flying fox *Pteropus poliocephalus* vulnerable	Suitable foraging habitat, with some recorded sightings. No evidence of a camp or of heavy utilisation. HHI is beyond the northern extent of current known range, but within what is believed to be the original range.	Lower importance
Brigalow reptiles: Yakka Skink *Egernia rugosai* vulnerable Collared delma (*Delma torquata*) (also Brigalow scaly-foot *Paradelma orientalis* which was delisted in May 2013)	Not identified in surveys and HHI is outside the modelled range of each species but modelling indicates that the species "may occur" on the adjacent mainland and suitable micro-habitat is available on HHI.	Lower importance (not present?)

Value	Description	Importance [1]
Water mouse *Xeromys myoides*. Vulnerable	Mapping accompanying SEWPaC's Significant impact guidelines for the vulnerable water mouse *Xeromys myoides* (DEWHA 2009b), indicates occurrence of water mouse on the eastern end of HHI. Suitable habitat exists but no known populations.	Lower-moderate importance
Flatback turtle *Natator depressus* Vulnerable, migratory, marine	Known to nest in very low numbers on beach to east of headland (Hodge et al 2007).	Moderate importance
Green turtle *Chelonia mydas* Vulnerable, migratory, marine	Known to occur in waters around HHI (GPC 2011).	Moderate importance
Loggerhead turtle *Caretta caretta* Endangered, migratory, marine	Known to occasionally occur in waters around HHI. No nesting sites within close proximity.	Lower importance

([1]) See also Section 1.7.4 for definitions of importance

Potential impacts of the project on MNES were reviewed in Section 8 and the following potentially significant impacts on listed threatened species and ecological communities were identified:

- Clearing of habitat and habitat disturbance for listed threatened species (grey-headed flying fox, yakka skink, collared delma, water mouse)
- Anchor damage to seagrass beds in Seven Mile Creek (loggerhead, flatback and green turtles)
- Artificial light on turtle nesting activities (loggerhead, flatback and green turtles)
- Boat strike and entanglement with litter and debris arising from increased recreational boating activity (loggerhead, flatback and green turtles).

A potential benefit may also arise through declaration of an actively managed conservation area which would remove or reduce several current threats to terrestrial MNES.

Each of these is discussed below.

Clearing of the endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* will not be required for the PTP (see also Section 8.3.2). As this area also provides habitat for black-breasted button-quail, direct impacts on this species will not occur. Indirect impacts on the ecological community, and habitat that potentially provides for black breasted button quail are also not expected due to the active management of the interface separating this vegetation from the development footprint through the conservation area management plan and as no alteration to surface hydrology will occur (see also Sections 8.4.2, 8.4.3).

9.2 Listed Threatened Species – Terrestrial

9.2.1 Grey-headed Flying Fox

Clearing of vegetation will reduce foraging habitat for grey-headed flying fox throughout clearing area (see also Section 8.3.2). Of the vegetation to be cleared, the following vegetation communities afford foraging habitat for grey-headed flying fox:

- *Eucalyptus crebra* woodland (clearing 23 ha)
- *Corymbia* spp., *Eucalyptus* spp., *Acacia* spp. open forest to low closed forest (clearing 185 ha)
- *Eucalyptus populnea* woodland (clearing 1 ha)
- *Eucalyptus tereticornis* and *E. crebra* dominated forest (clearing 175 ha).

A total area of 365 ha of woodland habitat suitable for grey-headed flying fox is to be affected, however, it is proposed to retain approximately 50% of mature habitat trees in each of these habitat types.

As grey-headed flying fox are known to forage in trees in developed areas, the residual loss of foraging habitat will be in the order of 182 ha. This represents about six per cent of the available habitat on HHI, and much less than 0.01% of the available habitat in the SEQ bioregion. The severity of this impact is considered to be moderate-low based on the criteria set out in Section 1.7.4.3, which sets the threshold for low severity at clearing of five per cent of habitat within HHI.

The PTP is required to provide vegetation offsets for clearing of endangered and of concern regional ecosystems under Queensland offset policies. The Coordinator-General's report for the HHID includes conditions requiring approximately 700 ha of native vegetation offsets, to be provided as close as possible to the proposed development. The areas identified for these offsets are shown in Figure 3.1. As grey-headed flying fox has a typical foraging range of 15 km, and a broader travel range of 50 km, offsets within close proximity of HHI are likely to provide compensatory habitat for any loss of habitat on HHI. The severity of any residual impact is therefore considered to be low.

Habitat available on HHI was assessed as being of lower importance to grey-headed flying fox (Section 7.4.3.3), and based on the impact significance criteria set out in Sections 1.7.4.4 and 1.7.7, residual impacts are not considered to be significant or unacceptable. No reduction in the regional population of grey-headed flying fox is expected. Further offsets are not proposed for grey-headed flying fox on the basis that a significant impact has not been identified. The EPBC Act Environmental Offsets Policy (SEWPaC 2012) only requires offsets to be provided where residual impacts are not considered significant. Regardless of this, it should be noted that offsets to be provided under Queensland legislation will provide a conservation benefit for grey-headed flying fox. Location of offsets required to be provided under Queensland legislation is shown in Figure 3.1.

9.2.2 Yakka Skink, Collared Delma and Brigalow Scaly-foot

Yakka skink, collared delma and brigalow scaly-foot have not been identified on HHI in surveys to date, however survey methods have not necessarily targeted these species (SEWPaC 2011). Surveys have also been limited in the coastal vine thicket as this area is outside the proposed development footprint. Given that there is a colony of brigalow scaly-foot on nearby Boyne Island, and that species modelling indicates that all three species “may occur” on the adjacent mainland, the potential presence of these species on HHI cannot be ruled out. However, the potential for occurrence is considered low given previous land uses and general lack of ground dwelling fauna identified on HHI through surveys (see also Section 7.4.3.7).

Note that the brigalow scaly-foot is no longer listed as a threatened species under the EPBC Act but has been retained in this assessment as the species is specifically identified in the EIS guidelines as requiring assessment.

If colonies of yakka skink, collared delma and brigalow scaly-foot are present, areas of habitat potentially utilised by these colonies could be lost as a result of clearing and earthworks. While the development footprint has generally been designed to avoid Queensland Regional Ecosystem classification land zone 3 vegetation communities as these are of conservation significance under Queensland legislation, two hectares of *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland (Queensland regional ecosystem classification 12.3.6) is required to be cleared for the main access road.

These animals are primarily ground dwelling, hiding under logs and rocks and in the bark of trees, all of which would be partially or wholly removed from this area to allow the road to be constructed (see Figure 7.11). The road would also increase the severance of habitat already caused by the existing airstrip. Section 8.6.3 describes measures that will be adopted to allow ground dwelling fauna to cross the main access road.

The methodology for this impact assessment requires a worst case scenario to be explored where there is uncertainty regarding whether a particular threatened species is present (see Section 1.7.8). This “worst case scenario” approach is appropriate in this situation where survey effort and methods have not fully met DotE requirements. If there were colonies of either yakka skink, collared delma or brigalow scaly-foot present within the proposed development footprint, or elsewhere on HHI, these would have a moderate or even high importance when considered against the criteria identified in Section 1.7.5, depending on the size and number of colonies. However this is a worst case scenario and is considered unlikely to occur.

Regardless, mitigation measures are proposed to address the worst case scenario. If the project proceeds, and before any vegetation clearing occurs, a suitably qualified brigalow reptile specialist will be retained to evaluate habitat within the proposed development footprint and within 500m of the main access road and identify areas which might potentially provide habitat for brigalow scaly-foot, collared delma or yakka skink. This can be carried out in conjunction with ecological equivalence studies (biocondition assessment) that are required to be carried out under Queensland

Government requirements for vegetation offsets as landzone 3 areas are included in the offsets package prepared for the State.

If this review identifies highly suitable habitat within the development footprint, targeted surveys will be undertaken at least 12 months in advance of clearing in a particular area. Surveys will follow the *Survey Guidelines for Australia's Threatened Reptiles* (SEWPaC 2011). If these surveys identify colonies within the actual development footprint:

- The proposed development plan will be reviewed and, if possible, the colony will be avoided and a suitable buffer provided, preferably with connectivity to adjacent potential habitat areas. Monitoring of the colony will then continue to determine whether the colony remains viable. If necessary predator-proof fencing can be installed to further protect the colony. The proposed development footprint has a high degree of permeability and it is quite likely that avoidance will be possible.
- If the location of the colony is such that the development footprint cannot be modified such that a viable patch of habitat can be retained:
    - A translocation site will be identified. This will need to feature highly suitable habitat, not be occupied by potential competitors, containing adequate foraging resources and located in the proposed conservation area such that future disturbance will not occur.
    - Habitat enhancement will be undertaken as required, including enhancement of movement corridors
    - The colony will be translocated through catch and release
    - Ongoing monitoring will be undertaken to determine the viability of the colony.

If colonies are identified within 500m of the main access road, the potential for the reptiles to be prevented from dispersal movements by the road will be reviewed and suitable fauna crossing measures will be incorporated into the design of the road. This will most likely involve underpasses along drainage lines, with enhanced microhabitat in movement corridors leading to this habitat to encourage use of the underpasses and protect the animals from predation while dispersing. Note that vehicle strike is less of a concern for these small reptiles as they are unlikely to venture into the open areas along the road shoulder and road pavement due to exposure to predation.

The potential for catch and release to be successful for either yakka skink, collared delma or brigalow scaly-foot is not known. Careful planning will therefore be required to select a suitable site and develop techniques for capturing and releasing target species. Translocation may include moving habitat features or burrows and re-establishing food sources at the translocation site. As there is some uncertainty as to the effectiveness of this mitigation measure, if yakka skink, collared delma or brigalow scaly-foot do need to be translocated, the proponent will engage with brigalow belt reptile specialists to develop the translocation plan.

A review of the success of vertebrate translocation programs identified that predation was the critical factor affecting success of translocation of vertebrates (Short 2009). As part of the active management of the conservation area, there will be a program to address feral dogs and pigs. In addition, if necessary, the selected translocation site can be fenced to protect the translocated population from predation. This would also benefit any populations that may be present that are not required to be translocated.

The Australian Government's Species Profile and Threats database infers that light spill from roadside lighting may be a threat to brigalow scaly-foot (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59134, accessed 30/03/2013). Artificial light can have both positive and negative effects on ground dwelling nocturnal species. Light may increase foraging success, but at the same time increase predation risk. Controls are proposed generally to prevent light spill beyond the development footprint (see Section 8.4.10) and if any colonies of brigalow reptiles are identified near the edge of the development footprint or in undisturbed areas within the footprint, light spillage in these areas will be monitored as development proceeds and screening put in place if necessary. Predator control will also reduce predation risk and proposed controls on domestic cats and dogs will prevent increased predation risk.

As the likelihood of brigalow reptiles being present on HHI has been assessed as low, offsets of potential habitat are not proposed. However, if a colony of yakka skink or collared delma is identified, and cannot be avoided or translocated, the proponent will provide offsets for any known habitat that is lost. If required, offsets will be in the form of:

- Protection and enhancement of suitable habitat within the proposed conservation area. This will include removal of threat of future development over this area, as well as predator control and, if necessary habitat enhancement.

- Protection and enhancement of suitable habitat within the area required to meet Queensland Government offset requirements. Required offsets include some areas of landzone 3 regional ecosystems which have been identified as potential habitat for yakka skink and collared delma.

Note that the proponent will not provide offsets for suitable habitat unless there is clear evidence that yakka skink or collared delma is present on HHI. The proposed pre-clearing monitoring will detect if this is the case.

Overall, impacts on yakka skink, collared delma and brigalow scaly-foot are not considered significant on the basis that:

- HHI has not been identified in species modelling as known or potential habitat for yakka skink, collared delma and brigalow scaly-foot and there is a low likelihood of yakka skink, collared delma or brigalow scaly-foot being present
- If the worst case scenario does eventuate and moderate or highly important habitat is identified on HHI, it is likely that these colonies can be avoided through re-working of the development footprint or, where the proposed development footprint cannot be reworked, captured and released into other suitable habitat
- If the worst case scenario does eventuate and important habitat is identified on HHI, effective mitigation measures are included in the proposal to address indirect impacts such as predation and light scatter as well as maintenance of dispersal movements.

Finally, if yakka skink, collared delma and/or brigalow-scaly-foot are present, the proposed actively managed conservation area may improve the security of colonies, particularly through potential to reduce predation by feral animals and restore appropriate fire regimes in the managed conservation area.

9.2.3 Water Mouse

Suitable water mouse habitat exists in mangrove and saltpan areas around HHI. Mapping accompanying DotE's Significant Impact Guidelines for the vulnerable water mouse *Xeromys myoides* (DEWHA 2009b), indicates occurrence of water mouse on the eastern end of HHI. While this record is outside the development footprint, water mouse forages over home ranges of at least several hundred metres radius. A trapping program undertaken at the site of the proposed bridge and boat ramp in 2007 did not identify any water mouse utilising this area. Hence, HHI as a whole may have lower to moderate importance in terms of habitat values for water mouse, and the area immediately adjacent to the development footprint has lower importance as it has not been identified as supporting a population of water mouse.

The proposed bridge and boat ramp will be located on the footprint of the existing causeway and hence only 0.11 ha of mangrove will be cleared for construction of the proposed bridge and boat ramp, including the area already disturbed by the existing causeway. An area of 0.24 ha of saltpan, including the area already disturbed by the existing access track will also be cleared or affected, with the majority of this on the mainland as a result or upgrading of the existing rock and earth causeway that conveys the extension of Clarke's Road across the saltpan. This upgrade will include provision for tidal flows to pass through the causeway.

These clearing areas are very small compared to the overall area of available mangrove and saltpan habitat. There is 473 ha of mangrove and 370 ha of saltpan on HHI, with significantly larger areas of saltpan on the mainland coast of the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary. The existing causeway already causes some severance of the mangrove fringe, and hence the proposed bridge and boat ramp will have negligible habitat severance for water mouse, and the bridge may in fact provide shelter to water mouse moving along the coastline. The level of activity at the boat ramp may however discourage water mouse from accessing this area.

Given the very low level of clearing required, and that the clearing takes place in areas already disturbed, impacts on water mouse are considered not significant, and no unacceptable impact is expected when considered against the criteria established in Section 1.7.4.

Provision for tidal flows where the existing Clark's Road causeway crosses salt pan on the mainland may slightly improve this area as habitat for crustaceans and other invertebrates that are food for water mouse. While this is unlikely to lead to any measurable increase in food availability at an estuary scale, given the small area involved, the area potentially benefiting is similar to that affected by bridge and road construction. Finally, if water mouse is present anywhere on HHI, the proposed actively managed conservation area may improve the security of colonies, particularly through potential to reduce predation by feral animals.

Offsets are not proposed for water mouse on the basis that a significant impact has not been identified. The EPBC Act Environmental Offsets Policy (SEWPC 2012) only requires offsets to be provided where residual impacts are considered significant.

9.2.4 Mitigation Measures – Listed Threatened Species – Terrestrial

A range of mitigation measures have been proposed in this EIS that will avoid or minimise impacts on threatened terrestrial species and known and potential habitat for these species. These include matters incorporated into conceptual design and overall footprint development as well as commitments in relation to design, construction, operation and maintenance. A summary of measures included in Sections 2, 8 and 9 are presented in Table 9.2.

As these measures are largely based on avoiding impacts on habitats identified as supporting or potentially supporting listed threatened terrestrial species, the measures are considered highly effective and reliable. Active management of the balance of HHI as a conservation area is expected to be effective in reversing current degradation and enhancing habitat. Further discussion of the proposed approach is provided in Section 8.3.8 and 8.3.9.

Some uncertainty remains regarding the effectiveness of relocation of collared delma and yakka skink, if these two species are identified in pre-clearing surveys. If these reptiles are identified as present, and habitat cannot be avoided, the proponent will work with Brigalow Belt reptile specialists to develop relocation plans and monitor the effectiveness of these plans. Reduction in predator levels will assist in addressing failure risk associated with translocation programs.

All contractors will be made aware of requirements in relation to vegetation and habitat clearing and management. Requirements will be enforced by the proponent through contract conditions and contractors may also face prosecution if vegetation and habitat clearing is not in accordance with development permits. Management of contractors is described in more detail in Section 1.3 of Appendix G.

Table 9.2 - Summary of Measures to Avoid and Mitigate Impacts on Terrestrial Threatened Species

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Avoid clearing in *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and potential black-breasted button quail habitat	Proponent commitment Statutory requirement (a development permit is required to clear this area)	Already in place	Monitoring of clearing effort	Contractors to reinstate vegetation if clearing does not comply with specification Contractor may face prosecution by Queensland Government if clearing is not in accordance with development permit
Ensure that all habitat types and vegetation communities present on HHI are retained at viable patch sizes	Proponent commitment Statutory requirement (vegetation can only be cleared in accordance with development permit)	Already in place	Monitoring of clearing effort	Contractors to reinstate vegetation if clearing does not comply with specification Contractor may face prosecution by Queensland Government if clearing is not in accordance with development permit
Manage interface zones around sensitive habitats	Proponent commitment Statutory requirement (vegetation can only be cleared in accordance with development permit)	Already in place	Monitoring of clearing effort	Contractors to reinstate vegetation if clearing does not comply with specification Contractor may face prosecution by Queensland Government if clearing is not in accordance with development permit.
Retain wildlife corridors and maximise permeability of proposed development to fauna movement	Proponent commitment Statutory requirement (vegetation can only be cleared in accordance with development permit)	Already in place	Monitoring of clearing effort	Contractors to reinstate vegetation if clearing does not comply with specification Contractor may face prosecution by Queensland Government if clearing is not in accordance with development permit
Provide offsets for clearing of Regional Ecosystems under Queensland *Vegetation Management Act 1994*.	Statutory requirement	Prior to clearing	Monitoring of offset areas as per development permit	Increase management levels in offset areas as required to achieve regional ecosystem status
Retain 50%of trees in woodland areas within development footprint	Plan of Development, enforced through	During clearing	Monitoring of clearing effort	Contractors to reinstate vegetation if clearing does not comply with

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
	Gladstone Regional Council			specification Contractor may face prosecution by Gladstone Regional Council if clearing is not in accordance with development permit
Conduct habitat assessment and, if necessary targeted surveys for brigalow belt reptiles	Proponent commitment	Prior to clearing	Habitat assessment completed Targeted surveys following Survey Guidelines for Australia's Threatened Reptiles (SEWPaC 2011)	If colonies are identified: Reconfigure the development footprint to avoid or, if this is not possible Devise a catch and release methodology
Minimise clearing of mangrove and salt flat habitat when constructing boat ramp and bridge and upgrading causeway.	Proponent commitment	Prior to and during construction	Monitoring of clearing extent	Prosecution of contractors who undertake clearing outside authorised areas Contractors required to reinstate damaged areas
Ensure that causeway on mainland provides for tidal flows.	Proponent commitment Statutory requirement (approval is required for coastal works under the Queensland *Sustainable Planning Act 2009*/*Coastal Protection and Management Act 1993*)	Detailed design	Design checks	Prosecution of contractors who do not comply with development permit (authorised design for causeway)
Establish a managed conservation area of the balance of HHI, develop and implement a management plan for this area	Proponent commitment Coordinator-General's report condition	Construction and operation	Monitoring program for conservation area to be developed	Develop additional management approaches as required to achieve conservation outcomes sought.

9.3 Listed Threatened Species - Marine Turtles

9.3.1 Overview

Marine turtles are known to utilise the waters of Seven Mile Creek and Boyne Creek and are expected to also be present in the deeper waters of Colosseum Inlet. In aerial surveys undertaken by GPC, five marine turtles were identified in the Rodds Bay area on a single day in April 2011 and 23 on a single day in June 2011, with three of the five sightings in April and all of the sightings in June at low tide. Sightings were in Boyne Creek, Seven Mile Creek and north of Rodd's Peninsula (GPC 2011). While this data is insufficient to estimate the likely number of turtles that may be utilising the area, it does indicate low-moderate usage of the area.

As discussed in Section 7.4.4, the waters around HHI are considered to be of moderate importance in relation to marine turtles, particularly the flatback turtle and green turtle, both of which are vulnerable under the EPBC Act. Flatback turtle nest intermittently in very low numbers on HHI and both flatback and green turtles also nest in low to moderate numbers on nearby islands such as Curtis Island and may use waters around HHI in the internesting period as well as for foraging generally. Loggerhead turtles and hawksbill turtles have also been sighted, however the waters around HHI are less likely to be important habitat to these species based on habitat preferences.

9.3.2 Anchor Damage to Seagrass Beds

As described in Section 6.6, there are intertidal and subtidal seagrass beds in Seven Mile Creek that appear to persist from year to year, with an approximate area in the order of 300ha. The majority of these beds are mapped as *Zostera capricorni* with some *Halodule sp* and *Halophila sp* intermixed, and one patch of subtidal patch of *Halophila sp* of area approximately 4 ha in 2002 and 43 ha in 2009 (Rasheed et al 2003, Thomas et al 2009).

There is also a large patch of dense subtidal *Halodule uninervis* in deeper water approximately one kilometre offshore (north-east) of HHI of area around 200 ha in 2002 and 439 ha in 2009 (Rasheed et al 2003, Thomas et al 2009).

Green turtles feed almost exclusively on seagrass and algae while flatback turtle are mostly carnivorous (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl, accessed 31/03/2013). Hence, damage to seagrass beds may directly affect green turtles, while effects on flatback turtles would be by an indirect pathway if loss of seagrass beds led to reductions in invertebrate food sources.

Increased recreational boating activity may increase the extent of anchoring that occurs in Seven Mile Creek as recreational boaters are likely to access this area for fishing. As the majority of seagrass beds in this area are identified as intertidal, this will limit boat access at low tide, however at high tide, some anchoring may still occur in shallow waters across these seagrass beds. Note however that boats fishing in the shallow waters of Seven Mile Creek may be left to drift as occupants fish, rather than anchored.

Frequency of anchoring is less likely to increase over the larger subtidal *Halodule uninervis* patch to the north of HHI, as the type of small boats that can be launched from the proposed boat ramp at PTP will only be able to access the offshore areas in fine weather (see also Section 8.8 and Figures 6.45 and 6.46). Further, there is no particular reason to anchor over this seagrass bed compared to any adjacent sandy bottom areas and the density of anchoring over the seagrass beds is expected to be low.

A seagrass monitoring study of the Whitsundays found a correlation between higher levels of anchoring and reduced seagrass abundance (Campbell and McKenzie, 2001). While damage from anchoring was considered to be recoverable if the disturbance from anchoring was reduced or halted, if anchor damage led to uprooting of rhizomes over large proportions of the seagrass bed, recovery would be compromised.

Anchor damage to corals, and to a lesser extent seagrass beds has been identified as a management issue for the GBRMP and GBRMPA has responded by providing fixed moorings in high visitation and/or highly sensitive areas (GBRMPA 2009).

As potential damage to seagrass beds in the vicinity of HHI cannot be quantified with available information, the proponent proposes to undertake monitoring of seagrass beds to check for damage and recovery. The proposed monitoring program is described in Section 9.3.8. Anchor damage to seagrass is easy to detect.

If this monitoring reveals that the extent or productivity (biomass) of seagrass beds appears to be declining, the proponent will work with the Queensland NPRSR, which manages the GBRMP to determine whether:

- A “no anchoring zone” can be established over the seagrass beds and
- Permanent moorings can be provided in this area so that anchoring is not required.

If these mitigation measures were considered to be appropriate, the proponent would install these at its own expense and provide information to recreational boaters on the location of and importance of the “no anchoring zone”. Information will also be provided on the use of the moorings, drawing particularly on information provided to GBRMP users such as the information brochure *Public moorings and anchoring protecting coral in the Whitsundays* (GBRMPA/Queensland Parks and Wildlife Service, 2002, available from http://www.gbrmpa.gov.au/__data/assets/pdf_file/0017/3266/gbrmpa_Mooring_Anchoring_Protecting_Coral_Whitsundays_2002.pdf). These management measures have been used by GBRMPA and Queensland NPRSR to manage anchoring impacts on seagrass and coral ecosystems (see for example http://www.nprsr.qld.gov.au/parks/brook-islands/about.html, http://www.gbrmpa.gov.au/visit-the-reef/responsible-reef-practices/anchoring-and-mooring). As enforcement can be an important aspect of the effectiveness of these programs, the proponent will discuss with the Queensland Government whether assistance with enforcement is necessary.

A key feature of seagrass-friendly moorings is that the moorings do not have chains that drag across the seabed which, in seagrass areas, can damage seagrass. Various trials have been undertaken to inform design of seagrass-friendly moorings and these will be utilised in determining and appropriate design for Seven Mile Creek, if the moorings are required. These studies include:

- Seagrass friendly mooring trials in Moreton Bay undertaken by Queensland Department of Employment, Economic Development and Innovation in 2010 and 2011 (DEEDI 2011)
- A comparison of seagrass friendly mooring systems undertaken by researchers at the University of Wollongong (Demers et al, 2013)
- A review of the effectiveness of seagrass friendly moorings in Pittwater, north Sydney (Gladstone 2010).

GBRMPA also has a policy on moorings in the GBRMPA and while the proposed moorings would be in the GBR Coastal Marine Park, this policy is considered relevant to determining the need for and approach to moorings.

Regardless of whether monitoring indicates anchor damage is affecting the abundance of the seagrass beds in Seven Mile Creek, the proponent will also provide signs and written information to boaters encouraging them to avoid anchoring over seagrass and to use sand anchors rather than plough anchors in estuarine waters. GBRMPA identifies education and public awareness as a vital component of the management of recreation in the Marine Park (GBRMPA 2012) and the proposed mitigation measures will contribute to this.

Provided that damage to seagrasses is detected early, recovery of seagrass is expected to occur within several years once the anchoring pressure is reduced or removed (Campbell and McKenzie 2001). Given that adverse impacts on seagrass beds are reversible in the short term if detected early, severe and ongoing impacts on productivity of seagrass beds on Seven Mile Creek can be avoided through monitoring and corrective action. As bi-annual monitoring is proposed in the initial five years, any decline in seagrass due to anchor damage will be detected early and this will trigger mitigation measures to prohibit anchoring over the seagrass beds. Provided that the impact is detected early, the seagrass beds can be expected to recover within several seasons, hence, in the worst case, the foraging resources of this particular seagrass meadow may be reduced for a period of two to three years.

Anchor damage to seagrass in open coastal waters north of HHI is not expected to arise from provision of the proposed boat ramp as trailerable boats launching from the boat ramp will not be able to access offshore waters except under fair weather conditions (see Section 8.8), and in any case, these seagrass beds re not detectable from the surface and hence, would not be targeted by recreational boats.

In terms of impacts on marine turtles, short term loss of seagrass resources in Seven Mile Creek will reduce foraging resources for the green turtle. There are a range of alternative seagrass resources available in the vicinity of HHI and provided that these other resources remain in moderate to good condition, foraging resources for green turtles should be maintained with no adverse impacts at a population level while seagrass beds in Seven Mile Creek recover.

Seagrass resources can fluctuate from year to year, and seasonally, in response to freshwater inputs, sediment levels (also related to rain events as sediment is mobilised from catchments) and other factors (Campbell and McKenzie 2001). As discussed in Section 7.5.3, severe weather events over the summer of 2010/2011 appear to have led to reduction in seagrass health and abundance along the east coast of Queensland. Studies of similar events indicate that seagrasses can recover from weather related events within three years (Campbell and McKenzie 2004). Should a reduction in seagrass resources in Seven Mile Creek from anchor damage coincide with a more widespread reduction in seagrass health, this would cause a further reduction in seagrass resources available to green turtles, however the quantum of this further reduction would be very small in comparison to overall impacts on seagrass resources from severe weather events. This combined impact of weather related impacts and impacts related to anchor damage would occur in the short term with recovery from anchor damage and weather related damage expected. Recovery of seagrass beds from weather related events can be expected to occur within about three years (Campbell and McKenzie 2004) and it would be possible to establish no-anchor zones within about 6 months of detecting a decline in seagrass beds in Seven Mile Creek from anchor damage. Given the proposed annual monitoring of seagrass beds in Seven Mile Creek in the early years of the proposed development, adverse effects of anchor damage will be detected early and should be reversible (Campbell and McKenzie 2001).

Therefore, there is a low likelihood that, if anchor damage to seagrass beds in Seven Mile will lead to any medium to long term impacts on green turtle health, and anchor damage would make a minor contribution to short term (reversible) impacts if anchor damage occurred coincidentally with weather related impacts on seagrass.

Significant or unacceptable impacts are therefore not anticipated.

9.3.3 Artificial Light

GHD (October 2012) identified two key impacts of artificial lighting on marine turtles:

- Disorientation of hatchlings, affecting hatchlings' ability to find the sea after hatching (see also GBRMPA 2009). The hatchlings become more vulnerable to predation if disoriented
- Disorientation of female turtles returning to the water after nesting. This can increase the energy costs of nesting activities and, where there are hazards such as roads adjacent to nesting beaches, female turtles may enter hazardous situations. A turtle nesting survey on HHI noted some apparent disorientation from observations of female turtle tracks which was ascribed to light glow from the Boyne Island smelter and general Gladstone/Boyne Island/Tannum Sands conurbation (Hodge et al 2007).

It would appear that both female turtles and hatchlings orient themselves by the differential between light reflecting from the ocean and land and hence, any artificial lighting that can make this differentiation less apparent can cause confusion (GHD 2012).

There are no formal guidelines regarding light levels that might affect turtle nesting behaviour and hatchling behaviour, and hence the proponent has made a commitment to ensure that artificial light from the project does not cause any (further) increase in light pollution at the beach east of the headland.

The beach utilised by flatback turtles (see Figure 6.52) is noted to be affected by light glow from development at Boyne Island and surrounding areas (Hodge et al 2006). The project avoids development at or near this beach with the nearest built features being over 300 m away. The coastal vine thicket vegetation provides a continuous vegetated screen along the rear of the beach and is to be retained.

The extent of vegetation to be retained can be seen on Figure 2.3, which shows the development master plan overlaid on aerial photography and also Figure 6.52 which shows the location of the beach where some flatback turtle nesting has been observed to occur. Vegetation outside the proposed development footprint is to be retained and managed as a conservation area (see also Section 2.6.3). Figures 6.1 and 6.2 show topography and slopes on HHI. As discussed in Section 8.10.2, there will be minimal change to topography within the development footprint and no change outside the development area as a result of the proposed development. Figure 9.1 to 9.4, which correspond to photo points on Figure 6.52 show the extent of vegetative screening:

- Figure 9.1 shows the view from the headland along the turtle nesting beach east of the headland. Only a small portion of the beach can be seen, with vegetation and topography screening the remainder of the beach to the east

- Figure 9.2 and Figure 9.3 show views toward the beach from the development footprint at the closest points to the beach. The dark green vegetation is the Littoral Rainforest and Coastal Vine Thickets of Eastern Australia/ *Corymbia spp.*, *Eucalyptus spp.*, *Acacia spp.* open forest to low closed forest complex which is to be retained and managed in the proposed conservation area (the location of this vegetation is also shown on Figure 7-1). This vegetation provides a thick screen between the development footprint and the beach.

- Figure 9.4 shows the view from the last known location where turtle nesting took place (Hodge et al, 2007) looking back towards the headland. The headland is not visible from this location due to the screening effect of vegetation and topography.

Figure 9.1 – Photo Point 1 (Figure 6.52) – Looking East from Headland

Figure 9.2 – Photo Point 2 (Figure 6.52) – Looking North-East from development footprint towards beach (beach is not visible due to vegetation)

Figure 9.3 – Photo Point 3 (Figure 6.52) – Looking North-East from development footprint towards beach (beach is not visible due to vegetation)

Figure 9.4 - Photo Point 4 (Figure 6.52) – Looking North-West from last known location of turtle nesting towards headland (headland is not visible because of vegetation)

Building heights have been shown in Section 2.3.3. Building heights will be imposed through the Plan of Development which will become a statutory instrument under the Gladstone Regional planning scheme.

In combination, retention of screening vegetation, avoiding any change to existing topographic features and building height restrictions imposed through the Plan of Development will mean that light spill from the Bushland, Hillside, Golf and Beach Resort and Resort Village precincts to the beach east of the headland is expected to be largely avoided. Light spill from the proposed Headland Resort precinct may occur and mitigation will be required.

During detailed design, further consideration will be given to potential for lighting from buildings to affect the ability of nesting turtles and hatchlings to find the water. While the main concern is expected to be in relation to the Headland Resort precinct, the potential for light spill from all precincts will be checked once building locations are available. The following measures will be incorporated into all aspects of design:

- All external lighting will comply with the Australian Standard AS 4282—1997, Control of the obtrusive effects of outdoor lighting. This standard includes a range of measures to prevent light spill from outdoor lighting. Consideration will also be given to standards set in the Gladstone and Calliope Planning Schemes which, while not directly applicable to PTP, are representative of appropriate local and regional standards
- Lighting will be downward facing and of the minimum brightness required for human safety
- Unnecessary lighting will be eliminated and outdoor lighting will be placed at the lowest level possible, with waist height lighting and ground lighting used for outdoor pathways wherever possible.
- If appropriate, motion sensors will be installed for external lighting so that lights are only on when needed.
- Windows opening directly towards the turtle nesting beach can have tinted glass.
- Low pressure sodium vapour lights will be used for external lighting in all locations where light spill may occur to the beach east of the headland. The recommendation report for the Great Keppel Island Revitalisation Project (EPBC 2010/5521) indicated that these lights are considered to be “turtle-friendly”.
- Balconies will be constructed so that screens can be added if necessary.

In addition, residents and guests in any accommodation facing towards the east beach will be asked to close blinds at night during turtle nesting season. Signs will be placed in rooms to explain the importance of this measure.

Prior to commencement of the proposed development, baseline light levels along the beach east of the headland will be recorded, together with observations of existing sources of light spill. As the beach is already light-affected due to development on the mainland, baseline monitoring will be required. As the development proceeds, monitoring of light spill from the development at the nesting beach will be undertaken and if this monitoring indicates that light spillage has increased, one or more of the following measures will be undertaken:

- Lights will be moved or modified to reduce light spill, or screens will be placed on lights to prevent spill towards the beach
- Lights will be replaced with low sodium vapour lights or similar low frequency lights
- Additional vegetation will be planted to increase screening. As vegetation may take some time to grow to the required height, temporary screens may be required. Temporary screens may be made from metal, wood, plastic or other suitable material and installed as required on buildings or on the land between buildings and the beach.
- Directional shields may be applied to windows and balconies.

Monitoring will occur annually, prior to the turtle nesting period until the proposed development is complete and will include measurement of light wavelengths outside the range visible to humans.

Given the natural screening features present, building height restrictions imposed in the Plan of Development, the distance of development from the nesting beach and that design, screening and other mitigation measures are available to address any light spillage that does occur, the potential severity of impact on turtle nesting activities is negligible. No significant or unacceptable impact is expected.

9.3.4 Boat Strike and Disruption to Movement

Boat strike, from both recreational and commercial boats, has been identified as a threatening process to marine turtles (Environment Australia 2003). The waters around HHI have been identified as being of moderate importance in relation to marine turtles, with the endangered loggerhead turtle an occasional visitor and the vulnerable green turtle and flatback turtle common (see also Section 7.4.4).

As discussed in Section 8.8, recreational boating activity is anticipated to increase in water surrounding HHI, and particularly in the waters of Colosseum Inlet, Boyne Creek and Seven Mile Creek as a result of the installation of a formal boat ramp as part of the PTP. A two lane boat ramp may induce recreational boat traffic in the order of 50-150 boats for normal and peak weekends respectively (see also Section 8.8.2). The increased activity in the waters around HHI is attributed to provision of a formal boat ramp rather than population increase associated with the proposed development, and as such, boating activity is not expected to increase significantly at a regional level but rather, to be redistributed from other locations.

Construction of the bridge and pontoon for the boat ramp will require a small piling barge and tender to be brought to Boyne Creek.

Queensland government maintains a database of strandings and deaths of turtles in Queensland, including in the GBRMP and GBRWHA. The data is based on confirmed sightings or findings of dead or injured animals and may represent only a proportion of the total mortality each year. Table 9.3

provides annual mortality and stranding data for waters in the 23° and 24° latitude blocks along the Queensland coast as well as the total mortality/stranding numbers for Queensland from 2009 to 2010 (Biddle and Limpus 2011). (HHI is located between latitude 23°59" and 24°02", the Port of Gladstone and associated shipping channel is located between about 23°45" and 23°55").

Table 9.3 – Summary of Mortality and Strandings by Latitude (All Causes, Including Animals Released Alive)

Year	23° latitude block	24° latitude block	Total Queensland	Proportion
1999	31	51	554	15%
2000	36	26	495	13%
2001	24	43	533	13%
2002	46	31	543	14%
2003	68	26	527+22?	17%
2004	53	25+1?	566+8?	14%
2005	29 +1?	16	563+14?	8%
2006	57	30+1?	617+32?	14%
2007	21+5?	15	749+45?	5%
2008	55	20+1?	788+37?	9%
2009	51	31	918+9?	9%
2010	52	28+1?	856+19?	9%
2011	323	Not available	1784	18 % (block 23 only)
2012	78	Not available	1358	NA 6% (block 23 only)

Significantly, Table 9.3 appears to show a large increase in turtle strandings in 2011 and 2012, although 2012 numbers are lower than 2011. Also, although data is only available for the latitude 23° block in 2011, the proportion of total strandings occurring in this block in 2011 is much higher than for all other years reported. Stranding data for the latitude 23° block in 2012 appears to show that the proportion of strandings in the region has reduced again. It must be noted that reporting of turtle strandings may be at least partly proportional to the level of surveillance in an area. As there were a number of major construction projects underway in Gladstone Harbour in 2011 and 2012, including the Western Basin Dredging and Disposal Project (http://www.westernbasinportdevelopment.com.au/), and monitoring activities have been undertaken in relation to these projects, this may be a factor in the increased numbers of reported turtle strandings.

Table 9.4 provides a summary of the cause of death of marine turtles, focussing on boat/ship strike and entanglement or ingestion as these are causes of death that might arise from recreational boating activities associated with the development. Data on cause of death is not available for 2011 and 2012. It must be noted that:

- Entanglement with rope/fishing line/floatline/crab pot could include both commercial and recreational fishing equipment

- Boat/ship strike may include both recreational and commercial vessels and there is no data to correlate boat strike incidents with size or speed of the vessel involved
- For at least two thirds of mortalities, the cause of death cannot be determined
- Data is based largely on opportunistic sightings and findings and may be an under-representation of actual numbers
- Reporting may be proportional to the level of surveillance in a particular area.

Table 9.4 – Summary of Cause of Death – All Queensland

	Total	Boat/ship strike		Entanglement and ingestion (1)		Unknown	
		number	% of total	number	% of total	Number	% of total
1999	554	84	15%	39	7%	347	63%
2000	495	78	16%	39	8%	313	63%
2001	533	83	16%	36	7%	363	68%
2002	543	65	12%	61	11%	370	68%
2003	549	62	11%	37	7%	387	70%
2004	574	75	13%	39	7%	381	66%
2005	498	63	13%	21	4%	328	66%
2006	562	67	12%	34	6%	392	70%
2007	657	70	11%	39	6%	489	74%
2008	682	92	13%	55	8%	451	66%
2009	745	68	9%	54	7%	569	76%
2010	671	63	9%	40	6%	509	76%

(1) Includes entanglement with rope/fishing line/ floatline/crab pot but excludes entanglement with shark nets and ghost nets.

While the data presented in Table 9.3 and Table 9.4 has a number of limitations, it does provide some insight into the risk to marine turtles from recreational boating and fishing activities. At least 9-16% of turtle deaths/strandings in the period 1999-2010 were caused by vessel strike, accounting for between 62 and 92 marine turtles across Queensland.

An increase in recreational boating in the waters around HHI may increase the risk of injury or mortality of marine turtles due to boat strike in this area. The PTP is not expected to significantly increase the overall levels of boating activity in the Gladstone area or Mackay-Capricorn region of the GBRMP/GBRWHA as the overall population increase attributable to the proposed development is small. Increased recreational boating activity in waters surrounding HHI will be largely the result of a redistribution of boat traffic due to the availability of a formal boat ramp rather than a significant increase in overall boat ownership levels.

Data on marine turtle mortality is insufficient to identify a formal relationship between the number of boats operating in an area and injury or mortality rates. GHD examined studies on vessel strike for the Western Basin Dredging and Disposal Project EIS and noted that:

- Risk of boat strike was higher for larger, high speed vessels as animals are less able to detect the approaching vessel in time to evade it
- Incidence of boat strike increased with increased boat traffic
- Water depth was also a factor, with the risk of boat strike lower in deeper waters where animals could dive to evade approach vessels (GHD 2009).

Recreational boats that utilise the proposed boat ramp at PTP will be trailerable boats, typically less than six metres long. The main recreational activity is expected to be fishing, with Maritime Safety Queensland identifying that 84% of recreational boat trips are for fishing during daylight hours (Maritime Safety Queensland 2007). This also means that for a large proportion of the time that these boats are in the water, the boats are stationary or drifting without power.

There are a number of navigational limitations in Boyne Creek and Seven Mile Creek that naturally limit boat speed (see also Section 8.7.6 and Figure 6.35). Seagrass beds in Seven Mile Creek on which turtle foraging may be focussed are intertidal and this will limit vessel movements, and the speed of movements across these beds. The *Transport Operations (Marine Safety) Regulation 2004* includes a general speed limit of six knots in the vicinity of boat ramps and near the shoreline. The Coordinator-General has recommended that this speed limit be extended by Maritime Safety Queensland (Queensland Coordinator-General 2011).

While the proponent does not have the legal power to impose a speed limit for recreational boats, the proponent is committed to working with Maritime Safety Queensland to also impose a six knot speed limit on vessels in all sensitive habitat areas. This management measure has been implemented by the Queensland Government in important turtle habitat areas in Moreton Bay.

The proponent will also provide signs and written awareness raising information to inform recreational boaters of the sensitivity of the waters in terms of turtles, and the need to adhere to speed limits and maintain a close look out for turtles.

The proponent will introduce measures relating to provision of information when the proposed boat ramp becomes operational. The proponent will commence discussions with Maritime Safety Queensland on boat speed limits if the PTP is approved.

In relation to the construction of the proposed bridge and pontoon for the boat ramp, any associated vessels will travel at a maximum speed of six knots in enclosed waters of Colosseum Inlet and Boyne Creek.

Noise and activity from recreational boats is unlikely to displace turtles from foraging and resting habitat. Turtles are frequently observed feeding in busy areas and in recent pile driving operations in Gladstone, were not observed moving away from piling noise (C Limpus pers com to GHD).

Hence, recreational boat traffic is not likely to cause indirect degradation of foraging and resting habitat in the waters around HHI.

Given the natural restrictions on boat speed and movement in the areas known to be frequented by foraging turtles, and that boats will largely be engaged in fishing and thus stationary or drifting without power, risk to turtles from boat strike is not expected to increase significantly. Mitigation measures are also available to restrict boat speed and raise awareness of impacts of boat strike on turtles.

Further, increased boating activities in the waters around HHI are largely the result of redistribution of boating activity from other areas due to provision of a formal boat ramp rather than significant increases associated with population increases. Hence, regional occurrence of small recreational boat strike on turtles is not expected to change as a result of the proposed development.

9.3.5 Entanglement and Ingestion

As identified in Table 9.4, entanglement and ingestion is a significant cause of turtle strandings and mortality, accounting for 4-11% of turtle strandings in the years 1999 to 2010, affecting between 21 and 61 turtles. Not all turtles that become entangled die; some are successfully released.

The main potential for recreational fishing activities in waters around HHI to increase risk of entanglement is through crab pots. Crab pots are usually placed adjacent to mangroves and particularly in mangrove lined channels. In the waters surrounding HHI, there are no mangrove lined channels in close proximity to main turtle foraging areas, and mangrove stands are fronted by extensive intertidal flats, making these less suitable for setting of crab pots. Interactions between foraging turtles and crab pots are therefore less likely to occur then in other areas where mangroves directly abut foraging areas.

Further, as crab pots require setting and retrieval, crab potting is generally undertaken by recreational fishers that live in the area rather than day visitors. Increases in recreational boating and fishing in waters surrounding HHI arising from the PTP boat ramp will be largely attributable to boat owners from further afield, as local boat owners would already be using the existing informal boat ramps available in the area. Hence, increases in recreational boating activity in waters surrounding HHI will not necessarily lead to a proportional increase in crab pot setting.

As discussed in Section 6.6.9, there is also commercial take of mud crabs in Colosseum Inlet and Rodds Bay. The level of commercial crabbing effort will not change as a result of the project.

Other fishing methods likely to be employed by recreational fishers in these waters will generally involve lines and hooks. Fishing line, if improperly disposed of to the sea, can also be a cause of entanglement. In some cases, fishing line becomes entangled with rocky or coral reefs and fishers must cut their lines, however the waters around HHI are generally soft bottomed substrate, and so this is not likely to be a significant cause of fishing line debris. Fishing line can also become entangled in mangroves.

As HHI is located within the Rodds Bay Dugong Protection Area, there are restrictions on the use of mesh nets imposed under the Queensland *Fisheries Act 1994*. The proponent will place signs explaining these restrictions at the proposed boat ramp.

Ingestion of plastic bags has been identified as major cause of turtle mortality in Moreton Bay, with University of Queensland researchers reporting this to be the cause of death in 23% of turtle strandings in 2007 (http://www.uq.edu.au/news/index.html?article=14238).

Under the Queensland *Transport Operations (Marine Pollution) Act 1995*, it is illegal to dispose of rubbish, including fishing net and fishing line from boats of any size. The proponent will provide signs at the proposed boat ramp and written information to recreational fishers to reinforce the importance of retaining all garbage, fishing line and other wastes for disposal on-shore.

The proponent also commits to the following measures in relation to plastic bags and other litter that may originate from land-based activities:

- Retention of coastal fringing vegetation, which will reduce likelihood of litter being blown into the coastal waters
- Fitting the stormwater system with gross pollutant traps to trap plastic litter. Gross pollutant traps will be installed as early as possible so that litter arising from construction activities can also be captured.
- Providing rubbish bins in public areas
- Inclusion of regular litter collection in the facility maintenance program
- Provision of information to visitors and residents of the PTP on management of litter and wastes and the importance of this in protecting the environment. This will include displays at the visitor information centre.

During construction activities, contractors will be required to maintain construction areas in a clean state, free of litter. The proponent will also encourage commercial traders within the PTP to minimise use of plastic bags and products with non-biodegradable plastic packaging.

As part of a marine monitoring program proposed for PTP, presence of litter and rubbish will be monitored and, if necessary, clean-up programs initiated if required. This may include links with “Clean Up Australia” activities (see Section 8.7.4). Monitoring will commence prior to commencement of any construction activities so that a baseline can be established and will continue annually initially with the potential to alter the frequency in response to observed impacts or lack of impacts. The monitoring program is discussed in more detail in Section 8.5.17.

Overall, given the mitigation measures that have been built into the project design, and existing controls on littering, the risk to marine turtles from ingestion of litter and entanglement with litter is not expected to increase.

9.3.6 Significance of Combined Direct and Indirect Impacts

Impacts on marine turtles must be considered in terms of:

- Direct loss of important habitat
- Direct impacts on individual turtles
- Habitat quality degradation through various mechanisms.

The PTP will not result in direct loss of marine turtle habitat.

Pathways for direct impacts to marine turtles have been identified through boat strike and entanglement with litter and debris. Mitigation measures have been identified and proposed for these impacts and are expected to be effective in avoiding increased risk to marine turtles from these two mechanisms. These mitigation measures are consistent with those applied in other locations where human activities intersect with marine turtle habitat, including most recently for the Great Keppel Island Revitalisation Project (EPBC 2010/5521).

Degradation of habitat quality may occur through a number of pathways:

- The potential for anchor damage to seagrass beds is expected to be low but will require monitoring as behaviour of recreational boaters is difficult to predict. Mitigation measures in the form of no-anchor zones and permanent moorings will be required if monitoring indicates degradation of seagrass resources. With these measures in place, significant impacts on marine turtle populations from decreases in foraging resources are not expected as impacts will be detected before impacts become irreversible.
- Severity of impact on the low density nesting beach from artificial light is considered negligible due to existing natural screening, the ability to detect any increase in lighting at beaches and the availability of effective controls. No additional impact is expected over that already occurring as a result of mainland activities.
- Turtles may be disturbed from foraging activities by the presence of recreational boat traffic, however the natural restrictions in navigation in waters surrounding HHI and the proposed boat speed controls will minimise disturbance to turtles, such that foraging activities are not expected to be impacted. It should also be noted that the majority of predicted boating traffic associated with the proposed boat ramp represents a redistribution of boat traffic at a regional level, with only a small number of additional boats associated with population increase arising from PTP.
- Water quality degradation may in turn affect productivity in coastal and marine ecosystems and reduce food availability for turtles. A comprehensive assessment of water quality impacts was provided in Section 8.5 and concluded that no degradation of water quality was expected as a result of the proposed development. Critically, PTP proposes a closed cycle water supply and reuse system and stormwater management in accordance with best practice principles (water sensitive urban design) such that no change in the quality and quantity of runoff is expected. A water quality monitoring program is also proposed to validate impact predictions and test the

effectiveness of proposed mitigation measures. Contingency measures are available in the event that water quality degradation attributable to the proposed development is detected.

A monitoring program is proposed to detect turtle nesting activity and restrict access to nesting beaches if nesting is observed to be occurring. A more active approach to management of turtle nesting may increase nesting success, however as nesting densities on HHI are very low, this is may not lead to any significant population increase.

Even when considered in combination, it is not considered likely that there will be additive or synergistic cumulative impacts on marine turtle populations, or on the suitability of habitats surrounding HHI as marine turtle habitat. Short or long term decreases in populations are not considered likely, and monitoring will assist in detecting any decrease and lead to development of additional contingency measures if necessary. Direct habitat loss or fragmentation will not occur. Proposed management and monitoring regimes for indirect impacts on habitat availability and quality for marine turtles are expected to be effective and habitat quality will therefore be retained. Breeding cycles, including nesting and foraging during the internesting period are not expected to be affected due to proposed beach monitoring and contingency actions in the event that nesting does occur. The proponent proposes a marine monitoring program that will include monitoring of water quality, benthic habitat and marine megafauna and this program will provide for early detection of habitat degradation, and implementation of corrective measures as required. An outline of the proposed marine monitoring program is provided in Section 8.5.17.

In a worst case scenario, where impacts on turtle populations are observed, the proponent would seek to work with the Queensland Government to:

- Establish “no go” zones in key turtle foraging areas, particularly seagrass beds of Seven Mile Creek
- Fund a marine ranger to enforce littering and speed limit requirements
- Place bans on crab potting in the area. Such bans would need to be imposed under the Queensland *Fisheries Act 1994*.

However, given the mitigation measures already described in this section and in Section 9.3.7, these additional measures are unlikely to be necessary.

9.3.7 Mitigation Measures (Marine Turtles)

A range of mitigation measures have been proposed in this EIS that will avoid or minimise impacts on marine turtles. These include matters incorporated into conceptual design and overall footprint development as well as commitments in relation to design, construction, operation and maintenance. A summary of measures included in **Sections 2**, **8** and **9** are presented in **Table 9.5**.

Effectiveness of these mitigation measures for potential impacts on marine turtles is assessed as follows:

- Measures in relation to stormwater and wastewater management and recycling are based on established standards and guidelines endorsed by the Australian and Queensland Governments (for example, Water Sensitive Urban Design, National Water Quality Management Strategy) and modelling has been undertaken to demonstrate the effectiveness of the adopted designs and systems in avoiding water quality impacts (see Appendix D2).
- Erosion and sediment control will be based on guidelines in place at the time. The current relevant guidelines are the IECA-Australasia (2007) guidelines which are called up by SEWPaC in recent conditions of approval for projects such as the GKI Revitalisation project.
- The effectiveness of a speed limit in minimising impacts on marine fauna will be enhanced by the proponent's commitments to awareness raising, but will depend to some extent on the regulatory basis and enforcement of these provisions. Unlike other locations where boat movements have been identified as a risk to marine fauna, the bathymetry of enclosed waters around HHI will naturally restrict boat speeds in the vicinity of seagrass beds.
- Measures to prevent and control release of litter to the marine and coastal environment are expected to be effective, and can be further backed up with regular litter clean-up activities if the marine ecosystem monitoring program indicates that this is necessary.
- Retention of vegetation and topographic features will be effective in minimising lighting impacts on beaches suitable for turtle nesting. Further measures in the form of management of obtrusive light and additional shielding are available if necessary.
- Access to beaches suitable for turtle nesting is naturally restricted, however additional restrictions can be imposed if turtle nesting occurs to effectively prevent access to these areas.
- The potential for anchor damage to occur to seagrasses is difficult to quantify, but if monitoring indicates that this is causing reduction in seagrass health or abundance, an effective mitigation measure in the form of a "no anchor" zone and permanent moorings is available.
- The effectiveness of mitigation measures involving awareness raising and community education is difficult to predict, and may depend on the regulatory and enforcement framework that sits behind these measures. The proponent is committed to working with Australian and Queensland Government regulatory agencies in relation to these mitigation measures.

The proponent has also committed to a marine water quality monitoring program and a marine ecological monitoring program (see Section 8.5.17). These programs will detect changes from pre-development conditions and trigger investigation of the causes of these changes and identify corrective actions. If changes are associated with recreational boating use, the proponent will work with GBRMPA, Queensland DNPRSR and other stakeholders to determine additional controls that may be required. The proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

As no significant residual impact to marine turtles is predicted, the proponent is not proposing any direct or indirect offsets under the EPBC Act Environmental Offsets Policy (SEWPC October 2012).

Monitoring of flatback turtle nesting activity on the north-eastern beach may add to knowledge of turtle nesting in central Queensland, however given the low levels of usage of this beach, this information may of limited value.

Table 9.5 - Summary of Measures to Avoid and Mitigate Impacts on Marine Turtles

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Wastewater and stormwater management and treatment systems avoid any degradation of coastal and marine water quality, or any changes in freshwater or contaminant inputs compared to the pre-development case	Proponent commitment Coordinator-General's Report Condition	Detailed design	• Ambient coastal/offshore water quality monitoring program • Monitoring of stormwater quality	Investigate source of contaminants and repair or upgrade systems as required
The stormwater system will include gross pollutant traps to remove litter from stormwater	Proponent commitment Coordinator-General's Report Condition Planning scheme requirement	Detailed design Operations and maintenance	• Ambient coastal/offshore water quality monitoring program • Monitoring of stormwater quality	Install additional litter removal devices Further enforcement of anti-littering laws Litter removal from coastal and marine areas if necessary
Retain vegetation through the entire coastal zone surrounding the proposed development (which will trap windblown litter and prevent light spill to beaches among other benefits)	Proponent commitment Requirement for Federal and State approval to clear in these areas	In place	• Visual inspection of clearing compliance	Prosecution of contractors for illegal clearing Contracts will require rehabilitation of damaged areas by contractor
Retain natural topographic and vegetation features that screen turtle nesting areas	Proponent commitment	Conceptual design / EIS phase	• Visual inspection of clearing compliance	Prosecution of contractors for illegal clearing Contracts will require rehabilitation of damaged areas by contractor
Detailed design of buildings and other facilities will consider the need to avoid light spill	Proponent commitment Coordinator-General's Report Condition Plan of Development requirement	Detailed design	• Monitor light levels and visibility of light sources on beach	Implement additional screening measures as required
Do not provide any access to turtle nesting beaches	Proponent commitment	All phases	• Monitor for turtle nesting activity	Provide barrier fencing and signs to prevent access to turtle nesting areas if nesting has occurred.

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Work with Maritime Safety Queensland to extend the six knot boat speed limit required by *Transport Operations (Marine Safety) Regulation 2004* near the boat ramp and shoreline to take in sensitive habitat areas. This is in addition to natural navigational restrictions in enclosed waters surrounding HHI	Proponent commitment Coordinator-General's Report recommendation	From opening of boat ramp	• Through boat speed limit enforcement programs by Queensland Police Service	Proponent work with Maritime Safety Queensland and Queensland Police Service regarding enforcement
Encourage traders to minimise plastic packaging and plastic bags and to use biodegradable plastics	Proponent commitment	Ongoing	• Take-up by traders	Assist traders in sourcing items utilising biodregradable packaging
Monitor seagrass beds in Seven Mile Creek for anchor damage	Proponent commitment	From opening of boat ramp	• Marine habitat monitoring program	Work with Maritime Safety Queensland and Queensland NPRSR to establish a no anchoring zone
Provide signs and written information to recreational boaters and other visitors to raise awareness of responsible boating behaviour, regulatory requirements regarding littering, and reporting of sightings of marine megafauna	Proponent commitment Coordinator-General's Report recommendation	From opening of boat ramp	• Marine habitat and water quality monitoring program	Identify need for corrective action if water quality or habitat degradation is detected.

9.3.8 Seagrass Monitoring

Monitoring of shallow and intertidal seagrass beds in Seven Mile Creek is proposed due to the uncertainty in predicting impacts of recreational boat anchoring on these seagrass beds. This monitoring will also detect whether other changes to the seagrass bed are occurring and provide a correlation with water quality monitoring described in Section 8.5.18).

As seagrass beds in water surrounding HHI have been monitored in 2002 and 2009 (Rasheed et al 2003, Thomas et al 2009), baseline monitoring data is available, however it is proposed to commence monitoring one year before construction of the boat ramp in recognition of the highly variable nature of seagrass beds and the possible weather related impacts that may have occurred in January 2011 and January/February 2013. Two monitoring events will be undertaken, in summer (circa November) and winter (circa June).

The impact monitoring program will then commence once the proposed boat ramp is constructed and will continue bi-annually for at least five years, in summer (circa November) and winter (circa June) to correlate with timing of other seagrass monitoring activities in Port Curtis and Rodds Bay. After five years, the frequency may be reduced and/or methodology reviewed if impacts have not been detected.

Methodology will be based on the methods used for seagrass health assessments undertaken within Port Curtis and Rodds Bay as part of the PCIMP and Western Basin Dredging and Disposal Project (WBDDP). The monitoring program for seagrasses in Port Curtis includes bi-annual remapping and assessment of all seagrasses within the Gladstone Western Basin area and Rodds Bay which has been undertaken since 2009 (see Davies *et al.* 2013). This program is most relevant to monitoring requirements associated with PTP and there is value in utilising the same monitoring methods so that results are directly comparable.

In these surveys, seagrass meadows are mapped using a combination of aerial surveys and diving surveys. Observations include species composition, above-ground biomass, percent algal cover, depth below mean sea level (MSL) for subtidal sites, sediment type, time and position (Global Positioning System; GPS). Power analysis has been applied to design this monitoring program in order to detect seagrass meadow changes and be able to distinguish between natural variability of meadows from drivers of change.

Surveys are conducted bi-annually each summer (circa November) and winter (circa June). This existing program, therefore, provides six monthly information on the overall seagrass distribution and abundance across the Gladstone region to discern between impacts that may be related to dredging or other construction works and those changes in seagrasses that may be linked to natural variability. This comprehensive monitoring program will inform the distribution of, and potential impacts to, the seagrass meadows associated with HHI.

The survey frequency, time and methodology has been explicitly designed by the research team at James Cook University, in conjunction with regulatory authorities and independent scientific advisors to the Western Basin Project to be able to detect and respond to changes in seagrass meadows from dredging and other construction works associated with development of Gladstone Harbour. The design, data and reporting is, therefore, considered of direct relevance to being able to detect and inform management of potential seagrass changes associated with HHI.

The proponent will approach Gladstone Ports Corporation and PCIMP regarding participation in this monitoring program. If the proponent cannot participate directly in this existing program, the proponent will still utilise the methodology established for this program to maximise comparability of data collected at a regional level. The PCIMP and WBDDP monitoring results will also provide important control sites to determine whether changes observed in seagrass meadows are the result of climatic or other regional influences, or can be attributed to PTP.

The PCIMP and WBBDP seagrass monitoring programs also include aerial surveys and if the proponent is able to participate in this program, findings can be used to track changes, observe whether these meadows are being used by dugongs or turtles and detect impacts such as anchor damage.

The findings from these surveys will be reviewed annually to detect whether changes are occurring, and whether these changes are attributable to PTP or to wider, regional influences.

SECTION 10
Evaluation of Potentially Significant Impacts on EPBC Act Listed Migratory Species

Contents

10. Evaluation of Potentially Significant Impacts on EPBC Act Listed Migratory Species

10.1 Introduction

MNES values associated with migratory species were identified in Section 7.5 and are summarised in Table 10.1.

Table 10.1 – Summary of MNES Values –Listed Migratory Species

Value	Description	Importance
Migratory Terrestrial Birds (See Section 7.5.1)	Seven species known or potentially occurring, however HHI does not support important populations or provide key habitat.	Lower importance
Migratory marine birds (See Section 7.5.1)	Several egret and tern species are known or likely to occur, however there is no evidence that HHI supports important populations or provides key habitat.	Lower importance
Migratory Shorebirds	Intertidal foraging and roosting habitat of international and national importance is available at HHI and in the surrounding Colosseum/Mundoolin and Rodds Bay conglomerate of sites. These sites are part of a larger network of sites extending from the mouth of the Fitzroy River, through Port Curtis/Port of Gladstone to Rodds Bay in the south.	Highest importance
Dugong *Dugong dugon* Migratory marine	Known to occur in waters around HHI. Not identified as one of the most important locations for dugong in Queensland, but nevertheless provides foraging habitat on intertidal and subtidal habitat.	Moderate importance
Indo-Pacific humpback dolphin *Sousa chinensis* Migratory, Cetacean.	Known to occur, however common throughout the region. Waters of HHI do not appear to offer any unique or important habitat.	Lower importance
Flatback turtle *Natator depressus* Vulnerable, migratory, marine	Known to nest in very low numbers on beach to east of headland.	Moderate importance
Green turtle *Chelonia mydas* Vulnerable, migratory, marine	Known to commonly occur in waters around HHI and across the central Queensland region..	Moderate importance
Loggerhead turtle *Caretta caretta* Endangered, migratory, marine	Known to occasionally occur in waters around HHI. No nesting sites within close proximity.	Lower importance

The following potentially significant impacts on migratory species were identified in Section 8:

- Potential impacts on migratory shorebirds from:
  - Clearing of habitat during bridge and boat ramp construction
  - Noise and disturbance from construction activities and recreational activities
- Potential impacts on migratory terrestrial birds from habitat clearance during construction
- Potential impacts on dugong (migratory marine mammals) from:
  - Anchor damage to food source - seagrass beds by recreational boats
  - Boat strike by recreational boats
  - Disturbance by recreational boats while feeding.

Potential impacts on migratory marine reptiles (marine turtles) are discussed in Section 9.3 as the migratory species occurring are all also listed threatened species. Impacts identified in Section 8 as clearly not being significant are not discussed further in this section.

In addition, potential benefits may arise from:

- Breaching of the causeway
- Inclusion of the balance of the land area of HHI in a managed conservation area.

10.2 Migratory Shorebirds

10.2.1 Importance of Habitat Values for Migratory Shorebirds

The combined Mundoolin/Colosseum and Rodds Peninsula area is identified as internationally important habitat for the migratory eastern curlew, and nationally important habitat for ten other migratory shorebird species and migratory shorebirds in general (see Section 6.7.6). On HHI, there is a significant shorebird roost and foraging site on mudflats and salt flats to the south-east of the island (sites 65a, 65b and 65c on Figure 6.56) and several other sites that are used by much lower numbers of migratory shorebirds. There are also important sites on the mainland adjacent to Boyne Creek and Seven Mile Creek including sites 64/66, 67, 71 and 75 and 76 shown on Figure 6.56.

More broadly, the area from Fitzroy River mouth north of Curtis Island, through The Narrows, Port Curtis/Port of Gladstone and south to Rodds Bay is identified as a network of nationally and internationally important sites for migratory shorebirds.

The Mundoolin/Colosseum and Rodds Peninsula conglomerate of migratory shorebird roosting and foraging sites, including one major and several minor sites on HHI, are therefore considered to be of the highest importance in relation to migratory shorebird habitat, in accordance with the methodology and criteria set out in Section 1.7.4.

10.2.2 Clearing of Vegetation

A total of 0.2 ha of saltpan vegetation and 0.1 ha of mangrove habitat (including the area already cleared for the existing causeway and track) will be cleared or directly disturbed as a result of construction of the proposed bridge and boat ramp. The majority of disturbance of saltpan vegetation is associated with upgrade of a section of the existing Clark's Road that crosses intertidal and supratidal saltpan on the mainland. This section of road is currently built on rock and earth causeways that do not allow for any passage of tidal flows. The upgrade will provide causeways with conduits for flows which may have some benefits for this habitat. Further information is provided in Section 8.3.2 and Section 8.3.3.

The area of saltpan on the mainland has not been identified as migratory shorebird roosting/foraging habitat (see Section 6.7.11 and Appendix E).

A small area on HHI will also be affected for the proposed bridge and boat ramp. This area is identified as a migratory shorebird site (site 63, Figure 6.56) but surveys have identified that this site occasionally supported one shorebird (See Section 6.7.11.4). The bridge and boat ramp will take less than 0.005% of the total foraging and roosting habitat in this area.

Hence, while HHI and the broader Mundoolin/Colosseum and Rodds Peninsula conglomerate area is considered of highest importance in relation to migratory shorebird habitat, the areas affected by the proposed PTP development are utilised by few migratory shorebirds and development of these areas is not expected to diminish the availability of suitable habitat at a localised level, or within the conglomerate area. The restoration of tidal flows across the saltflats may improve this habitat. Overall, the severity of this aspect of the proposed development is considered negligible and will not cause any discernible change to the resources locally available to migratory shorebird populations or the populations themselves.

The impact of clearing and disturbance of intertidal areas is therefore not significant and no unacceptable impact on migratory shorebirds is expected.

10.2.3 Conservation Area

As identified in Section 8.3.8, a condition of approval by the Queensland Government is that the proponent rehabilitate, manage and conserve the remainder of HHI for the initial 16 years of the proposed PTP and then enter into an agreement with the Gladstone Regional Council for ongoing management (Queensland Government 2011). The Queensland Coordinator-General also recommended that the Minister responsible for the Queensland *Nature Conservation Act 1992* declare the area as a conservation park or similar.

While this would not lead to a direct protection of most of the migratory shorebird habitat on HHI, it would preclude development adjacent to this habitat, including the most significant site at the south-east part of HHI. This will have benefits in terms of avoiding disturbance to the migratory shorebird sites.

10.2.4 Noise and Human Disturbance

10.2.4.1 Overview

Migratory shorebirds may be disturbed by anthropogenic noise and human presence, causing various behavioural responses in the birds from stopping foraging activities to taking flight and moving to another area. Feeding and resting is very important for migratory shorebirds as the birds are preparing for migration to northern hemisphere breeding areas. If birds are disturbed from feeding and/or take flight and move to other areas, energy expenditure increases and food intake decreases. Repeated disturbances may affect an individual's ability to make the northward migration, which in turn reduces breeding success.

10.2.4.2 Disturbance from Access via Land or Proximity of Development

As discussed in Section 2.3.3 it is not proposed to provide any enhanced access via land to coastal areas except for the beaches to the north of HHI. This area has not been identified as providing important migratory shorebird habitat, with surveys identifying that sites in this area supported less than five individuals.

Land access to sites 65a, 65b and 65c, which have collectively been identified as the most important site on HHI, is currently very difficult due to the need to cross the intertidal Sandfly Creek and traverse uncleared vegetation including mudflats and mangrove areas (see Figure 6.56). The proposed PTP will not reduce the difficulty of access to this area by land and hence, no impacts are expected due to foot traffic. It is not intended to fence off the migratory shorebird roosting and feeding areas due to these natural restrictions.

The minimum separation distance from the edge of the proposed development footprint to the nearest significant roosting and foraging sites, being sites 65a, 65b and 65c, is over 500m. This can be seen from Figure 6.56. This is greater than observed distances at which shorebirds might take flight due to disturbance (see also Table 4.1 of Appendix E).

The masterplan does not have any significant components of the development facing towards the key migratory shorebird feeding and roosting sites (see Figure 1.2). Given the separation distance and existing screening vegetation that will be retained as part of the managed conservation area (see Section 8.3.8), light spillage into the main migratory shorebird feeding and roosting sites is not expected to be significant (see also Section 8.4.10). Similarly, as discussed in Section 8.4.6, the separation distance means that noise from the proposed development is unlikely to be audible at levels that would disturb migratory shorebirds at the key feeding and roosting sites.

10.2.4.3 Disturbance by Recreational Boat Traffic

Recreational boat traffic may pass migratory shorebird habitat along Boyne Creek and Seven Mile Creek/Mundoolin Inlet.

Appendix E includes a review of literature available in relation to sensitivity of migratory shorebirds to disturbance. While most of the data available is in relation to walkers with and without dogs, an Australian study identified that shore-birds may fly away from roosting sites when disturbed by boats within 75 m of a roosting site (see Table 4.1 in Appendix E). International studies identified that kayaks may disturb some species at distances of 210-230 m (see Table 4.1 in Attachment E). Appendix E also notes that there is likely to be significant differences in sensitivity to disturbance between species and that eastern curlew, whimbrel and bar-tailed godwit may be more sensitive to disturbance than smaller shorebird species.

There is data to suggest that migratory shorebirds will habituate to higher levels of recreational boat traffic over time. It is noted that there are a number of highly utilised roost and foraging sites in the Curtis Coast area and in Moreton Bay that are subject to disturbance by recreational boat traffic (see also Appendix E).

As discussed in Section 8.8.4, recreational boating activity derived from the proposed boat ramp at PTP is expected to peak at approximately 150 boats over holiday weekends. Boat numbers would be expected to be lower on other weekends and during the week. The main recreational activity is expected to be fishing, with Maritime Safety Queensland identifying that 84% of recreational boat trips are for fishing during daylight hours (Maritime Safety Queensland 2007). This means that for a large proportion of the time that boats are in the water, the boats are stationary or drifting without power.

The expected increase in boat traffic within the Mundoolin and Colosseum estuaries as a result of the project has potential to increase the frequency with which roosting birds are disturbed at important roost sites. However, there is insufficient knowledge to predict at what frequency such disturbance is likely to cause a substantial reduction in migratory shorebird use of the Mundoolin/Colosseum area and whether this in turn might affect the energy budgets of individual birds.

Nonetheless, two key characteristics of the Boyne Creek/Seven Mile Creek waterways are expected to largely mitigate the potential impact of increased boat traffic on migratory shorebirds.

Firstly, waters adjacent to the more important roosting and foraging sites, including sites 65a, 65b and 65c on the south-east part of HHI and sites 64 and 67 on the mainland south-east of Mundoolin Rocks are quite shallow with extensive sand bars and mud flats exposed at low tide. The channel of Boyne Creek east of the proposed bridge becomes increasingly narrow before opening up again east of the existing settlement of Mundoolin Rocks. This is evident from Figure 6.35.

Recreational boat traffic will tend to utilise wider, deeper channels to the west of the proposed bridge, and if operating in the more confined waterways to the east of the bridge, will by necessity be travelling at low speeds. If boats are accessing this area east of the proposed bridge, it is likely to be for the purpose of fishing and hence boats will be largely stationary (anchored) or drifting without power. The area is not suitable for waterskiing or other high speed boating activities except in the deeper waters of Colosseum Inlet.

The bathymetry and extent of mudflats close to the more important roosting and foraging sites is such that it will be difficult for recreational boats to approach within several hundred metres of most high tide roosting areas or low tide foraging areas, and that recreational boats operating in these areas will, by necessity, be travelling slowly. Migratory shorebirds forage at a relatively low density across a very extensive area of intertidal mudflats in the study area once they are exposed during the low tide phase of the tidal cycle (GHD 2011c). As the extensive areas of exposed mudflat are generally distant from deeper waters used by recreational boat traffic during low tide, foraging migratory shorebirds are unlikely to be disturbed by passing boat traffic to the extent that significant impacts on bird health are likely to occur.

Recreational fishers may access mangrove-lined creek channels to set crab pots and consequently, mangrove roosts may be more susceptible to disturbance by recreational fishers in boats, who may regularly disturb mangrove roosts due to their habit of moving along the mangrove fringe to fish and/or set crab pots. Mangrove roosts in the study area are reportedly utilised by small numbers of only three species, whimbrel, terek sandpiper and grey-tailed tattler (GHD 2011a; Sandpiper Ecological Services 2012a,b,c), all of which will roost at sites other than mangroves.

Secondly, if birds are disturbed by boat traffic during peak periods such as holiday weekends, there is a diversity of roosting and foraging sites available to migratory shorebirds in the Mundoolin and Colosseum estuaries, so birds disturbed at one site will be able to relocate to alternative sites in close proximity and therefore with little expenditure of energy. The major foraging sites are also individually quite extensive such that if birds are disturbed, they will be able to relocate within the site or move to another nearby site, again with minimal expenditure of energy.

Therefore, the impact of increased recreational boat traffic is not expected to disturb migratory shorebirds to the extent that it will cause any noticeable reduction in migratory shorebird use of the Mundoolin/Colosseum area or any reduction in the ability of migratory shorebirds to prepare for northwards migration. This conclusion is partially supported by the status of migratory shorebird populations in Moreton Bay, an area with substantial recreational boat traffic and other sources of disturbance to migratory shorebird roosts and feeding areas due to its proximity to the major population centre of Brisbane. Moreton Bay is an internationally important migratory shorebird area in Australia that has experienced significant declines in the abundances of several migratory shorebird species, yet there is no evidence to suggest the cause of the declines is due to conditions in Moreton Bay, with the cause thought to lie outside Moreton Bay, possibly elsewhere on the flyway (Wilson *et al*. 2011). Furthermore, migratory shorebirds continue to use the most disturbed roost site in Moreton Bay (Milton *et al*. 2011).

The *Transport Operations (Marine Safety) Regulation 2004* includes a general speed limit of six knots within 60 metres of a boat ramp or the shoreline. In the Coordinator-General's report for the Hummock Hill Island Development, the Coordinator-General has recommended that this speed limit be extended along Boyne Creek by Maritime Safety Queensland (Queensland Coordinator-General 2011).

While the proponent does not have the legal power to impose a speed limit for recreational boats, the proponent is committed to working with Maritime Safety Queensland to also impose a six knot speed limit on vessels in all sensitive habitat areas. Signs will also be placed at the proposed boat ramp, and printed information made available to boaters explaining the importance of adhering to speed limits and avoiding sensitive habitat areas.

Given these factors, recreational boat traffic associated with the proposed PTP development is not expected to:

- Reduce the overall availability or suitability of roosting or foraging habitat
- Reduce the level of usage of the Mundoolin/Colosseum and Rodds Bay conglomerate area by migratory shorebirds.

As the Mundoolin/Colosseum area has been identified as being important habitat for migratory shorebirds, the proponent will continue to monitor key sites in the vicinity of the proposed PTP, building on the data compiled in the studies undertaken for GPC. This monitoring will allow for validation of the predicted lack of impact and inform general understanding of the effects of recreational boating on migratory shorebird roosting and foraging behaviour. This information may be of benefit in determining protection requirements for migratory shorebird habitat along the Curtis Coast.

The proponent will make monitoring data collected publicly available and, if GPC or others are to continue monitoring at a regional level, will seek to collaborate with such monitoring programs such that data collected is directly comparable.

10.2.4.4 Disturbance by Aircraft

Following on from discussion in Section 8.6.4, the existing airstrip will be reinstated and used as a private facility for small aircraft undertaking scenic joy flights as a tourism activity or charter flights bringing visitors to the island. The airstrip will not be suitable for use by jet aircraft, and it will not be equipped for night time operation. The number of flights is not likely to exceed about 10-20 aircraft per day at peak periods and on most days will be less than 10 flights per day. Section 8.8.3.2 provides general discussion on management of aircraft.

Analysis of studies on shorebird behaviour presented in Appendix E indicates that aircraft, both fixed wing and helicopters, approaching within 1000 m of roosting and foraging sites can cause significant disturbance to some migratory shorebird species. The Brisbane Airport New Parallel Runway EIS noted that during migratory shorebird studies in the vicinity of the existing runway at Brisbane Airport, birds did not react to aircraft flying overhead but did not provide any details on the aircraft height or other determinants (Brisbane Airport Corporation 2007).

The proposed airstrip at PTP is in the location of the existing airstrip, which is over two km laterally from the nearest of the important roosting or foraging sites that make up the Mundoolin/Colosseum conglomerate area (sites 65a, b and c). The air strip is oriented such that neither approach requires aircraft to directly overfly migratory shorebird roosting or foraging sites. Prevailing winds are from the south-east and this will reduce noise propagation from the airstrip towards the major foraging and roosting sites 64, 65, 66 and 67.

Civil aviation rules require that aircraft continue on the runway axis after take-off until a height of 500 feet (152 metres) above ground level has been reached. For small aircraft, this height would be reached after about 1.5 to two kilometres from take-off. At this point the aircraft can turn. Turns to the east would place the flight path over the important roosting sites 64, 65, 66 and 67, potentially at heights below 1,000m (see figure 6.58 for locations of these sites).

The proponent therefore proposes a flight restriction area as shown in Figure 2.15 and described in Section 2.11.2. The flight restriction area provides a horizontal exclusion zone of 1,000m from the important sites 64, 65, 66 and 67 and a vertical height restriction of 1,000m will also be imposed within this area. Management of this restriction zone is discussed in Section 2.11.2.

Literature presented in Appendix E indicates that this should be an adequate distance. The proponent will include this requirement in any lease agreements with scenic flight operators seeking to operate from HHI and will inform operators of charter flights within the Central and South-East Queensland area of the restriction. The proponent will also seek assistance from the Civil Aviation Safety Authority regarding dissemination of information on the exclusion zone.

Should scenic flights be introduced at the proposed PTP, the proponent will also undertake targeted monitoring of the effects of scenic flights on migratory shorebird populations to check the effectiveness of proposed exclusion zone. This may lead to expansion or contraction of the exclusion zone and may also improve understanding of the effects of light aircraft on roosting and foraging behaviours of migratory shorebirds which may be helpful for management of light aircraft at other locations in the GBRMP/GBRWHA. The exclusion zone can be expanded to 1500m without affecting the southern approach to the airstrip, however the proposed 1,000m is already considered conservatively large.

With these measures in place, it is not considered that any significant impact will occur on migratory shorebird habitat or populations. If monitoring indicates a significant impact, the proposed exclusion zone can be increased.

10.2.5 Aircraft Strike

The flight path from the airstrip takes aircraft over the coastline, flying roughly perpendicular to the coastline as shown in Figure 2.14. As migratory shorebirds tend to commute between roost and feeding sites along the coastline, this introduces the potential for bird/aircraft interactions particularly on the southern approach.

When commuting between roost sites and feeding sites and when put to flight by disturbances, migratory shorebirds typically fly at altitudes less than 50m, and generally less than 25m over water (Paton *et al*. 2010). Hence, the height of aircraft over the coastline is a key determinant of potential risk to migratory shorebirds.

The orientation of the airstrip means that aircraft on approach and take off will fly over the coastline as shown on Figure 2.14. Prevailing winds are generally from the south and east quarters

(EIS), meaning that aircraft will typically come in to land from the north and then take off to the south.

The vast majority of shorebird strikes by civil aircraft (97% of 573 reported strikes) occur while aircraft are flying at altitudes less than 150 m (Dolbeer 2006). Furthermore, about 61% of the reported strikes above 150 m occurred at night compared to only 18% of aircraft movements occurring at night (Dolbeer 2006). There will be no night time landing or take off at the airstrip.

The northern and southern ends of the runway for the proposed airstrip are approximately 1.5 km and 1.8 km (in the direction of aircraft approach/departure) from the northern and southern shorelines of the island respectively. Given these distances, and that the angle for descent and take off is usually more than 5%, the small aircraft using the airstrip at PTP would be above 150m when they clear the coastline on either approach or take off. Hence, there is very limited potential for the aircraft to interact with migratory shorebirds commuting along the coastline during take-off and landing.

It should be noted that Civil Aviation Safety Authority rules are that aircraft must not deviate from the take-off path until a height of 500 feet (152 metres) above ground level has been reached, which, for the types of aircraft utilising the airstrip at PTP would mean that the aircraft would be approximately 1.5 to two kilometres from the airstrip. Hence, aircraft taking off from the airstrip cannot turn off the runway axis while at low heights, preventing them flying along the coast line of HHI at heights below about 150m.

As discussed in Section 10.2.4.4, the proponent will impose a flight restriction area on users of the airstrip as shown in Figure 2.14 and described in Section 2.11.2. Aircraft will not be able to fly at heights below 1,000 metres in this area. This will avoid any interaction with migratory birds commuting between the important sites 64, 65, 66 and 67. It should also be noted that the number of aircraft likely to use the airstrip is expected to be low, typically less than 10 aircraft per day, with up to 20 aircraft in peak holiday periods.

Migratory shorebirds typically fly at much higher altitudes while migrating, which they undertake mostly at night (Drury & Keith 1962). Hence, interaction of birds on migratory paths with aircraft using the airstrip at PTP is also expected to be negligible.

10.2.6 Other Indirect Impacts

Degradation of the migratory shorebird habitat by indirect impacts on water quality is not anticipated. Section 8.5 provides an evaluation of potential impacts on water quality from the proposed development, and sets out any additional mitigation measures required to manage potential impacts.

Identified migratory shorebird habitat is not within the same catchments in which the proposed PTP takes place and stormwater runoff from the proposed development will not be directed towards areas used by migratory shorebirds. As described in Section 2.4.2 and Section 8.5.6, the stormwater system has been designed to avoid changes in flows and water quality compared to pre-development conditions. This will also prevent overall degradation of coastal and marine water quality from stormwater runoff.

In addition, as discussed in Section 8.5.6, there is no direct discharge of treated wastewater, with wastewater to be recycled and used for irrigation. Sustainable irrigation rates have been identified and a water balance undertaken to demonstrate that all treated wastewater can be reused. A management and monitoring program is proposed for irrigation areas, including the proposed golf course, to ensure that nutrients are not released to the environment from irrigation using treated wastewater.

Emergency discharges of wastewater may be required in exceptional circumstances, however, the overall load of nutrients and other contaminants that would be released is small and would be assimilated into the environment. The emergency release point is distant from any migratory shorebird habitat.

A marine water quality monitoring program is proposed to check that the proposed measures to avoid and mitigate impacts on water quality are effective.

10.2.7 Overall Significance of Impacts

While recreational boat traffic has been identified by international studies as having potentially significant impacts on migratory shorebird habitat, the characteristics of the foraging and roosting areas in the vicinity of the proposed PTP, natural navigational hazards and the location of channels in relation to foraging and roosting areas will mean that, at this location:

- Recreational boats will generally not be able to approach within several hundred metres of important roosting and foraging sites
- Recreational boats operating in the vicinity of important roosting and foraging sites will be travelling at low speeds (or stationary while fishing)
- If shorebirds are disturbed, these will be able to move easily to alternative foraging and roosting sites in close proximity, with minimal energy expenditure.

The proponent will also seek to impose a six knot speed limit adjacent to all sensitive habitats, and provide signs and written information to raise awareness of the importance of adhering to speed limits and avoiding sensitive areas.

While the proponent has no current proposal to operate scenic flights from PTP, if a commercial operator seeks to undertake scenic flights from the proposed PTP, a horizontal and vertical exclusion zone of 1000m will be imposed as part of any agreement to use the airstrip and monitoring undertaken to check whether this exclusion zone is sufficient. The location of the airstrip in relation to the coastline minimise interaction between aircraft and migratory shorebirds undertaking “commuting” movements between foraging and roosting sites.

While the impact assessment criteria set out in the Draft Migratory Shorebird Guidelines (DEWHA 2009a,b) are intended for application at the referral stage of a proposed action, there is value in considering these criteria on completion of a more detailed impact assessment. An assessment against these criteria is provided in Table 10.2.

Table 10.2 – Assessment of Potential Impacts of the PTP on Migratory Shorebirds against EPBC Draft Migratory Shorebird Guidelines Impact Assessment Criteria (DEWHA 2009a,b)

Impact assessment criterion	Impact assessment
Loss of important foraging habitat leading to a reduction in the capacity of the habitat to support migratory shorebirds	No significant impact likely. A very small area of foraging habitat (intertidal mudflat) will be lost for the construction of the proposed boat ramp, however the magnitude of this impact is negligible as this small area of habitat is already disturbed by the existing causeway and is used only occasionally by very small numbers of migratory shorebirds.
Loss of important roosting habitat leading to a reduction in the capacity of the habitat to support migratory shorebirds	No significant impact likely. No important roost sites will be lost; all important roost sites are distant from the proposed project footprint.
Degradation of important foraging habitat leading to a *substantial reduction* in migratory shorebirds using the site	No significant impact likely. The implementation of measures to avoid degradation of water quality and associated impacts on the food chain is expected to ensure the project does not lead to a sustained reduction in invertebrate food availability on intertidal mudflats.
Degradation of important roosting habitat leading to a *substantial reduction* in migratory shorebirds using the site	No significant impact likely. No important roost sites are expected to be degraded; all important roost sites are distant from the proposed project footprint.
Increased disturbance leading to a *substantial reduction* in migratory shorebirds using important foraging habitat	No significant impact likely. Important intertidal foraging habitats are remote from the proposed development and proposed development will not provide any increase in access to these areas from land. As the extensive areas of exposed mudflat are generally distant from deeper waters used by recreational boat traffic during low tide, foraging migratory shorebirds are unlikely to be disturbed by passing boat traffic to the extent that significant impacts are likely to occur.
Increased disturbance leading to a *substantial reduction* in migratory shorebirds using important roosting habitat	No significant impact likely. Important roost sites on Hummock Hill Island are currently inaccessible to vehicles and very difficult to access by foot and proposed development will not provide any increase in access to these areas from land.
Direct mortality of birds leading to a *substantial reduction* in migratory shorebirds using important habitat	No significant impact likely. No direct mortality of migratory shorebirds is expected to occur as a result of project activities.

Hence, while migratory shorebird habitat in the Mundoolin/Colosseum and Rodds Bay conglomerate area is of highest importance in relation to environmental value, the severity of impacts is negligible and hence, no significant or unacceptable impact is expected.

It should be noted that, while the proponent is proposing mitigation measures and monitoring to address impacts, there are natural characteristics of the area that will effectively prevent humans, vehicles and boats from approaching important migratory shorebird habitat, and hence, there is negligible risk that mitigation measures will be ineffective.

10.2.8 Summary of Mitigation Measures – Migratory Shorebirds

A range of mitigation measures have been proposed in this EIS that will avoid or minimise impacts on migratory shorebirds. These include matters incorporated into conceptual design and overall footprint development as well as commitments in relation to design, construction, operation and maintenance. A summary of measures included in Sections 2, 8 and 10 are presented in Table 10.3.

Table 10.3 – Summary of Measures to Avoid and Mitigate Impacts on Migratory Shorebirds

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Wastewater and stormwater management and treatment systems avoid any degradation of coastal and marine water quality, or any changes in freshwater or contaminant inputs compared to the pre-development case	Proponent commitment Coordinator-General's Report Condition	Detailed design	• Ambient coastal/offshore water quality monitoring program • Monitoring of stormwater quality	Investigate source of contaminants and repair or upgrade systems as required
The stormwater system will include gross pollutant traps to remove litter from stormwater	Proponent commitment Coordinator-General's Report Condition Planning scheme requirement	Detailed design Operations and maintenan ce	• Ambient coastal/offshore water quality monitoring program • Monitoring of stormwater quality	Install additional litter removal devices Further enforcement of anti-littering laws Litter removal from coastal and marine areas if necessary
Retain vegetation through the entire coastal zone surrounding the proposed development (which will trap windblown litter and prevent light spill to beaches among other benefits)	Proponent commitment Requirement for Federal and State approval to clear in these areas	In place	• Visual inspection of clearing compliance	Prosecution of contractors for illegal clearing Contracts will require rehabilitation of damaged areas by contractor
Avoid clearing or activity in recognised migratory shorebird habitat	Proponent commitment Statutory requirement (a development permit is required to clear this area)	Already in place	• Not required (no activity in close proximity to shorebird habitat)	NA
Do not provide any access to migratory	Proponent commitment	Ongoing (already in	• Monitor access by residents and visitors	Place physical barriers and/or signs if

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
shorebird habitat by foot		place)		required to prevent access
If scenic flights are operated from the airstrip, impose a 1000m exclusion zone vertically and horizontally from migratory shorebird sites 65a, 65b and 65c, 64/66, 67, 71 and 75 and 76 (see Figure 2.14) and monitor whether this is adequate to avoid disturbing roosting and foraging shorebirds	Proponent commitment	In the event that scenic flights commence operation	• Monitor disturbance to shorebird roosting and feeding behaviour when aircraft fly over or near sites	Increase or decrease the exclusion zone based on observed levels of disturbance.
Work with Maritime Safety Queensland to extend the six knot boat speed limit required by *Transport Operations (Marine Safety) Regulation 2004* near the boat ramp and shoreline to take in sensitive habitat areas. This is in addition to natural navigational restrictions in enclosed waters surrounding HHI	Proponent commitment Coordinator-General's Report recommendation	From opening of boat ramp	• Through boat speed limit enforcement programs by Queensland Police Service	Proponent work with Maritime Safety Queensland and Queensland Police Service regarding enforcement
Encourage traders to minimise plastic packaging and plastic bags and to use biodegradable plastics	Proponent commitment	Ongoing	• Take-up by traders	Assist traders in sourcing items utilising biodregradable packaging
Provide signs and written information to recreational boaters and other visitors to raise awareness of responsible boating behaviour, regulatory requirements regarding littering, and reporting of sightings of marine megafauna	Proponent commitment Coordinator-General's Report recommendation	From opening of boat ramp	• Marine habitat and water quality monitoring program	Identify need for corrective action if water quality or habitat degradation is detected.
Implement erosion and sediment control plans for all disturbed areas where the stormwater system is not in place	Proponent commitment Coordinator-General's Report	Ongoing	• Marine and coastal water quality monitoring • Stormwater monitoring	Augment erosion and sediment control measures as required

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
	condition			
Manage fertiliser and pesticide application at the proposed golf course to prevent direct and indirect releases of contaminants above trigger levels	Proponent commitment Coordinator-General's Report condition	Ongoing	• Marine and coastal water quality monitoring • Monitoring of soils, surface waters and groundwater at the proposed golf course	Upgrade or augment treatment system Review irrigation practices Review pesticide and fertiliser application practices
Minimise clearing of mangrove and salt flat habitat when constructing boat ramp and bridge and upgrading causeway.	Proponent commitment	Prior to and during constructio n	• Monitoring of clearing extent	Prosecution of contractors who undertake clearing outside authorised areas Contractors required to reinstate damaged areas
Ensure that causeway on mainland provides for tidal flows.	Proponent commitment Statutory requirement (approval is required for coastal works under the Queensland *Sustainable Planning Act 2009*/*Coastal Protection and Management Act 1993*)	Detailed design	• Design checks	Prosecution of contractors who do not comply with development permit (authorised design for causeway)
Establish a managed conservation area of the balance of HHI, develop and implement a management plan for this area	Proponent commitment Coordinator-General's report condition	Constructio n and operation	• Monitoring program for conservation area to be developed	Develop additional management approaches as required to achieve conservation outcomes sought.

Effectiveness of these mitigation measures is assessed as follows:

- Measures in relation to avoiding disturbance of important roosting and foraging areas and other intertidal areas are considered highly effective in avoiding impacts.
- Literature suggests that the proposed 1000m horizontal and vertical exclusion zone for scenic flights over important migratory shorebird roosting and foraging sites should be adequate to avoid disturbance to migratory shorebirds, however monitoring will also be undertaken to check the effectiveness of this mitigation measure and adjust the exclusion zone as necessary.

This exclusion zone exceeds that recommended by GBRMPA for seabird breeding islands (note that seabird breeding colonies have not been identified at or around HHI).

- Measures in relation to stormwater and wastewater management and recycling are based on established standards and guidelines endorsed by the Australian and Queensland Governments (for example, Water Sensitive Urban Design, National Water Quality Management Strategy) and modelling has been undertaken to demonstrate the effectiveness of the adopted designs and systems in avoiding water quality impacts (see Appendix D2).
- The effectiveness of a speed limit in minimising impacts on migratory shorebirds will be enhanced by the proponent's commitments to awareness raising, but will depend to some extent on the regulatory basis and enforcement of these provisions. The bathymetry of waters near key migratory shorebird foraging and roosting sites naturally restrict boat speeds and proximity of approach.
- Measures to prevent and control release of litter to the marine and coastal environment are expected to be effective, and can be further backed up with regular litter clean-up activities if the marine ecosystem monitoring program indicates that this is necessary.
- The effectiveness of mitigation measures involving awareness raising and community education is difficult to predict, and may depend on the regulatory and enforcement framework that sits behind these measures. The proponent is committed to working with Australian and Queensland Government regulatory agencies in relation to these mitigation measures.

As there are no significant direct or indirect impacts to migratory shorebird habitat, offsets are not required under the EPBC Act Environmental Offsets Policy (SEWPC October 2012).

10.3 Other Migratory Birds (Terrestrial and Marine)

10.3.1 Importance of Habitat Values

Seven terrestrial migratory birds are known or highly likely to occur within or close to the PTP development area, however the area does not appear to offer any critical or important habitat when considered against the significant impact guidelines that DotE has developed for use at the referral stage (DEWHA 2009). Most of the species are quite common, are habitat generalists and are known to utilise urban areas (see also Section 7.5.1). The white-bellied sea-eagle is identified as declining in southern states, but not in Queensland. HHI and the proposed development area is therefore considered of lowest importance in relation to terrestrial migratory bird species.

Five marine migratory birds are also known to occur on HHI. Of these, the crested tern and little tern nest on beaches and sand spits similar to those on HHI although there are no breeding colonies known on HHI or in the immediate vicinity. There is no suitable habitat for terns within the proposed development footprint. Cattle egret and great egret may utilise farm dams on HHI from time to time. With the exception of little tern, *Sterna albifrons,* which is listed as endangered in Queensland (but not under the EPBC Act), all of these species are common and not listed as threatened under the EPBC Act or any State or Territory legislation. The species are all listed as "least concern" on the IUCN redlist database. HHI is therefore considered of lowest importance to these species when considered against criteria established by DotE for determining important migratory bird sites (DotE 2013).

10.3.2 Clearing of Habitat

Some habitat loss for migratory terrestrial birds will occur as a result of vegetation clearing within the PTP footprint.

For the white-bellied sea eagle, preferred habitat, including nesting habitat, is adjacent to large bodies of open water and no clearing is proposed in the immediately vicinity of coastline so most suitable habitat on HHI will not be affected. Clearing within the PTP footprint might cause a reduction in prey species within the development footprint however this will be minimal, and potentially offset by the actively managed conservation area which will potentially enhance habitat for prey species of the white-bellied sea eagle. The white-bellied sea eagle forages in and near urban areas. The severity of impacts is therefore considered to be negligible.

White throated needletail, barn swallow, rainbow bee-eater and black faced monarch are all habitat generalists, foraging largely on insects. All are known to utilise urban and rural areas. Clearing for the proposed PTP is not likely to cause any noticeable reduction in prey species and retention of trees throughout the development footprint will mean that roosting and perching behaviour is not altered. Of these species, only rainbow bee-eater was identified during surveys of HHI (see Section 6.7.6.2). The severity of impacts is therefore considered to be negligible.

Satin flycatcher and rufous fantail forage in native vegetation and the Australian Government's Species Profile and Threats Database indicates that these two birds do not appear to utilise modified habitats (see also Table 7.8). Both are insectivorous. These birds will most likely not utilise areas within the proposed development footprint, however extensive habitat is available on the balance of HHI, on Wild Cattle Island immediately west of HHI and on the mainland, including in protected areas. Rufous fantail was identified during the surveys of HHI (see Section 6.7.6.2). As both species are common and widespread there is not expected to be any reduction in the population of these species.

There will be no loss of habitat for the little tern, crested tern and Caspian tern as these species forage over water, and roost on beaches and sand spits. Beaches and sand spits will not be affected by the proposed development. Ponds associated with water recycling and stormwater management, including those at the golf course, will generally be too steep sided to provide habitat for egrets however, further consideration will be given to whether access points can be provided for egrets and other wetland species. Existing farm dams will not be affected by the proposed development.

Overall, clearing of vegetation is not expected to have any significant or unacceptable impacts on migratory terrestrial birds.

10.3.3 Disturbance to Beach Habitat (Terns)

Caspian, crested and little terns all nest on beaches. Although there are no nesting sites identified on or near HHI, there is potential that terns may utilise HHI beaches for nesting. Beaches on HHI are typically quite narrow at high tide, as shown in Figure 10-1 and are exposed to storm events, which would limit suitability of these beaches for breeding, and also, as northerly storms are most common in summer, reduce breeding success.

Figure 10-1 – Beach on HHI at High Tide (west of headland)

As breeding is not known or considered likely to occur, increased human access to the beaches of HHI is not expected to cause any impact. It is proposed to beaches for signs of turtle nesting in October to February, and this timing correlates with Caspian, crested and little tern breeding seasons on the east coast of Australia, hence, if any breeding activity occurs, this will be identified as part of turtle nesting inspections.

In the event that nest sites are identified, these will be marked off with temporary fencing, allowing a wide protection area around the nest site. Warning signs will also be provided. As it is not proposed to allow uncontrolled dogs on the beach, interference with nesting by dogs is not expected to occur.

Given that monitoring will detect any nesting activity, and effective controls are available to protect nests from disturbance, in the unlikely event that terns do nest on HHI, it is not expected that the proposed PTP will contribute to any reduced nesting success.

10.3.4 Conservation Area

The proposed conservation area on the balance of HHI, including the revegetation of cleared areas, will increase the area of habitat for migratory terrestrial birds that is protected at a local and regional level and remove the likelihood of further development within the special lease area on HHI. As these species are not under any particular threat, this will have limited benefit to terrestrial migratory species. However, active management of the conservation area may increase availability of prey species of these birds.

10.3.5 Summary

Direct and indirect impacts on terrestrial migratory birds are not expected. Mitigation measures in relation to terrestrial threatened species will also be effective in protecting habitat for migratory terrestrial birds (see Section 9.2.4). In relation to terns, in the event that nesting is detected on beaches, effective controls are available to protect nesting areas from disturbance (see also Section 8).

Offsets are not required in relation to migratory bird species as there are no significant residual impacts on these species or their habitat.

10.4 Migratory Marine Mammals (Dugong)

10.4.1 Habitat Value

The waters around HHI have been identified as being of moderate importance for Dugong as the area has potential to support a low to moderate proportion of the regional population, based on a dugong density model developed by Grech and Marsh (2007). The area is designated a Dugong Protection Area (Zone B) under the Queensland *Fisheries Act 1994*.

10.4.2 Anchor Damage to Seagrass Beds

Anchor damage to seagrass beds is described in detail for marine turtles in Section 9.3.2. Monitoring of seagrass meadows in Seven Mile Creek is proposed as discussed in Section 9.3.8 and mitigation measures are available if damage is detected as described in Section 9.3.2. Principal among these measures is that the seagrass meadows will be monitored bi-annually for the first five years to detect any changes in seagrass health due to anchor damage (monitoring frequency will then be reviewed and may continue at the same frequency or at a reduced frequency depending on results). This means that, should any degradation due to anchoring occur, it will be detected within 6-12 months of occurrence, well before significant loss of seagrass has occurred from the seagrass meadow.

If degradation is detected, or suspected, the mitigation measures described in Section 9.3.2 will then be implemented. Based on research at seagrass sites where anchor damage has occurred, if seagrass damage is detected early and steps taken to prevent further damage, the seagrass beds will recover within several seasons (see also Section 9.3.2). Hence, in the worst case, the amount of food available in the seagrass beds in Seven Mile Creek may be reduced for a period of several years but is expected to recover.

Dugong feed almost exclusively on seagrass, and while *Halophila* and *Halodule* species are preferred, *Zostera sp* and other species would also be relied on when other species were not available (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 04/02/2013).

Although the majority of the seagrass resources in Seven Mile Creek are not the preferred dugong food species, any reduction in this resource will reduce foraging resources for the dugong. There are a range of alternative seagrass resources available in the vicinity of HHI and provided that these other resources remain in moderate to good condition, foraging resources for dugong should be maintained with no adverse impacts at a population level. Dugong are known to make large migratory movements in response to fluctuations in seagrass resources (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 04/02/2013).

Seagrass resources can fluctuate from year to year, and seasonally, in response to freshwater inputs, sediment levels (also related to rain events as sediment is mobilised from catchments) and other factors (Campbell and McKenzie 2001). As discussed in Section 7.5.3, severe weather events over the summer of 2010/2011 appear to have led to reduction in seagrass health and abundance along the east coast of Queensland. Studies of similar events indicate that seagrasses can recover from weather related events within three years (Campbell and McKenzie 2004).

Should a reduction in seagrass resources in Seven Mile Creek from anchor damage coincide with a more widespread reduction in seagrass health, this would cause a further reduction in seagrass resources available to dugong, however the quantum of this further reduction would be small in comparison to overall impacts on seagrass resources from severe weather events. This combined impact of weather related impacts and impacts related to anchor damage would occur in the short term. Recovery of seagrass beds from weather related events can be expected to occur within about three years (Campbell and McKenzie 2004) and it would be possible to establish no-anchor zones within about 6 months of detecting a decline in seagrass beds in Seven Mile Creek from anchor damage. Given the proposed annual monitoring of seagrass beds in Seven Mile Creek, adverse effects of anchor damage will be detected early and should be reversible (Cambpell and McKenzie 2001). In the worst case, food resources in the seagrass meadow in Seven Mile Creek might be diminished for two to three years, that is, the time between detecting an impact and the impact being reversed due to the proposed prevention of further anchoring.

Therefore, there is a low likelihood that, if anchor damage to seagrass beds in Seven Mile will lead to any medium to long term impacts on dugong health, and anchor damage would make a minor contribution to short term (reversible) impacts if anchor damage occurred coincidentally with weather related impacts on seagrass.

Significant or unacceptable impacts are therefore not anticipated.

10.4.3 Breaching of Causeway

While there have not been any observations of dugong movements being restricted by the existing causeway, the causeway is less than 0.2 m below the water surface at mean low water springs and may present a barrier to movement to dugong. Dugong may seek to move along the sheltered waters of Boyne Creek to access seagrass beds in the Seven Mile Creek area, or as part of local or regional movements.

Breaching of the causeway through removal of the mid-section may therefore provide some benefits in relation to movement of dugong, although this benefit cannot be quantified. There do not appear to be any negative impacts on dugong or on the marine environmental generally from partial breaching of the causeway (see also Section 8.3.6, 8.5.14, 8.10.3)

10.4.4 Boat Strike

10.4.4.1 Stranding Data

Recent data on dugong strandings (mortality) across Queensland has been made available by Queensland Department of Environment and Heritage Protection (http://www.ehp.qld.gov.au/wildlife/caring-for-wildlife/stranding-hotspots.html, accessed 1 March 2013). The website reports that "an increased number of marine strandings have occurred in the Moreton Bay, Townsville and Gladstone areas".

In the Gladstone area (Rodds Peninsula to Yeppoon), there were 21 dugong strandings recorded in the period 1 January 2011 to 30 November 2012. This compared to 28 strandings in Moreton Bay and 59 in the Townsville region over the same period.

Annually, Queensland DEHP reports that there were 9 dugong strandings in the Gladstone area in 2012, 12 in 2011, three in 2010 and one in 2009. This would appear to indicate an increase in strandings that may be attributable to loss of seagrass health due to severe weather events in 2010/2011 and increased vessel activity and construction and dredging activity in Gladstone Harbour. It must be noted however that a higher rate of sightings of stranded dugong may be due to the presence of more observers than previously.

One of the 21 dugongs stranded in the Gladstone area during the period 1 January 2011 to 30 November 2012 one was released alive. For those that died:

- 1 mortality was suspected to be the result of a vessel strike
- 1 died of disease
- 1 was suspected to have been entangled in a net
- Cause of death has not been established for the other 17 strandings.

A more comprehensive breakdown of cause of death of dugongs in Queensland has been undertaken by Greenland and Limpus (2007) for historic stranding and mortality data and is presented Table 10.4. More recent data has not been released in this form.

Table 10.4 - Dugong Stranding and Mortality Data 1996-2007 (Greenland and Limpus 2007)

Cause	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Natural causes												
Disease and ill health	2	3	1+2?	4	14	7	2	4	1	2		2
Shark	1?	1					1	1				
Stingray barb					1							
Undetermined		2	1	2	2	2	1	1				
Natural escape	1	1	2	2+2*	1+5*	1+1*	1R		1R	1R		
Human related												
Boat strike	3	4	2		2+1*	4	7	3	4+1?	1+1R +2?	2	2
Entanglement in floatlines/ropes					1		1	1R	1		2	
Netting	4	5	1+1?	9	3+1R	2			2	3+1R	1	2
QDPI Shark Control	3			2	2				2	2		2+1R
Ingestion fishing line/hooks								2				
Research			1									
Hunting	3	4	1			1	2	1	3+1			1
Disease - *toxoplasmosis*								1				
Undetermined (anthropogenic)		1	1?	5	3		1	5	2	1	2	5+1?
Undetermined Cause	19	18	18	40+2?	47+1?	31+6?	23+3?	19+7?	21+2?	25+2?	29+2?	23+2 R+6?
Total	35+1?	39	27+4?	70+2?	83+1?	49+6?	40+3?	38+7?	38+3?	36+4?	36+2?	40+7?

* = Natural escape

R = rescued

Dugong stranding data must be interpreted with caution, particularly as:

- A number of strandings and deaths are expected to go unnoticed due to lack of observers in more remote areas
- Apparent increases in strandings, or higher incidents of strandings in a particular location may relate to increased surveillance rather than increased likelihood of strandings
- For most strandings involving injury or mortality, the cause of death is very difficult to determine.

The data does however indicate that boat strike is responsible for a significant proportion of dugong deaths in Queensland, and must be considered as a threatening process. There is however no information on the size of vessels that may have caused death of dugongs and no data that can be used to correlate vessel size or speed with death or injury to dugong.

10.4.4.2 Severity of Potential Impacts and Proposed Mitigation

As discussed in Section 8.7.6, recreational boating activity is anticipated to increase in water surrounding HHI, and particularly in the waters of Colosseum Inlet, Boyne Creek and Seven Mile Creek as a result of the installation of a formal boat ramp as part of the development. A two lane boat ramp may induce recreational boat traffic in the order of 50-150 boats for normal and peak weekends respectively. The increased activity in the waters around HHI is attributed to provision of a formal boat ramp rather than population increase associated with the proposed development, and as such, boating activity is not expected to increase significantly at a regional level but rather, to be redistributed from other locations.

An increase in recreational boating may increase the risk of injury or mortality of dugong due to boat strike.

Data on dugong mortality is insufficient to identify a formal relationship between the number of boats operating in an area and injury or mortality rates. GHD examined studies on vessel strike for the Western Basin Dredging project EIS and noted that:

- Risk of boat strike was higher for larger, high speed vessels as animals are less able to detect the approaching vessel in time to evade it
- Incidence of boat strike increased with increased boat traffic
- Water depth was also a factor, with the risk of boat strike lower in deeper waters where animals could dive to evade approach vessels (GHD 2009).

Other studies have also noted that dugong react quite slowly to vessels, with the reaction based on the distance of the vessel from the dugong rather than speed or size (Hodgson 2004). This can be interpreted to mean that dugong are more vulnerable to fast moving boats as there may be insufficient time between the dugong detecting the boat's presence and moving out of the way.

Dugong are known to utilise the waters of Seven Mile Creek and Boyne Creek and are expected to also be present in the deeper waters of Colosseum Inlet. The dugong density model developed by Grech (Grech and Marsh 2007, see also Section 7.5.3) indicates the dugong density in the waters surrounding HHI of up to 0.15 dugong per km^2 (1 dugong for every 6.7 km^2). The Colosseum Estuary is 55 km^2, hence, on average, around eight dugong may be present in this area, although of course numbers at any one time may be higher or lower than this. This is consistent with results of marine megafauna surveys undertaken by GPC which identified two dugong in the area, in two surveys (GPC November 2011).

Recreational boats that utilise the proposed boat ramp at PTP will be trailerable boats, typically less than six metres long. The main recreational activity is expected to be fishing, with Maritime Safety Queensland identifying that 84% of recreational boat trips are for fishing during daylight hours (Maritime Safety Queensland 2007). This means that for a large proportion of the time that boats are in the water, the boats are stationary or drifting without power.

As discussed in Section 10.2.4.3, there are a number of navigational limitations that naturally restrict boat speed, particularly in the shallow areas of Seven Mile Creek that feature intertidal seagrass beds on which dugong might be feeding (see also Figure 6.35). The *Transport Operations (Marine Safety) Regulation 2004* includes a general speed limit of six knots within 60 m of a boat ramp or the shoreline. The Coordinator-General has recommended that this speed limit be extended along Boyne Creek by Maritime Safety Queensland (Queensland Coordinator-General 2011).

While the proponent does not have the legal power to impose a speed limit for recreational boats beyond the boat ramp and shoreline, the proponent is committed to working with Maritime Safety Queensland to impose a six knot speed limit on vessels in all sensitive habitat areas. This management measure has been implemented by the Queensland Government in important dugong habitat areas in Moreton Bay and the GBRMPA in Hinchinbrook Channel. This measure has also been imposed as a condition of approval on the GKI Revitalisation Project (EPBC 2010/5521).

The proponent will also provide signs and written awareness raising information to inform recreational boaters of the sensitivity of the waters in terms of dugongs, and the need to adhere to speed limits and maintain a close look out for dugong.

The proponent will introduce measures relating to provision of information when the proposed boat ramp becomes operational and will commence discussions with Maritime Safety Queensland on boat speed limits if the proposed PTP is approved.

Vessels required for construction of the proposed bridge and pontoon for the boat ramp will travel at a maximum speed of six knots in enclosed waters of Colosseum Inlet and Boyne Creek. Given the relatively low density of dugong occurrence in the waters around HHI, and the relatively low numbers of recreational boats that may arise from the proposed PTP the potential for interaction between dugong and boats may be limited. However, it must be recognised that from time to time, there may be larger groups of dugong present, and also that boat numbers on peak weekends may mean that interactions do occur. The natural restrictions on boat size and speed imposed by the bathymetry of the area will, however, increase the time available for boat drivers to avoid dugong, and for dugong to move away from boats as well as reduce the potential for injury in the event that a boat strike does occur. Mitigation measures are also available to restrict boat speed and raise awareness of impacts of boat strike on dugong.

It is therefore considered unlikely that the risk of dugong injury or death in the waters surrounding HHI will increase significantly as a result of recreational boat traffic arising from the proposed PTP. Further, at a regional level, the increase in recreational boat numbers is not significant and an increased likelihood of injury or mortality from vessel strike is not anticipated at a regional level. Hence, cumulative impacts relating to increased pressure at a regional or broader scale from increased recreational boating activity are not expected.

10.4.5 Disturbance While Feeding

Research by Hodgson and Marsh (2006) tested response of groups and individuals of feeding dugong to passing boats. While the results contained a number of variables, the overall finding was that in shallow waters (<2m), boats passing within 50m of feeding dugong may disturb the feeding activity, with average disturbance periods of 122 seconds. Otherwise, the research noted that “the percentage of time focal dugongs [the dugong randomly selected for tracking as part of the study] spent feeding and travelling was unaffected by boat presence, the number of boat passes and whether a pass included a stop and restart”.

Given the relatively low density of dugong occurrence in the waters around HHI, and the relatively low numbers of recreational boats that may arise from the proposed PTP the potential for such interaction between dugong and boats may be limited. However, it must be recognised that from time to time, there may be larger groups of dugong present, and also that boat numbers during daylight hours on peak weekends may mean that interactions do occur and during these periods dugong may experience some minor feeding disturbance. However, such disturbance will be relatively infrequent and is not likely to significantly affect health of dugong.

On this basis, it would seem that disturbance to dugongs feeding in Colosseum Inlet and Boyne Creek/Seven Mile Creek will be minimal given the natural restrictions on vessel speed and movement and potential additional mitigation measures to impose a legal speed limit. Dugongs feeding on the extensive subtidal seagrass beds on the seaward side of HHI are not expected to be affected at all due to lower likely boating activity in this area and depth of water.

10.4.6 Bridge and Boat Ramp Construction

As discussed in Section 8.7.5, underwater noise caused by construction of the bridge and boat ramp may deter dugong movements along Boyne Creek. Construction will take place during daylight hours and is of short duration, with noisy activities such as pile driving occurring intermittently and being completed within one to two months. Significant impacts on dugong movements are not expected.

Once the bridge is complete, traffic noise during the operational phase is not likely to deter dugong from moving along Boyne Creek.

10.4.7 Upgrade of Rodds Bay Dugong Protection Area Zoning

The Rodds Bay Dugong Protection Area, declared under the Queensland *Fisheries Act 1994*, is currently designated as Zone B in relation to the types of fishing methods that may be undertaken. The proponent has committed to working with the Queensland Government to contribute to a proposal to upgrade the zoning from Zone B to Zone A. This would further restrict the types of fishing methods and activities that can take place in the dugong protection area.

In order for this to occur without disadvantaging local and regional commercial fishing interests, an estimated four commercial fishing licences would need to be purchased. The proponent’s contribution would be to provide the funding to purchase these fishing licences. This would then reduce the fishing activity in the area, and also reduce the risk to dugong from mesh nets.

10.4.8 Overall Significance of Impact

Based on the criteria detailed in Section 1.7.4, impacts are not expected to be significant or unacceptable. The area has moderate value in relation to dugong, and the severity of identified impacts is evaluated as negligible or low.

The proponent's commitment to purchase commercial fishing licences to support the upgrade of zoning of the Rodds Bay Dugong Protection Area may reduce risks to dugong in this area from commercial fishing activities.

10.4.9 Summary of Mitigation Measures – Dugong

A range of mitigation measures have been proposed in this EIS that will avoid or minimise impacts on Dugong. These include matters incorporated into conceptual design and overall footprint development as well as commitments in relation to design, construction, operation and maintenance. A summary of measures included in Sections 2, 8 and 10 are presented in Table 10.5.

Table 10.5 – Summary of Measures to Avoid and Mitigate Impacts on Dugong

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Wastewater and stormwater management and treatment systems avoid any degradation of coastal and marine water quality, or any changes in freshwater or contaminant inputs compared to the pre-development case	Proponent commitment Coordinator-General's Report Condition	Detailed design	• Ambient coastal/offshore water quality monitoring program • Monitoring of stormwater quality	Investigate source of contaminants and repair or upgrade systems as required
Work with Maritime Safety Queensland to extend the six knot boat speed limit required by *Transport Operations (Marine Safety) Regulation 2004* near the boat ramp and shoreline to take in sensitive habitat areas. This is in addition to natural navigational restrictions in enclosed waters surrounding HHI	Proponent commitment Coordinator-General's Report recommendation	From opening of boat ramp	• Through boat speed limit enforcement programs by Queensland Police Service	Proponent work with Maritime Safety Queensland and Queensland Police Service regarding enforcement
Implement erosion and sediment control plans for all disturbed areas where the stormwater system is	Proponent commitment Coordinator-General's Report	Ongoing	• Marine and coastal water quality monitoring • Stormwater monitoring	Augment erosion and sediment control measures as required

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
not in place	condition			
Manage fertiliser and pesticide application at the proposed golf course to prevent direct and indirect releases of contaminants above trigger levels	Proponent commitment Coordinator-General's Report condition	Ongoing	• Marine and coastal water quality monitoring • Monitoring of soils, surface waters and groundwater at the proposed golf course	Upgrade or augment treatment system Review irrigation practices Review pesticide and fertiliser application practices
Monitor seagrass beds in Seven Mile Creek for anchor damage	Proponent commitment	From opening of boat ramp	• Marine habitat monitoring program	Work with Maritime Safety Queensland and Queensland Department of National Parks, Recreation, Sport and Racing to establish a no anchoring zone
Provide signs and written information to recreational boaters and other visitors to raise awareness of responsible boating behaviour, regulatory requirements regarding littering, and reporting of sightings of marine megafauna	Proponent commitment Coordinator-General's Report recommendation	From opening of boat ramp	• Marine habitat and water quality monitoring program	Identify need for corrective action if water quality or habitat degradation is detected.
Provide support to Queensland Government to upgrade Rodds Bay Dugong Protection Area from Zone B to Zone A by funding purchase of up to four commercial fishing licences.	Proponent commitment Coordinator-General's Report condition/ recommendation	In consultation with Queensland government	• Not applicable	NA

Effectiveness of these mitigation measures for potential impacts on marine turtles is assessed as follows:

- Measures in relation to stormwater and wastewater management and recycling are based on established standards and guidelines endorsed by the Australian and Queensland Governments (for example, Water Sensitive Urban Design, National Water Quality Management Strategy) and modelling has been undertaken to demonstrate the effectiveness of the adopted designs and systems in avoiding water quality impacts (see Attachment D).

- Erosion and sediment control will be based on guidelines in place at the time. The current relevant guidelines are the IECA-Australasia (2007) guidelines which are called up by SEWPaC in recent conditions of approval for projects such as the GKI Revitalisation project.
- The effectiveness of a speed limit in minimising impacts on marine fauna will be enhanced by the proponent's commitments to awareness raising, but will depend to some extent on the regulatory basis and enforcement of these provisions. Unlike other locations where boat movements have been identified as a risk to marine fauna, the bathymetry of enclosed waters around HHI will naturally restrict boat speeds in the vicinity of seagrass beds.
- Measures to prevent and control release of litter to the marine and coastal environment are expected to be effective, and can be further backed up with regular litter clean-up activities if the marine ecosystem monitoring program indicates that this is necessary.
- Retention of vegetation and topographic features will be effective in minimising lighting impacts on beaches suitable for turtle nesting. Further measures in the form of management of obtrusive light and additional shielding are available if necessary.
- The potential for anchor damage to occur to seagrasses is difficult to quantify, but if monitoring indicates that this is causing reduction in seagrass health or abundance, an effective mitigation measure in the form of a "no anchor" zone is available.
- The effectiveness of mitigation measures involving awareness raising and community education is difficult to predict, and may depend on the regulatory and enforcement framework that sits behind these measures. The proponent is committed to working with Australian and Queensland Government regulatory agencies in relation to these mitigation measures.

As no significant residual impacts have been identified to dugong or other migratory marine mammals, offsets are not required under the EPBC Act Environmental Offset Policy (SEWPC October 2012).

10.5 Migratory Reptiles (Marine Turtles)

Potentially significant impacts on marine turtles are evaluated in Section 9.3 and measures to avoid and mitigate impacts are presented. Significant or unacceptable impacts are not predicted.

SECTION 11

Evaluation of Potentially Significant Impacts on Great Barrier Reef World Heritage Area and National Heritage Place

PACIFICUS
TOURISM PROJECT

Contents

11. Evaluation of Potentially Significant Impacts on Great Barrier Reef World Heritage Area and National Heritage Place

11.1 Introduction

This section addresses potential impacts of the project on the OUV of the GBRWHA and the GBRNHP. In terms of impacts on the OUV of the GBRWHA, there are two key considerations:

- The potential for significant impacts on features of HHI and surrounding areas that contribute to the OUV of the GBRWHA/NHP is evaluated. This component of the assessment addresses impacts on both the GBRWHA and GBRNHP
- The potential for the development to impact on more holistic values of the GBRWHA such as integrity, amenity and the ongoing protection and management of the GBRWHA is examined. This part of the assessment is not relevant to the GBRNHP as it relates specifically to listing as a WHA.

The methodology for evaluating the significance of impacts is as set out in Section 1.7.4, based on the approach that impact is the product of the importance of the value and the severity of the change or impact that will occur. Section 7.2 evaluated the contribution that HHI and the surrounding waters make to the OUV of the GBRWHA and the importance of values and features of HHI and surrounding waters in that regard. An evaluation of the contribution that HHI and surrounding waters make to the integrity of the GBRWHA was also provided in Section 7.2.6 and protection and management issues identified in Section 7.2.7.

The assessment draws on the identification and assessment of impacts presented in Section 8. As biodiversity and provision of habitat for threatened species is one of the factors that contributes to the OUV of the GBRWHA, this assessment also draws on the more detailed assessment of impacts on threatened species and migratory species in Sections 9 and 10 respectively. Findings of the impact evaluation in Section 8, 9 and 10 are considered here in terms of the four criterion against which the GBRWHA was listed and the particular values or attributes on or around HHI that are identified as contributing to the OUV of the GBRWHA and the GBRNHP (Sections 11.2, 11.3, 11.4 and 11.5).

Consideration is also given to more holistic issues associated with integrity and ongoing protection and management of the OUV of the GBRWHA and the extent to which PTP might undermine these aspects (Sections 11.6 and 11.7).

11.2 Potential Impacts on Criterion vii Values

Superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance (UNESCO 2012a)

11.2.1 Summary of Values and Attributes Present

A detailed evaluation of the values and attributes present on and around HHI that contribute to criterion vii is presented in Section 7.2.2.

Overall, in relation to the criterion "*contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance*", HHI and surrounding waters feature a minor expression of some aesthetic values associated with the low profile coastal panoramas of the coastline south of Gladstone, with some modification to the sense of naturalness having already occurred due to industrial development at nearby Boyne Island and shipping traffic (see Section 7.2.2).

A study of aesthetic values of the GBRWHA did not identify any sites on or in the vicinity of HHI as a special place based on previous studies and consultation with GBRMPA personnel (Context, 2013).

Presence of "*spectacular and globally important breeding colonies of seabirds and marine turtles*" was also identified in the statement of OUV (UNESCO 2012a, see also Appendix C2). While marine turtles utilise waters around HHI and intermittent, low level nesting occurs on the beach east of the headland, this does not constitute a spectacular and globally important population when compared to other sites (See Section 7.2.2). Intertidal flats on and around HHI and also extending from Fitzroy River to Rodds Bay are nationally and internationally important for migratory shorebirds but in relation to expression of "superlative natural phenomena", shorebirds occur at densities of less than one shorebird per hectare, and there is no breeding activity and hence, there is no appearance of large congregations of birds as occurs in other locations in the GBRWHA (for example Raine Island, Michaelmas Cay, the cays of the Swain reefs and the islands of the Capricorn Bunker Group (GBRMPA 2009)).

11.2.2 Potential Impacts - Landscape Character and Visual Amenity

11.2.2.1 Scenic Values

Landscapes of HHI include minor expressions of aesthetic values identified as contributing to the OUV of the GBRWHA, mainly associated with its mangrove fringes. HHI also represents a continental island, however is indistinguishable from the mainland from most viewpoints and does not feature any unique or unusual landscape features that contribute to the OUV of the GBRWHA.

11.2.2.2 Scenic Preference Rating Assessment

While visual impact assessment studies for the project and its predecessor HHID concluded that visual impacts from the developments were low (Cardno Chenoweth 2013a, SKM 2007), further assessment was conducted of impacts on views towards HHI from viewpoints offshore in the GBRWHA/NHP (viewer group 4, viewpoint R7 in Table 8.18 and Figure 8.15). This location was selected to represent a "worst case" visual impact of the development on viewers within the GBRWHA/NHP. This location represents the most likely view point from the GBRWHA/NHP towards the project as other viewpoints are generally screened by topography and vegetation (see also Section 8.9 and Appendix F).

Figure 11-1 - ***Excerpt from Appendix A7.6 of the 2007 EIS (SKM) – Photo Montage of HHID viewed from a location north of HHI***

The Queensland Government's Scenic Preference Rating Tool (SPRAT2), which was developed to assess visual impact of coastal development on natural sections of coastline was utilised for this assessment (Queensland State Planning Policy 3/11 – Coastal Protection, Section 4).

The assessment approach underpinning SPRAT2 is comparison of "before" and "after" images with respect to the visible areas of the natural and built form and elements. Acceptable levels of change were defined in the now suspended State Planning Policy 3/11. The photo montage in Figure 11-1, showing views towards HHI from viewpoint R7 in Table 8.18 and Figure 8.15 is analysed as a "before and after" image in Figure 11-2. The SPR assessment worksheet is shown in Figure 11-3.

The calculation showed that that the "before" scenic preference rating was 8.8, indicating an area of high scenic preference. For areas of high scenic preference, the lowest acceptable level of change to the scenic preference rating for the "after" scenario is 8.0. The calculation undertaken by Cardno Chenoweth (Appendix F) indicated that the "after" scenic preference rating was 8.6. This is well within the acceptable level of change defined in the now suspended State Planning Policy 3/11.

Some buildings on hillsides will be visible from offshore as can be seen in Figure 11-1, but the SPRAT2 rating tool indicates that the low proportion of visible development relative to the area of vegetated landform would be a minor and acceptable change. Also, the hillside built form will not affect the wooded ridge skyline.

These outcomes will be achieved mainly through the constraints-based approach to site planning for the development footprint, with wide, actively managed setbacks to the coastline and retention of screening vegetation. It is also relevant to consideration of impacts on the OUV of the GBRWHA that there is currently little GBRWHA/GBRMP related tourism in the region, with no existing resorts, Great Barrier Reef attractions, dive spots, vessel routes, or scenic flights likely to result in tourists passing within view of HHI. While PTP will attract tourists and visitors to the region, the expectation of these tourists and visitors will be that there is a tourism development on HHI.

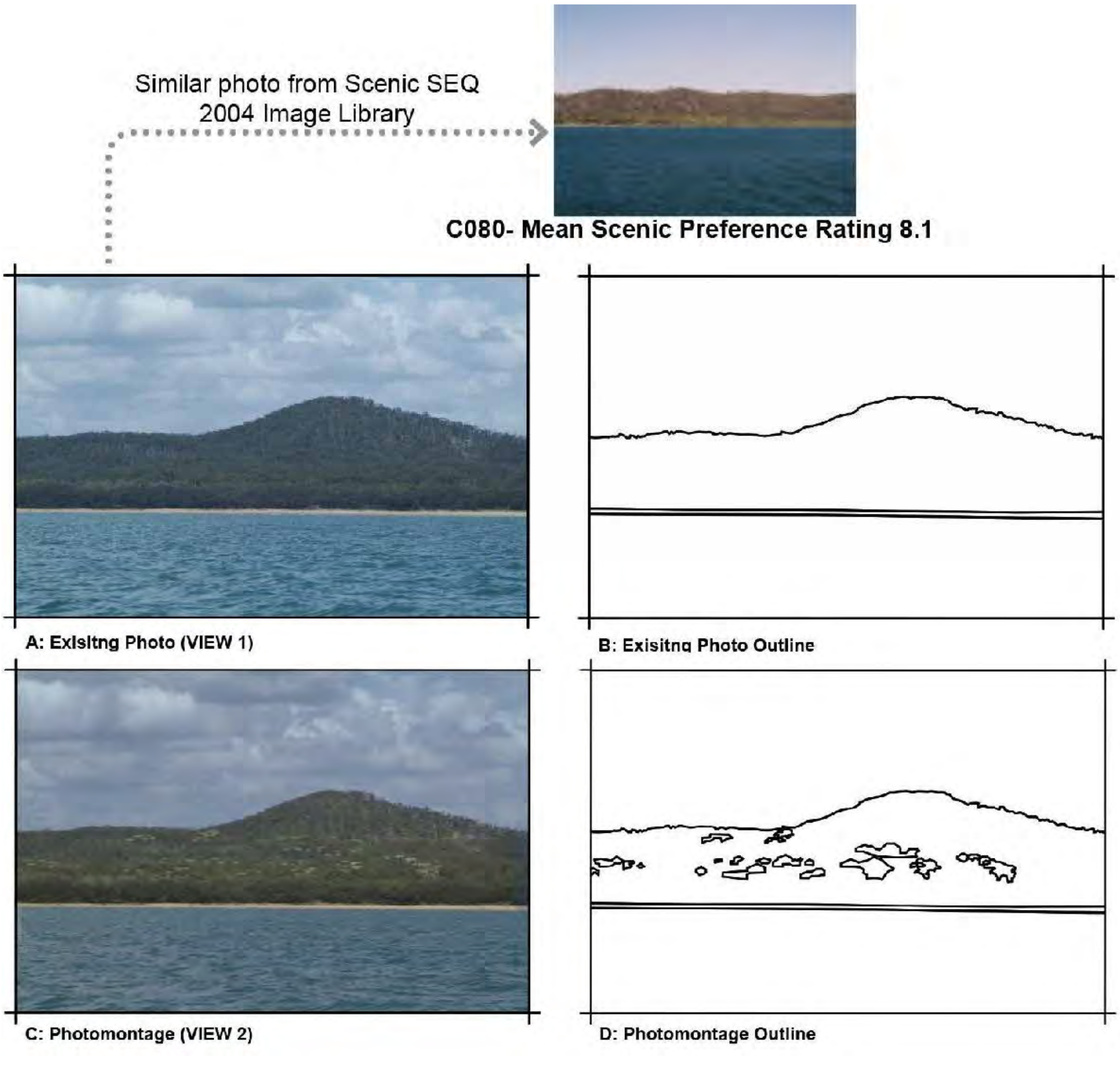

Figure 11-2 – SPRAT Photo Montages (see also Appendix F)

SEQ SPRAT-2 SEQ Scenic Preferece Rating Assessment Tool for Two views

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Inputs

	Visual Domains	View 1	View 2			View 1	View 2
1	BUSH	26%	26%	3	RURAL		
2	COAST	74%	74%	4	URBAN		
					TOTAL (Domains)	100%	100%

	Visual Elements - Built	View 1	View 2		Visual Elements - Natural	View 1	View 2
1	Buildings low non-residential			1	Coastal vegetation		
2	Buildings low residential		2%	2	Crops pasture animals		
3	Building low solitary			3	Euc forest etc	37%	31%
4	Buildings medum - high			4	Garden		
5	Building trees grass			5	Grass mown		
6	Built elements water			6	Grass natural		
7	Farm elements			7	Grass unmanaged		
8	Fence			8	Modified vegetation		4%
9	Mines, Quarries, Dumps			9	Mud		
10	Park cultural buildings			10	Native pine		
11	Park elements			11	Pine forest		
12	Path			12	Rainforest		
13	People			13	Rock		
14	Retaining wall			14	Sand	1%	1%
15	Road freeways			15	Trees planted		
16	Roads			16	Water bay		
17	Signs			17	Water constructed		
18	Towers cables poles			18	Water inland		
19	Vehicles			19	Water ocean estuary	42%	42%
20	Built misc			20	Natural misc		
					TOTAL (built + natural)	80%	80%

Output

	View 1	View 2	Difference	Direction	Statistically significant
SCENIC PREFERENCE RATING (1-10)	8.8	8.6	-0.2	decrease	N

Visual impacts will also be controlled through the Plan of Development, to be agreed with GRC, which will specify:

- building envelopes that generally require at 50% of habitat trees to be retained on each residential lot
- building height controls such that building heights are consistent with tree height and the height of the ridgeline which bisects HHI and do not protrude significantly above these natural features
- contemporary architecture with a tropical character, utilising a blend of masonry and timber, low pitch roofs, avoidance of “blocky” structures and selection of light, natural colours and non-reflective building materials
- controls to minimise light spillage to habitat areas.

Condition 34 of Schedule 2 of the Coordinator-General’s report also contains conditions in relation to minimising visual intrusiveness of various elements of the proposed development.

Figure 11-3 – SPR Calculation Worksheet (see also Appendix F)

11.2.2.3 Views from the Air

The development will be visible from the air, and passengers on commercial flights into and out of Gladstone will have brief and high altitude views of the built form and golf course. Although the development footprint will occupy only a small proportion of HHI, it will contrast visually with the island bushland and coastline as seen from the air. This contrast will be most apparent when the

PTP development is under construction and in the early years of operation, but with revegetation, landscaping and appropriate controls on built form design and materials (and especially roof colours) the visual contrast will decrease and the development will appear more integrated.

However even when first developed, the development and its visual contrast as seen from the air will not constitute a visual impact on ‘unparalleled aerial vistas’ of the Great Barrier Reef, for reasons listed in Section 11.2.1 above. Aerial views of HHI are in the context of the port, industrial and residential development associated with Gladstone, and are not part of a tourism experience of the Great Barrier Reef. The superlative aerial vistas over systems of reefs, lagoons and islands, which uniquely characterise the Great Barrier Reef and clearly contribute to the OUV of the GBRWHA, are not apparent at or near HHI (Context 2013).

11.2.2.4 Evaluation of Impacts

With respect to scenic integrity, and its relevance to the overall integrity of World Heritage properties, the visual impact assessment indicates that changes to views of HHI will be minor. HHI is considered of lower importance in relation to visual amenity values (criterion vii) (see also Context 2013).

As seen from land and sea based viewpoints, the wide vegetated coastal zone will screen most of the PTP development, and the relatively small proportion of built form seen at a distance will be visually subordinate to the undisturbed parts of the island and its wooded skylines. However any glimpse of buildings or night-time lights, even when seen at a distance, will indicate that HHI is no longer an undeveloped part of the coastline, and to that extent will diminish its current scenic integrity and perceptions of isolation.

This will be particularly applicable to aerial views, which will clearly show that HHI has a developed central band and is no longer a mainly undeveloped island. Some loss of scenic integrity will be perceived by a small number of land and sea based viewers, and by air passengers.

Although HHI appears from most viewpoints to be part of the mainland, the change from an undeveloped island to an accessible and developed part of the coastline may be perceived as affecting the overall integrity of the GBRWHA/NHP, even if the particular views over HHI are not perceived as making a major contribution to the OUV of the GBRWHA. This perception is not just visual, and may include the intangible values associated with islands as ‘other’ places, in which case even a fully screened development would cause some loss of perceived integrity. However, HHI is not in a remote location of the GBRWHA/NHP and does not have wilderness values.

This assessment indicates that the PTP development will not significantly degrade the scenic and aesthetic values which contribute to the OUV of the GBRWHA. While some built form elements will be visible at a distance from offshore and some mainland viewpoints, and the development will cause a change in character as seen from the air, the landscape and views around HHI do not make a major contribution to the OUV of the GBRWHA.

The low level of visual impacts associated with the development will be further reduced by mitigation measures such as design, colour and height controls on built form, street trees and other landscape planting. These mitigation measures reflect the overall intent of PTP as a development that blends harmoniously with the surrounding environment (see also development principles in Section 2.2).

With these measures in place, the PTP development will not degrade scenic values that contribute to the OUV of the GBRWHA, and will have only minor visual impacts on the distant views of land and sea based viewers. Mitigation measures in relation to visual impacts are described throughout Section 2 (see in particular Section 2.2.4 and Section 2.5). In summary:

- Built elements have been located away from the immediate coastal zone
- Fringing coastal vegetation is to be retained and managed as part of a managed conservation area (see Section 8.3.8). This will assist in screening structures and also minimising light spill.
- There is no change to topography and particularly, the prominent ridgeline and headland features remain unchanged
- The Plan of Development will specify building envelopes for most components of the PTP will require at least 50% of habitat trees to be retained on each lot
- The Plan of Development will impose building height controls such that building heights are consistent with tree height and the height of the ridgeline which bisects HHI and do not protrude significantly above these natural features
- The Plan of Development will include architectural guidelines specifying contemporary architecture with a tropical character, utilising a blend of masonry and timber, low pitch roofs, avoidance of "blocky" structures and selection of light, natural colours and non-reflective building materials. This will minimise contrast between buildings and the natural shapes of the area
- Lighting, and particularly external lighting, will be required to conform with the Australian Standard AS 4282—1997, Control of the obtrusive effects of outdoor lighting. In addition, controls to minimise light spillage to habitat areas will also minimise visible light from the PTP.

Based on the impact significance assessment methodology developed for this assessment, the severity of impacts on visual amenity and impact on the contribution that HHI makes to the OUV of the GBRWHA/NHP is considered low. The importance of the contributing features values is also assessed as "lower importance" in relation to this criterion and significant or unacceptable impacts are not predicted.

11.2.3 Potential Impacts - Other Superlative Natural Phenomena

In relation to this criterion, the statement of OUV notes that the following aspects contribute to the OUV of the GBRWHA/NHP:

> *On many of the cays there are spectacular and globally important breeding colonies of seabirds and marine turtles, and Raine Island is the world's largest green turtle breeding area.*
>
> *and*
>
> *Other superlative natural phenomena include the annual coral spawning, migrating whales, nesting turtles, and significant spawning aggregations of many fish species.* (UNESCO June 2012a)

While turtles are present in waters around HHI, and there is intermittent low density turtle nesting on the beach to the east of the headland, the numbers of turtles and low level and intermittent use of the beaches for breeding means that this level of nesting does not contribute to the superlative natural phenomenon referred to in the statement of OUV. As discussed in Section 7.2.2, there are many thousands of turtles nesting at Raine Island, and hence this location is identified as being a superlative natural phenomenon, over and above any biological importance attached to the turtle nesting activity. Some other locations in and out of the GBRWHA have also become a focus for tourism activities based on watching turtles nesting and hatching, indicating what level of activity might be considered to be spectacular. At locations such as Mon Repos, over 25 nesting turtles per night are often seen in the peak of the nesting season, whereas the maximum number observed at HHI was six or seven turtles over several days.

The combined Mundoolin/Colosseum and Rodds Peninsula area is identified as internationally important habitat for the migratory eastern curlew, and nationally important habitat for ten other migratory shorebird species and migratory shorebirds in general. However, there are no breeding colonies present and the density of birds is low, with less than one bird per hectare. As such, although the conglomerate of sites is ecologically important, it does not represent a superlative natural phenomenon in the sense implied in this criterion (Context 2013). Further, as discussed in Section 10.2, PTP is not expected to have any significant impacts on migratory shore birds as any direct impacts on habitat are avoided, there are adequate separation distances between habitat and the development footprint and controls have been proposed to prevent recreational boat and air traffic from approaching close enough to major roosting and foraging sites to cause disturbance to roosting and foraging birds.

11.2.4 Impact Evaluation and Mitigation

An evaluation of potential impacts on values that contribute to criterion vii (s*uperlative natural phenomena or areas of exceptional natural beauty and aesthetic importance)* is provided in Table 11.1. The evaluation has not identified any significant or unacceptable impacts on values of the GBRWHA/NHP.

Table 11.1 – Evaluation of Impacts on Criterion vii

Feature	Importance of Contribution to OUV ([1])	Severity of Impact on Contribution to OUV([1])	Significance ([1])
Landscape and visual amenity	Lower importance, minor contribution	Low severity	Not significant
Superlative natural phenomena	Lower importance, minor contribution	Negligible severity	No impact

([1]) See also Section 1.7 for definitions of importance, severity and significance

A number of mitigation measures are relevant to minimisation of impacts on landscape and visual amenity. These are described in Sections 2, 8 and 11.2.2 and summarised in Table 11.2. Mitigation measures proposed are considered to be effective and reliable in addressing impacts as:

- Impacts have been avoided wherever possible through the development footprint, which avoids areas of moderate or highest value for MNES and retention of vegetation
- Mitigation measures in relation to building design and light spill can be enforced through the incorporation of the Plan of Development into the Gladstone planning Scheme, which then makes the Plan of Development a statutory document that is applied to all development approvals for PTP (see also Section 2.5)
- Mitigation measures reflect practices adopted for similar developments at other locations, in particular, Great Keppel Island Revitalisation Project (EPBC 2010/5521).

Table 11.2 – Summary of Measures to Avoid and Mitigate Impacts on Visual Amenity

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Retention of coastal vegetation within the coastal management district	Proponent commitment Statutory requirement (a development permit is required to clear this area and compliance will be enforced by Queensland government)	Already in place through master plan development	• Visual inspection of clearing compliance	Prosecution of contractors for illegal clearing under Queensland legislation Proponent to require contractors to reinstate vegetation if clearing does not comply with specification
Retention of 50% of mature habitat trees outside building envelopes	Plan of Development, which is enforced by Gladstone Regional Council	During clearing	• Monitoring of clearing effort	Proponent to require contractors to reinstate vegetation if clearing does not comply with specification
Architectural standards, including restricting building heights based on treeline and ridgeline	Plan of Development which is enforced by Gladstone Regional Council	Development approval process (pre-construction)	• Assessment of development approvals	Refusal of development permits for non-compliant buildings

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
levels and reducing visual "bulkiness" of buildings	Coordinator-General's report conditions, which are enforced by Queensland government			
Building material and colour selection that minimises obtrusiveness and blends with backdrops	Plan of Development which is enforced by Gladstone Regional Council Coordinator-General's report conditions, which are enforced by Queensland government	Development approval process (pre-construction)	• Assessment of development approvals	Refusal of development permits for non-compliant buildings
Landscape plantings and street trees	Proponent commitment Coordinator-General's report conditions, which are enforced by Queensland government	Throughout construction and operation/ maintenance phase	• Visual monitoring of landscaped areas	Additional plantings as required
Detailed design of buildings and other facilities to minimise light spill (see Section 9.3.3 for details)	Proponent commitment Coordinator-General's Report conditions, which are enforced by Queensland government Plan of Development which is enforced by Gladstone Regional Council	Detailed design	• Monitor light levels and visibility of light sources	Implement additional screening measures as required

As the assessment undertaken has not identified any significant residual impacts on the attributes and values associated with criterion vii, offsets are not required under the EPBC Act Environmental Offsets Policy (SEWPaC October 2012).

11.3 Potential Impacts on Criterion viii Values

Outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features (UNESCO 2012a, see also Appendix C2)

11.3.1 Summary of Values and Attributes Present

A detailed evaluation of the values and attributes present on and around HHI that contribute to criterion viii is presented in Section 7.2.3.

In relation to the criterion "outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features" there is a minor expression of several features that contribute to the OUV of the GBRWHA present at HHI and in surrounding estuarine waters:

- Minor expression of coastal geological and geomorphological changes and estuary formation typical of similar estuaries in the region. In this regard, HHI and surrounding waters is not unique or unusual and makes a minor contribution to the OUV of the GBRWHA
- Minor expression of geological and geomorphological processes in formation of coastal beaches and sand dunes, intertidal mud flats and tidal creeks. Similar features are represented nearby including in the GBRWHA/NHP and nearby national parks. The contribution made to the OUV of the GBRWHA by these features at HHI is considered minor.
- Minor expression as an example of a continental island. Continental islands are recognised as contributing to the OUV of the GBRWHA however HHI makes only a minor contribution as it does not contain any notable geological or geomorphological features or provide any significant information about the earth's history that is not readily available from a range of similar features in the GBRWHA.

HHI does not feature any unique or unusual landscape or geomorphological features when considered either at either a regional or WHA/NHP-wide scale and hence does not contribute to the OUV of the GBRWHA in this regard.

11.3.2 Potential Impacts

Potential impacts on geology, landform and geomorphological processes are evaluated in Section 8.10. In summary:

- The development footprint avoids steep slopes and coastal areas and precinct layouts and road networks have been determined to follow existing contours rather than require major earthworks and topographical change. Minor changes to topography will be required on individual lots to create building pads, however, the overall landform will not be altered
- Stormwater management and drainage has been designed so that existing sub-catchments are retained with minimal alteration and runoff is managed such that increased erosion or destabilisation of ephemeral watercourses is avoided (see also Section 8.5.9)
- Coastal processes will not be altered by the bridge and boat ramp, and breaching of the existing causeway on Boyne Creek and upgrade of the Clarke's Road causeway will restore natural tidal flows (see Section 8.10.3).

- While HHI tends to blend with the mainland, the features that make recognisable from some viewpoints it a continental island are retained, with all of the current landform and geomorphological features remaining fully apparent.
- PTP is not expected to contribute to or exacerbate any identified threats to geological and geomorphological features.

11.3.3 Impact Evaluation and Mitigation

An evaluation of potential impacts on values and features that contribute to criterion viii (*outstanding example representing major stages of the earth's history)* is provided in Table 11.3. The evaluation has not identified any significant or unacceptable impacts on values of the GBRWHA/NHP.

Table 11.3 – Evaluation of Impacts on Criterion viii

Feature	Importance of Contribution to OUV (1)	Severity of Impact on Contribution to OUV(1)	Significance (1)
coastal geological and geomorphological changes and estuary formation	Lower importance, minor contribution	Low or negligible severity	Not significant
geological and geomorphological landforms or processes	Lower importance, minor contribution	Low or negligible severity	Not significant
example of a continental island	Lower importance, minor contribution	Negligible severity	No impact

(1) See also Section 1.7 for definitions of importance, severity and significance

A number of mitigation measures are relevant to minimisation of impacts on geology and geomorphological process and features. These are described in Sections 2 and 8 and summarised in Table 11.4. As these mitigation measures are largely based on avoiding impacts through the master planning process and design of aspects such as stormwater systems according to best practice standards, the level of effectiveness is considered to be highly reliable.

Table 11.4 – Summary of Measures to Avoid and Mitigate Impacts on Geology and Geomorphological Processes and Features

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
No development in the coastal zone apart from bridge and boat ramp. The bridge and boat ramp will be designed so as not to impede tidal flows	Proponent commitment Coordinator-General's Report condition Statutory requirement (a development permit is required to undertake works in this area)	Already in place through master plan development	• NA	Not required
Master plan layout and design avoids the need for topographical changes	Proponent commitment Plan of Development	Already in place through master plan development	• Assessment of development approvals	Refusal of development permits that do not comply with earthworks code
Stormwater system retains rainfall runoff patterns, including at low flows	Proponent commitment Plan of Development Coordinator-General's report condition	Throughout construction phase	• Assessment of development approvals • Validation of detention basin performance	Augment or amend stormwater system design.
Control access to the northern beach to avoid destabilisation of frontal dunes. Use of boardwalks and fauna friendly fencing to direct pedestrian traffic to low impact areas.	Proponent commitment Coordinator-General's report condition	Throughout construction and operation phase	• Visual monitoring of beach access	Implement additional access control measures as required

As the assessment undertaken has not identified any significant residual impacts on the attributes and values associated with criterion viii or any diminution of the contribution that HHI and surrounding waters makes to the OUV of the GBRWHA, offsets are not required under the EPBC Act Environmental Offsets Policy (SEWPaC October 2012).

11.4 Potential Impacts on Criterion ix Values

Outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals(UNESCO 2012a)

11.4.1 Summary of Values and Attributes Present

A detailed evaluation of the values and attributes present on and around HHI that contribute to criterion ix is presented in Section 7.2.4.

In relation to the criterion "outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals", minor expressions of some features that contribute to the OUV of the GBRWHA are considered present as follows:

- Minor expression of the relationship between coastal geomorphic processes and environmental processes. These relationships are also evident at a number of nearby locations.
- Minor expression of erosion and accretion processes in relation to sand banks and beaches
- Minor expression of relationship of local Aboriginal groups to the natural environment as evidenced through shell middens and artefact scatters in locations such as sand dunes and ephemeral wetlands. Minor evidence of post-settlement use as a grazing property.

While plants, animals and ecosystems on HHI and in the surrounding waters are the result of ongoing evolutionary processes, evidence of these processes is not apparent, and there are no unique or unusual features arising from evolutionary processes.

On this basis, HHI is of lower importance for this criterion. Potential impacts on values and attributes present that contribute to this criterion are discussed in the following sections.

11.4.2 Potential Impacts – Relationship Between Coastal Geomorphic Processes and Environmental Processes

Estuarine processes within the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary provide a range of habitats including mangrove stands, intertidal and supratidal mud flats and salt flats and soft sandy and muddy substrate. Sub-tidal and intertidal sea grass beds are present in some locations.

Detailed information on the coastal and estuarine environment is provided in Section 6.5. The key physical processes that are critical in defining the estuarine habitats surrounding HHI are tidal flows and catchment runoff, with both the quality and quantity of catchment runoff being important. Nutrient cycles are related to physical and biological processes and all of these processes also drive water quality which is a key habitat determinant.

Changes to any of these processes may in turn affect the type and quality of habitat available and hence, degrade the clear relationships between geomorphic processes and environmental processes.

Section 8 provides evaluation of a wide range of impacts that might affect the complex interrelationships between coastal geomorphic and environmental processes, including effects on water quality and coastal processes. In summary:

- Stormwater systems have been designed so that catchment runoff characteristics do not change, including in low flow events (see Section 8.5.9)
- The stormwater system includes stormwater quality improvement devices that comply with Water Sensitive Urban Design requirements (Water by Design 2007) and the Queensland Urban

Drainage Manual (DNRW 2008). Modelling has demonstrated that stormwater quality will meet water quality guidelines (see Section 8.5.8)

- Erosion and sediment controls will follow best practice requirements such that risk of sediment releases to the coastal environment causing water quality degradation is very low (see Section 8.5.4)
- There is no planned discharge of treated wastewater and measures have been designed into the proposed wastewater system to minimise the likelihood and volume of an emergency discharge. Wastewater will be treated to a high standard and recycled for toilet flushing and irrigation. Queensland Government regulatory requirements apply to management of health and environmental risks of recycled water schemes. A strict management and monitoring regime will be applied to the proposed golf course and other irrigation areas to manage stormwater runoff quality and prevent degradation of groundwater and coastal water quality (see Section 8.5.6 and 8.5.7). This will include management of fertiliser use at the golf course. The proponent will utilise the Australian Golf Course Superintendents Association e-par® environmental management system and also comply with National Water Quality Strategy guidelines in relation to use of recycled water.
- Pesticide use will be minimised and pesticides carefully selected based on analysis of environmental fate, such that release of toxicants to coastal waters and groundwater is avoided (see Section 8.5.12)
- Environmentally hazardous materials can be managed such that there is very low risk of accidental release to the environment (see Section 8.5.11 and 8.5.13)
- Potential impacts on water quality from boat based recreation have been evaluated and are considered to be negligible (see Sections 8.5.15 and 8.5.16)
- The only structures to be placed in the tidal zone are the proposed bridge and boat ramp, both of which will be designed and constructed to avoid any changes in tidal flows. An existing causeway will be breached which will restore tidal flows. No changes to tidal processes are expected (see Section 8.10.3).

Overall, with proposed design and management controls to prevent changes in flows and water quality impacts, and given the minimal level of disturbance to the coastal and tidal zone, negligible impact is expected to the contribution that coastal and estuarine processes around HHI make to the OUV of the GBRWHA.

11.4.3 Potential Impacts – Erosion and Accretion Processes in Relation to Sand Banks and Beaches

Sand bars and mud flats in the entrances to Colosseum Inlet and Seven Mile Creek appear dynamic and undergo regular changes over periods of decades to centuries, largely due to tidal movements and storm events. Sand dunes formed by aeolian processes are present and beaches on HHI appear to be accreting. While these features are examples of erosion and accretion processes, the features present are typical and common of such features throughout the GBRWHA/NHP and represent only a minor contribution to the OUV of the GBRWHA in this regard.

In any case the project footprint avoids development in the coastal zone, including the beach and foredunes. The golf and beach resort precinct will affect relict sand dunes however and assessment of these sand dunes has identified that these sand dunes are not unique at a local or regional level (see also Section 7.2.3). Similar sand dune systems are present on Wild Cattle Island which is protected as a national park and Curtis Island which is within the GBRWHA/NHP and parts of which are also protected as national park. A large area of sand ridges on the western tip of HHI will not be affected by the project and will be protected in the proposed managed conservation area.

Accordingly, the severity of impacts on landform is assessed as being low as the features that contribute to the OUV of the GBRWHA will remain readily discernible and available. The contribution made by these features to the OUV of the GBRWHA is minor and using the assessment framework set out in Section 1.7, the overall impact on the OUV of the GBRWHA is not significant or unacceptable.

11.4.4 Potential Impacts – Human Interaction with the Natural Environment

Aboriginal people's use of natural resources on HHI is evidenced by shell middens and artefact scatters on the island which show that food was gathered and eaten. An archaeological assessment did not identify any unique or unusual evidence of ways in which natural resources were used by Aboriginal people but did identify a pattern of use and information of interest to local Aborignal groups (SKM 2007). A cultural heritage management plan prepared under the Queensland *Aboriginal Cultural Heritage Act 2003* is in place with the Port Curtis Coral Coast traditional owner group. The plan contains measures to avoid and manage impacts on places and items of Aboriginal cultural heritage significance. With this plan in place, impacts on Aboriginal cultural heritage are considered of low severity.

More recently, pastoralists and loggers have also utilised natural resources on HHI. While regrowth native vegetation now occurs in many of the areas disturbed by logging and grazing, the presence of pasture grasses and other introduced plant species, feral dogs and remnants of fences and buildings provides evidence of the way that natural resources were used since settlement. A cultural heritage assessment did not identify any unique or unusual evidence of ways in which natural resources were used, nor are the remaining structures considered to have more than local cultural heritage significance (SKM 2007).

As discussed in Section 8.8, the project will increase access to the GBRWHA/NHP. Access in the Mackay-Capricorn management area is low compared to other areas and hence, opportunities for the community to interact with the natural resources of the area are low. Increased access to and presentation of the GBRWHA/NHP values is considered beneficial, provided that measures are in place to manage the impacts that increased access can have.

An evaluation of the potential impacts of increased access to land and water areas of the GBRWHA/NHP arising from the project has been undertaken in Section 8 (See Sections 8.4.6, 8.4.7, 8.4.8, 8.4.10, 8.4.11, 8.5.15, 8.5.16, 8.7, 8.8).

For the terrestrial component, it is not proposed to provide any access to sensitive habitats such as the coastal vine thicket and migratory shorebird roosting and feeding sites. Controlled access will be provided to the beach to northern beaches, and walking tracks will also be provided in the proposed conservation area to allow visitors to interact with the natural environment without affecting sensitive areas. Access track routes will be selected based on tolerance of disturbance of habitats to foot traffic.

The PTP also includes an environmental educational facility, and numerous opportunities to present the OUV of the GBRWHA/NHP and raise understanding and awareness of the OUV and the need for protection of features that contribute to the OUV of the GBRWHA. This is described further in Section 8.8.6.

The range of potential impacts arising from recreational boat traffic on the marine environment has been assessed. This assessment is presented and evaluated in Section 12.

Overall, the project will obscure some evidence of past human interaction with the natural environment and use of natural resources, and hence the severity of the potential impact is considered moderate in accordance with the criteria established in Section 1.7.4. As the values present are considered of lower importance and make only a minor contribution to the OUV of the GBRWHA, the impact is not assessed as being significant. Potential benefits will arise as a result of presentation of the OUV of the GBRWHA/NHP to visitors to PTP. The active management and restoration of the balanced lands also has the potential to reinstate and enhance the on-going ecological and biological processes that have been lost or diminished through historic use of HHI as well as preserve representative features.

11.4.5 Impact Evaluation and Mitigation

An evaluation of potential impacts on values that contribute to criterion ix (o*utstanding example representing significant ongoing ecological and biological processes)* is provided in Table 11.5. The evaluation has not identified any significant or unacceptable impacts and no diminution of the contribution that HHI and surrounding coastal areas make to the OUV of the GBRWHA/NHP.

Table 11.5 – Evaluation of Impacts on Criterion ix

Feature	Importance of Contribution to OUV (1)	Severity of Impact on Contribution to OUV(1)	Significance (1)
Relationship between coastal geomorphic processes and environmental processes	Lower importance, minor contribution	Negligible severity	No impact
Erosion and accretion processes in relation to sand banks and beaches	Lower importance, minor contribution	Low severity	Not significant
Human interaction with the natural environment	Lower importance (minor contribution)	Moderate severity [Potential benefit]	Not significant

(1) See also Section 1.7 for definitions of importance, severity and significance

A number of mitigation measures are relevant to minimisation of impacts on ecological and biological processes and the interrelationships between ecological and geological processes. These are described in Sections 2, 8 and 11.2.2 and summarised in Table 11.6.

Table 11.6 – Summary of Measures to Avoid and Mitigate Impacts on Ecological and Biological Processes and Interrelationships

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
No structures in the coastal zone, including beaches and foredune apart from bridge and boat ramp. The bridge and boat ramp will be designed so as not to impede tidal flows	Proponent commitment Coordinator-General's Report condition Statutory requirement (a development permit is required to undertake works in this area)	Already in place through master plan development	• Visual check for scouring at the boat ramp and bridge	Stabilise any damaged areas
Control access to the northern beach to avoid destabilisation of frontal dunes. Use of boardwalks and fauna friendly fencing to direct pedestrian traffic to low impact areas.	Proponent commitment Coordinator-General's report condition	Ongoing	• Beach and dune stability	Repair damage and review access requirements
Cultural heritage management plan (with Port Curtis Coral Coast Aboriginal Corporation)	Statutory requirement	Already in place, to be implemented throughout development phase	• As per CHMP	As per CHMP
Restrict access to sensitive terrestrial and coastal habitats	Proponent commitment	Ongoing	• Human access and activity levels	Utilise signage and/or physical barriers
Raise awareness and promote responsible recreational boating and fishing behaviour	Proponent commitment Coordinator-General's report condition	Ongoing	• Behaviour of recreational boaters	Increases information, seek Queensland government assistance with enforcement
Present the OUV of the GBRWHA/NHP and contribution that HHI and surrounding areas makes to the OUV. Promote the need to protect the OUV of the GBRWHA through an environmental educational centre and other means	Proponent commitment Coordinator-General's report condition	Ongoing	• Review effectiveness of program	Amend and augment program as required

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Actively manage the balance of HHI as a conservation area.	Proponent commitment Coordinator-General's report condition	Ongoing	• Monitor effectiveness of conservation area management, including pest and weed presence, habitat values and species abundance and diversity.	

Likely effectiveness of mitigation measures is assessed as follows:

- Mitigation measures in relation to avoiding development in the coastal zone and controlling impacts of access to the coastal zone and other sensitive habitats are considered to be highly effective as these are based on avoiding impacts.
- Use of a cultural heritage management plan to manage indigenous cultural heritage is an established approach that is supported by a statutory framework.
- The effectiveness of mitigation measures involving awareness raising and community education is difficult to predict, and may depend on the regulatory and enforcement framework that sits behind these measures. The proponent is committed to working with Australian and Queensland Government regulatory agencies in relation to these mitigation measures.
- Active management of the balance of HHI as a conservation area is expected to be effective in reversing current degradation and enhancing habitat. Further discussion of the proposed approach is provided in Section 8.3.8 and 8.3.9.

Mitigation measures reflect practices adopted for similar developments at other locations, in particular, Great Keppel Island Revitalisation Project (EPBC 2010/5521).

As the assessment undertaken has not identified any significant residual impacts on the attributes and values associated with criterion ix or the contribution that HHI and surrounding waters makes to the OUV of the GBRWHA, offsets are not required under the EPBC Act Environmental Offsets Policy (SEWPaC October 2012).

11.5 Potential Impacts on Criterion x Values

Contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation (UNESCO 2012a)

11.5.1 Summary of Values and Attributes Present

A detailed evaluation of the values and attributes present on and around HHI that contribute to criterion x is presented in Section 7.2.5.

In summary, HHI and surrounding waters make a minor or moderate contribution to the values associated with criterion x and the overall OUV of the GBRWHA due to a number of features as follows:

- Minor contribution to the OUV of the GBRWHA through a minor expression of terrestrial and marine biodiversity, supporting a range of plants and animals typical of the Capricorn/Mackay region, including some threatened species and a critically endangered ecological community
- Moderate contribution to the OUV of the GBRWHA through a regionally important expression of floristic diversity, with two vegetation communities that, while present on the adjacent mainland, are not well represented elsewhere in the GBRWHA
- Minor to moderate contribution to the OUV of the GBRWHA due to the waters around HHI supporting iconic species and species of conservation significance including:
  - Regionally important expression in relation to dugong habitat, with the wider Rodds Bay DPA supporting 5-10% of the southern GBRMP population of dugong.
  - Minor expression as habitat for the Indo-Pacific humpback dolphin.
  - Regional expression as habitat for green, flatback and loggerhead turtles, with minor nesting by flatback turtles occurring some years
- Moderate contribution to the OUV of the GBRWHA through regionally important expression of shallow intertidal and subtidal mangrove, seagrass and mud flat habitats.

In addition, the conglomeration of migratory shorebird roosting and foraging habitat on HHI and in the Mundoolin/Colosseum/Rodds Bay area makes a major contribution to the OUV of the GBRWHA as these sites have been identified as being nationally and internationally important migratory shorebird sites. These sites are also part of a larger area of highly significant migratory shorebird sites stretching from the mouth of the Fitzroy River through Port Curtis and the Port of Gladstone to Rodds Bay just south of HHI. (see http://www.westernbasinportdevelopment.com.au/environmental_reports/section/environmental)

11.5.2 Potential Impacts – Biodiversity (Terrestrial and Marine)

In relation to OUV of the GBRWHA/NHP, biodiversity values can be considered in terms of the overall degree of variation of species within a given bioregion, ecosystem or ecological community. In this regard, retention of both threatened and common native species is important, as all contribute to biodiversity and an impact on biodiversity within the GBRWHA would occur if a plant, animal or vegetation community became locally extinct, even if that plant, animal or vegetation community was not listed as threatened under Federal or State legislation. Biodiversity assessments also give a particular focus to threatened species as the risk of local and more wide widespread extinction is higher.

Key considerations in relation to impacts on overall biodiversity values therefore relate to both maintaining the overall range of species present at a local and bioregional scale, and ensuring that habitat quality for native species and threats to native species are controlled such that population viability is not affected, and is preferably enhanced. This has been the approach taken by the proponent in development of the master plan (see also Section 2.2.2 and Section 4).

As discussed in Sections 6.7 and 7.2.5, terrestrial biodiversity on HHI is similar to or less than that of other nearby continental islands and the nearby mainland. A number of factors may have influenced this, including isolation from the mainland, previous grazing and logging land uses and, until graziers constructed dams, lack of permanent freshwater resources. The land area of HHI supports a limited number of species of conservation significance and does not appear to provide important habitat for any of these species (see also Section 7.3). HHI is considered to be of lower importance in relation to terrestrial biodiversity and therefore makes a minor overall contribution to the OUV of the GBRWHA in this regard.

The exception to this is that HHI features three vegetation communities that are important to the floristic diversity of the GBRWHA and hence, makes a moderate contribution to the OUV of the GBRWHA in this regard. This is also examined further in Section 11.5.3.

Biodiversity of the waters surrounding HHI is also considered to be typical of waters within the "high nutrient coastal strip" bioregion as identified by GBRMPA (see also Section 7.6.2). The waters are however considered to be of moderate importance against the criteria established in Section 1.7.4 as the enclosed and open coastal habitats support some species of marine turtles and dugong and contain examples of intertidal and subtidal habitats, including mangroves and seagrass, in good condition. Hence, a moderate contribution is made to the OUV of the GBRWHA by the waters around HHI. Further examination of issues associated with iconic species is also provided in Section 11.5.4.

Section 8 identified and evaluated a range of direct and indirect impacts on terrestrial and marine habitats, ecological communities and individual species. In summary:

- The development footprint has been designed such that viable examples of all habitat types and vegetation communities present on HHI are retained (see Section 8.3.2).
- Areas identified as having high conservation values are retained in their entirety, without direct or indirect disturbance (see Sections 8.3.2 and 8.3.3). These areas are:
  - Coastal, intertidal and subtidal areas, with the exception of a small area of already disturbed habitat that is required for the proposed bridge and boat ramp
  - Migratory shore bird roosting and feeding habitat
  - Critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*
  - Vegetation communities that are classified as endangered under the Queensland regional ecosystem classification system
- The 10.6ha patch of *Eucalyptus melanophloia* woodland which, when considered against Queensland regional ecosystem classification, is not found elsewhere in the GBRWHA/NHP, is retained. 230 ha of *Eucalyptus tereticornis* and *E. crebra* dominated forests which, when considered against Queensland regional ecosystem classification is not found elsewhere in the

GBRWHA/NHP is also retained. This ensures no loss of floristic diversity and retains viable patches of both vegetation types within the GBRWHA/NHP (see also Section 8.3.2 and Section 11.5.3).

- Terrestrial habitat fragmentation is minimised by providing movement corridors and maximising permeability of the development to wildlife (see Sections 8.3.2 and 8.3.4). Some particular features of the development in this regard are:
  - Retention of an east west habitat corridor
  - Location of the golf course to enhance east-west movement through the western part of the footprint.
  - Design of the main arterial road through the 500m wide habitat corridor as divided road with a a naturally vegetated median strip of 50–60 metres wide to reduce exposure of animals to vehicle strike
  - Provision of culverts under the roads to provided movement corridors for small, ground dwelling animals
  - Design of roads in accordance with Queensland Department of Transport and Main Roads Fauna Sensitive Road Design Manual (DMR 2000, DTMR 2010)
  - Alignment of the main arterial road along an existing track and the area disturbed by the airstrip
  - Retention of all mature habitat trees outside building envelopes.
- Marine habitat fragmentation will not occur, and may be reduced by breaching of the existing causeway (see Section 8.3.5 and 8.3.6)
- Indirect impacts such as weed and pest proliferation, deposition of dust and changes from natural fire regimes are reduced by separation distance between the development footprint and sensitive habitats and vegetation communities and can be managed using established management techniques (see Sections 8.4.2, 8.4.5 and 8.4.11)
- Active management of interface zones has been allowed for in habitat retention areas to minimise effects of microclimatic changes at the edge of vegetation (see Section 8.4.9)
- Disturbance to animals through noise and activity are assessed as being within acceptable limits (see Sections 8.4.6, 8.4.7, 8.4.8, 8.4.10). There are also significant separation distances between the development and key habitats such as roosting and feeding areas for migratory shorebirds and beaches used intermittently for low level turtle nesting
- Potential impacts on coastal and marine water quality from land-based activities can be controlled through design and management measures (Section 8.5). Proposed design and management measures are based on regulatory and policy requirements and established standards. Some key design and management measures include:
  - Stormwater systems have been designed so that catchment runoff characteristics do not change, including in low flow events (see Section 8.5.9)

- The stormwater system includes stormwater quality improvement devices that comply with Water Sensitive Urban Design requirements (Water by Design 2007) and the Queensland Urban Drainage Manual (DNRW 2008). Modelling has demonstrated that stormwater quality will be within water quality guidelines for the receiving environment (see Section 8.5.8)
- Erosion and sediment controls will follow best practice requirements such that risk of sediment releases to the coastal environment causing water quality degradation is very low (see Section 8.5.4)
- There is no planned discharge of treated wastewater and measures have been designed into the proposed wastewater system to minimise the likelihood and volume of an emergency discharge. Wastewater will be treated to a high standard recycled for toilet flushing and irrigation. A strict management and monitoring regime will be applied to the golf course and other irrigation areas to manage stormwater runoff quality and prevent degradation of groundwater and coastal water quality (see Section 8.5.6 and 8.5.7). This will include management of fertiliser use at the golf course
- Pesticide use will be minimised and pesticides carefully selected based on analysis of environmental fate, such that release of toxicants to coastal waters and groundwater is avoided (see Section 8.5.12)
- Environmentally hazardous materials can be managed such that there is very low risk of accidental release to the environment (see Section 8.5.11 and 8.5.13)

- Potential impacts on water quality from boat based recreation have been evaluated and are considered to be negligible (see Sections 8.5.15 and 8.5.16)
- Pre-clearing surveys and use of fauna spotters in areas likely to be inhabited by native species will minimise mortality to native species during vegetation clearing activities (see Section 8.6.2)
- Underwater noise impacts from construction of the bridge and boat ramp are short term (one to two months), intermittent and considered to have negligible impact on marine fauna (Section 8.4.6.2).
- Natural navigational restrictions exist and in addition, boat speed controls and provision of awareness raising information to recreational boaters are proposed to manage the risk of boat strike on marine turtles and dugong (see Section 8.7.3 and also 9.2.4 and 10.4.4)
- Boat speed controls and natural navigational restrictions will limit potential for migratory shorebirds and other animals to be disturbed by boat traffic (see Section 8.7.3 and 10.2.4.3)
- A significant increase in risk of marine animals becoming entangled in litter is not expected given proposed controls on litter from land based activities and existing legislative requirements in relation to littering on land or from boats (see Section 8.7.4 and 9.2.5)
- Local recreational fishing effort may increase but a regional increase in fishing effort is not expected. There is some uncertainty as to the impact of recreational fishing on the Great Barrier Reef ecosystem (GBRMPA 2009, 2012), however, a range of controls on fishing methods

and take are already in place through the GBRMP zoning plan and the Queensland *Fisheries Act 1994* and the proponent will provide information to recreational fishers to raise awareness of these requirements (see Section 8.7.6) The Queensland government undertakes surveys of fishing effort and boating activity and the proponent will support any surveys undertaken of users at the PTP boat ramp.

- Recreational boats may cause anchor damage of intertidal seagrass beds in Seven Mile Creek and this will require monitoring and potentially mitigation in the form of a no-anchor zone (See Section 8.3.7, 9.2.2 and 10.4.2)
- An increase in demand for commercial tourism activities may arise but is unlikely to exceed sustainable limits of use, given low levels of current use and the GBRMP/GBRCMP permit requirements in relation to commercial tourism activities.

Overall, a reduction in biodiversity is not expected to arise as a result of the project as:

- The overall design of the development has been developed to avoid all impacts on sensitive habitats and retain representative areas all habitat types and vegetation communities
- Effective management and mitigation measures are available for indirect and consequential impacts on species and species' habitat.

Further, as discussed in Sections 2.3.5.3 and 8.3.8, the proponent has committed to surrendering the remainder of the development lease and managing the remainder of HHI as a conservation area. The Queensland Coordinator-General has imposed this as a condition of development (Queensland Government 2011) and has also recommended to the Minister administering the Queensland *Nature Conservation Act 1992* that the balance of HHI be given conservation area status under this Act. This will remove any pressure for development in the remainder of the development lease area and other land parcels on HHI.

The proponent is required to, and is committed to, actively manage the conservation area to enhance conservation values and provide a sustainable level of human access for appreciation of the natural values of HHI and the GBRWHA/NHP. This active management will reduce threats such as weed invasion and predation.

Viable examples of all existing biodiversity values of HHI and surrounding waters that contribute to the OUV of the GBRWHA/NHP will be retained and actively managed. Examples of moderate and high conservation significance habitat or vegetation communities will be entirely retained, except for some of the *Eucalyptus tereticornis* and *E. crebra* dominated forests which will be cleared. While some terrestrial habitat for common native species will be lost, this will not reduce the range or degree of variation of species present, or affect the ongoing presence of these species. The contribution that the area makes to the OUV of the GBRWHA/NHP will therefore not be diminished. The severity of impact is therefore considered as low.

11.5.3 Potential Impacts – Floristic Diversity

A specific focus on floristic diversity is required as HHI features three ecological communities of significance in terms of biodiversity of the GBRWHA:

- Two patches of the EPBC Act critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*. While patches of this ecological community are present at other locations in the GBRWHA including in national parks on Curtis Island, the patches on HHI represent relatively large patches and, apart from some weed invasion, are in reasonable condition
- A 10 ha patch of *Eucalyptus melanophloia* woodland. While similar vegetation types are present on other islands within the GBRWHA/NHP, including Curtis Island, when considered against Queensland broad vegetation group classifications and regional ecosystem classifications, this ecological community, classified as Broad Vegetation Group 17b and Regional Ecosystem 12.12.8 is not represented elsewhere within the GBRWHA/NHP. It is present on the adjacent mainland including in national parks outside the WHA/NHP
- 382 ha of *Eucalyptus tereticornis* and *E. crebra* dominated forests. This community is classified under Queensland Governments Broad Vegetation Group as 9h, and is also present on Curtis Island and Facing Island within the GBRWHA/NHP and the Eurimbula Resources Reserve, which is protected under Queensland legislation. When considered against Queensland regional ecosystem classifications, this ecological community, classified as 12.12.12 is not well represented elsewhere within the GBRWHA/NHP. It is present on the adjacent mainland including in national parks outside the WHA/NHP.

No individual plant species of conservation significance have been identified within the development footprint or in other areas of HHI that have been surveyed to date. A condition of the Queensland Coordinator-General's report and a proponent commitment is to undertake pre-clearing surveys for listed threatened plant species (see also Section 8.6.6). If plant species of conservation significance are identified, a species specific management plan will be developed and implemented.

Floristic diversity is recognised as an important component of the OUV of the GBRWHA/NHP, and the presence of three significant vegetation communities on HHI means that HHI makes a moderate contribution in relation to this aspect of biodiversity and a major contribution in relation to the presence of a critically endangered ecological community.

The development footprint therefore avoids all areas of the critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* and the 10 ha patch of *Eucalyptus melanophloia* woodland. A separation distance of 80-150 m is provided between the development footprint and each of these communities at the closest point of development. The ongoing conservation of these areas, and the interface area will be achieved through inclusion in the actively managed conservation area.

The location of *Eucalyptus tereticornis* and *E. crebra* dominated forests within the special lease area is such that it has not been possible to avoid clearing some of this community, however, patches totalling 230 ha, being 60% of the total extent, will remain on HHI and will be managed through the actively managed conservation area. These patches are largely contiguous with other areas of vegetation to be retained and hence, not diminished by edge effects. Where this vegetation community is required to be cleared, it is proposed to retain all mature habitat trees outside building envelopes, thus minimising loss of habitat values for arboreal animals that may depend on these trees.

By adjusting the development footprint to avoid or minimise impacts on these three vegetation communities, and by including the communities in the actively managed conservation area, there is no impact on floristic diversity of the GBRWH/NHP and hence the contribution that HHI makes to the OUV of the GBRWHA in this regard is not diminished. The severity of impact in this regard is therefore negligible.

11.5.4 Potential Impacts – Iconic Species and Species of Conservation Significance

In addition to the overall range of species present in the GBRWHA/NHP, the GBRWHA/NHP is recognised as providing habitat for as number of conservation significant species. In this regard, the GBRWHA/NHP contributes to global biodiversity.

EPBC Act listed threatened species and migratory species are identified in Section 7.4 and 7.5 respectively. Of those species present or considered likely to occur:

- The waters around HHI are considered to be of moderate importance as habitat for dugong, and therefore make a moderate contribution to the OUV of the GBRWHA. While not listed as threatened under the EPBC Act, at a global scale, dugong populations are considered threatened and hence habitat and populations within the GBRWHA/NHP have a particular role to play in the context of global biodiversity (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28, accessed 04/02/2013). Dugong are listed as a migratory and marine species under the EPBC Act
- The waters around HHI support green turtle and flatback turtle and are occasionally visited by loggerhead and hawksbill turtles. Flatback turtle nest intermittently in low numbers on one of the beaches of HHI. At a regional level, there are a number of turtle nesting sites on nearby islands. Flatback, green and hawksbill turtles are listed as vulnerable under the EPBC Act and loggerhead turtles are listed as endangered. Waters around HHI are considered of moderate importance in this regard and make a moderate contribution to the OUV of the GBRWHA
- The combined Mundoolin/Colosseum and Rodds Peninsula area is identified as internationally important habitat for the migratory eastern curlew, and nationally important habitat for ten other migratory shorebird species and migratory shorebirds in general. On HHI, there is a significant shorebird roost and foraging site on mudflats and salt flats to the south-east of the island, outside the development footprint. This conglomerate of sites is considered of highest importance. The sites therefore make a major contribution to the OUV of the GBRWHA particularly when considered in conjunction with a network of sites extending from the Fitzroy River estuary through Port Curtis/Port of Gladstone to Rodds Bay.

There are two large patches of the critically endangered ecological community *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*. This is assessed further in Section 11.5.3.

For all other EPBC Act listed threatened and migratory species, HHI is considered of lower importance and makes only a minor contribution to the OUV of the GBRWHA. It should also be noted that HHI and surrounding waters do not provide any habitat that is considered of critical importance to the survival of any of the EPBC listed threatened or migratory species.

The range of measures set out in Section 11.5.2 in relation to impacts on overall biodiversity are also relevant in relation to protection of these iconic species and species of conservation significance. In particular:

- The development footprint has avoided direct impacts on habitat for these listed species and communities and provided for management of interfaces between development and sensitive ecological areas as well as restriction of access to these areas
- Mechanisms for indirect impacts on coastal processes and water quality have been addressed through design of the site wastewater and stormwater management systems and a range of effective management and mitigation measures.

Impact on migratory shorebird habitat is considered negligible as there is no direct or indirect disturbance to these areas (see also Section 10.2.2).

The severity of direct disturbance to marine habitats that support dugong and turtles is also considered negligible, with less than 0.001% of total habitat disturbed by the bridge and boat ramp, and some potential offset in relation to breaching of the existing causeway. Indirect impacts on water quality are also considered to be negligible as effective design measures and other management controls are available to avoid or manage potential contaminants arising from land based activities. There will be an increase in recreational boat traffic and this will be managed through existing regulatory regimes, additional speed limits and awareness raising. Evaluation of impacts on turtles and dugongs concludes that populations will not be significantly affected and the severity of the impact is assessed as low.

Overall, impacts on the contribution that HHI and surrounding waters makes to the OUV of the GBRWHA/NHP in terms of providing habitat for species of conservation significance are assessed as not significant and as such, unacceptable impacts on the OUV of the GBRWHA are not predicted.

11.5.5 Potential Impacts – Shallow Intertidal and Subtidal Mangrove, Seagrass and Mud Flat Habitats

While the coral reefs of the GBRWHA/NHP are the most well-known feature, other habitats including mangrove and seagrass habitats are important in terms of supporting the biodiversity of the GBRWHA/NHP, particularly as many of the reef fish and iconic species associated with the coral reef spend part of their life cycle in inshore and estuarine waters. Mangroves and to a lesser extent seagrasses also have an important role in coastal processes and water quality, particularly trapping sediments in mobilised by terrestrial runoff and coastal currents.

The types of shallow intertidal and subtidal habitats present in waters around HHI are typical of similar estuarine and enclosed coastal areas in the region but are considered of moderate importance as the mangrove fringe is quite substantial, with widths up to 900 m, and there are persistent intertidal and subtidal seagrass beds in Seven Mile Creek and offshore from HHI.

Apart from a small amount of clearing of mangrove and intertidal habitat will be required for the bridge and boat ramp, and some subtidal habitat will also be affected. The affected area represents less than 0.001% of the available habitat, there is no direct disturbance to mangrove habitat. Disturbance to intertidal seagrass habitat may occur due to anchoring of recreational vessels and a monitoring and corrective action program is proposed. Otherwise, there is no other direct disturbance to intertidal and subtidal habitats.

The main source of indirect disturbance to mangrove habitats would arise if there were changes in surface runoff characteristics, particularly if the quantity of freshwater entering the system increased or decreased or if nutrient levels exceeded water quality guidelines for extended periods of time. Wastewater and stormwater management systems have been designed for the project that manage impacts on quantity or quality of flows from catchments to coastal areas in accordance with water quality guidelines.

Overall, as there may be a discernible change to seagrass beds due to the effect of anchoring, impacts on intertidal seagrass habitats are considered low rather than negligible. This impact is expected to be reversible given the proposed monitoring program that will detect impacts before significant decline has occurred. Impacts on all other shallow intertidal and subtidal habitats are considered negligible.

Diminution of the contribution that the shallow intertidal and subtidal habitats surrounding HHI make to the OUV of the GBRWHA is therefore not expected.

11.5.6 Impact Evaluation and Mitigation

An evaluation of potential impacts on values that contribute to criterion x (*important and significant natural habitats for in-situ conservation of biological diversity)* is provided in Table 11.7. The evaluation has not identified any significant or unacceptable impacts on values of the GBRWHA/NHP.

Table 11.7 – Evaluation of Impacts on Criterion x

Feature	Importance of Contribution to OUV ([1])	Severity of Impact on Contribution to OUV([1])	Significance ([1])
Overall biodiversity – terrestrial	Lower importance, minor contribution	Low severity	Not significant
Overall diversity – marine	Moderate importance, moderate contribution	Low severity	Not significant
Overall floristic diversity Critically endangered ecological community	Moderate importance, moderate contribution Highest importance	Negligible severity Negligible severity	No impact Not significant
Iconic species and species of conservation significance: Dugong Marine turtles Migratory shorebirds	 Moderate importance, moderate contribution Moderate importance, moderate contribution Highest importance, major contribution	 Low severity Low severity Negligible severity	 Not significant Not significant Not significant
Shallow intertidal and subtidal mangrove, seagrass and mud flat habitats	Moderate importance, moderate contribution	Low severity (seagrasses) Negligible severity (other habitats)	Not significant No impact

([1]) See also Section 1.7 for definitions of importance, severity and significance

A number of mitigation measures are relevant to minimisation of impacts on ecological and biological processes and interrelationships. These are described in Sections 2 and 8 and 11.5 and summarised in Table 11.8.

Table 11.8 - Summary of Measures to Avoid and Mitigate Impacts on important and significant natural habitats for in-situ conservation of biological diversity

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Footprint ensures that all vegetation community types and habitat types are retained in viable areas	Proponent commitment Statutory requirement (a development permit is required to clear vegetation)	Already in place through master plan development	• NA	NA
No disturbance to vegetation communities and habitats identified as high conservation significance (highest importance)	Proponent commitment Statutory requirement (a development permit is required to clear vegetation) Coordinator-General's report condition	Already in place through master plan development	• Monitor clearing activities	Prosecution of contractors for illegal clearing Contractors to reinstate vegetation if clearing does not comply with specification
Wildlife movement corridors are provided and development retains permeability to native animals	Proponent commitment Coordinator-General's report condition Plan of Development, which is enforced through the Gladstone Planning Scheme	Ongoing from commencem ent of construction	• Monitoring of wildlife movements as part of wildlife and habitat management	Enhance and augment wildlife movement corridors as required
Design of roads to facilitate fauna crossing and meet requirements of Queensland Department of Transport and Main Roads Fauna Sensitive Road Design Manual	Proponent commitment Coordinator-General's report condition Statutory requirement under *Nature Conservation Act 1992*	Detailed design	• Monitor road impacts on fauna	Review and upgrade fauna crossing arrangements as required
Aircraft exclusion zone around migratory shore bird foraging and roosting habitat	Proponent commitment	From commencem ent of any aircraft activities	• Monitor compliance • Monitor effect of aircraft on migratory shorebirds	Take action as required against aircraft operators to achieve compliance Expand or reduce exclusion zone in response to observations of impacts
Development of a Wildlife and Habitat Management Plan for management of wildlife and habitat within the PTP footprint, including weed and predator management, managed interface zones and bushfire management.	Proponent commitment Coordinator-General's report condition	Ongoing from commencem ent of construction	• Monitor biodiversity indicators within the PTP footprint	Enhance habitat and management arrangements as required

Mitigation Measure	Responsibility and Enforcement	Timing	Monitoring	Corrective Action
Pre-clearing surveys for plants and animals of conservation significance in areas of potential habitat	Proponent commitment Coordinator-General's report condition	Prior to and throughout construction phase	• Surveys undertaken and recommenda tions implemented	Cease works until surveys are undertaken and recommendations implemented
Protect marine and coastal water quality through design and management of stormwater system to maintain catchment runoff characteristics and treat stormwater to meet water quality guidelines	Proponent commitment Coordinator-General's report condition	Detailed design Ongoing from commencem ent of construction	• Monitor stormwater quality and flows	Augment and upgrade stormwater system as required to meet water quality guidelines and flow requirements
Protect marine and coastal water quality through design and management of a fully enclosed wastewater treatment and recycling system	Proponent commitment Coordinator-General's report condition	Detailed design Ongoing from commencem ent of construction	• Monitor treated water quality • Monitor irrigation areas	Adjust irrigation practices as required Augment or upgrade treatment systems as required
Protect marine and coastal water quality through implementation of erosion and sediment control plans for all construction areas	Proponent commitment Coordinator-General's report condition	Construction phase	• Visual checks of erosion and sediment controls • Water quality monitoring	Contractors to upgrade erosion and sediment controls as required to meet standards
Work with Maritime Safety Queensland to expand six knot speed limit to include sensitive marine and coastal habitat areas	Proponent commitment Coordinator-General's report condition	Prior to opening of boat ramp	• Boat speed compliance	Request Queensland Government assistance to enforce compliance
Establish an actively managed conservation area over the balance of HHI. Seek formal designation under the Queensland *Nature Conservation Act 1992*.	Proponent commitment Coordinator-General's report condition	Ongoing from commencem ent of construction	• Monitor biodiversity of the conservation area	Review and revise management approach

The likely effectiveness of these mitigation measures is assessed as follows:

- Mitigation measures based on avoiding direct and indirect impacts on habitat will be reliable and effective in avoiding impacts on biodiversity
- Wildlife corridors are recognised as an effective means of mitigating impacts of fragmentation (DEWHA 2009, NRMMC, 2010)
- The aircraft exclusion zone is expected to be effective in avoiding disturbance to migratory shorebirds (see also Section 10.2.4), however if scenic flights do commence operating from PTP, monitoring of the effectiveness of this mitigation measure will be undertaken and the exclusion zone adjusted as appropriate.
- Measures in relation to stormwater and wastewater management and recycling are based on established standards and guidelines endorsed by the Australian and Queensland Governments (for example, Water Sensitive Urban Design, National Water Quality Management Strategy) and modelling has been undertaken to demonstrate the effectiveness of the adopted designs and systems in avoiding water quality impacts (see Appendix D2).
- The effectiveness of a speed limit in minimising impacts on marine fauna will be enhanced by the proponent's commitments to awareness raising, but will depend to some extent on the regulatory basis and enforcement of these provisions. Unlike other locations where boat movements have been identified as a risk to marine fauna, the bathymetry of enclosed waters around HHI will naturally restrict boat speeds in the vicinity of seagrass beds.
- Active management of the balance of HHI as a conservation area is expected to be effective in reversing current degradation and enhancing habitat. Further discussion of the proposed approach is provided in Section 8.3.8 and 8.3.9.

Mitigation measures reflect practices adopted for similar developments at other locations, in particular, Great Keppel Island Revitalisation Project (EPBC 2010/5521). As the assessment undertaken has not identified any significant residual impacts on the attributes and values associated with criterion x that contribute to the OUV of the GBRWHA, offsets are not required under the EPBC Act Environmental Offsets Policy (SEWPaC October 2012).

11.6 Impacts on Integrity of the World Heritage Area

11.6.1 Introduction

Section 7.2.6 explores the importance of HHI and surrounding waters in the context of the overall integrity of the GBRWHA. Based on UNESCO's operational guideline for world heritage, integrity can be understood by examining the extent to which a world heritage property:

a) *includes all elements necessary to express its outstanding universal value*

b) *is of adequate size to ensure the complete representation of the features and processes which convey the property's significance*

c) *suffers from adverse effects of development and/or neglect* (UNESCO July 2012, paragraph 88).

The GBRWHA currently meets these conditions of integrity, notwithstanding concerns that have been raised by UNESCO regarding port related development (UNESCO, June 2012b).

This evaluation therefore focuses on whether the project might affect these dimensions of integrity.

11.6.2 Includes all Elements Necessary to Express its Outstanding Universal Value

Values and attributes of HHI and surrounding waters, while generally not providing important expressions of the OUV of the GBRWHA, have a role to play in protection of the OUV, particularly as:

- Migratory shorebird roosting and foraging habitat on and adjacent to HHI is part of an internationally (eastern curlew) and nationally (other species) important conglomerate of sites. Key sites on HHI in this regard are to the south-east of the island. While similarly important habitat is present at other locations in the GBRWHA, including in the Mackay-Capricorn management area, HHI is still considered to make an important contribution to this value as it is part of a much wider network of sites. This aspect therefore represents a highly important element in the overall expression of OUV when considered against the criteria set out in Section 1.7.4 (see also Section 11.5).
- HHI features two patches of an EPBC Act critically endangered threatened ecological community and also two vegetation communities that are not well represented elsewhere in the GBRWHA. As floristic diversity across a wide latitudinal range is recognised as one aspect of the outstanding universal value of the GBRWHA, HHI makes a moderately to highly important contribution to the OUV of the GBRWHA in this regard when considered against the criteria set out in Section 1.7.4 (see also Section 11.5).
- Waters provide habitat for dugong (EPBC Act listed migratory species) and some EPBC Act listed vulnerable and migratory species of marine turtles also utilise waters around HHI at certain stages of their lifecycle. One endangered marine turtle has also been observed. While the waters around HHI are not recognised as core or important habitat for these animals, (see also Sections 7.5.3.3 and 7.4.4.2), and there are extensive areas of similar habitat in the GBRWHA including in the Mackay-Capricorn management area the waters are considered of moderate importance in relation to preservation of these elements specifically mentioned in the statement of OUV of the GBRWHA.
- Shallow intertidal and subtidal mangrove, seagrass and mud flat habitats present around HHI, while not unique or unusual, are in good condition and are therefore considered moderately important. This value overlaps somewhat with the value relating to habitat for dugong and turtle. This value is also important as a range of fish species utilise estuarine habitats such as those present inshore of HHI at certain stages of the lifecycle, and the wide diversity of fish of the Great Barrier Reef is recognised as contributing to the OUV of the GBRWHA under criterion vii and x.

Evaluation of impacts presented in Sections 8, 9 and 10 have identified that impacts on the contribution that each of these features makes to the OUV will not be significant:

- There is no direct disturbance to migratory shore bird habitat. The habitat has adequate separation distance from the development to avoid disturbance from noise and activity and access is not available to walkers. An aircraft exclusion zone is proposed over the most important sites on and near HHI and natural navigational features of the area will prevent recreational boat traffic from approaching the foraging and roosting areas.
- Direct disturbance to marine habitats is restricted to the bridge and boat ramp and comprises less than 0.005% of available habitat within Colosseum Inlet/Boyne Creek/Seven Mile Creek. Breaching of the causeway may improve access along Boyne Creek for dugong. The project has been designed to avoid degradation of coastal and marine water quality from land based activities and an assessment of water quality impacts from recreational boating indicates that degradation of water quality is not expected (see Section 8.5). The proponent has committed to supporting the Queensland Government in upgrading Rodds Bay Dugong Protection Area from Zone B to Zone A by purchasing commercial fishing licences.
- There will not be any direct disturbance of the critically endangered ecological community and viable and representative examples of all other vegetation communities will be retained on HHI (see also Section 8.3.2 and 11.5.3).
- Indirect disturbance to these ecological and vegetation communities is avoided by the active management of interfaces between these areas, which are also to be included in an actively managed conservation area (see Section 8.3.8, 8.3.9 and 11.5.3).

Hence, those elements of HHI that contribute to the OUV of the GBRWHA will be retained and in some cases, further protected and there will be no diminution of the contribution that HHI and surrounding waters makes to the OUV of the GBRWHA.

More broadly, evaluation of impacts of the project on other values that contribute to the OUV of the GBRWHA is provided in Sections 11.2 to 11.5. No significant impacts have been identified. It is therefore concluded that the project will not detract from any of the elements that contribute to or express the OUV of the GBRWHA.

11.6.3 Is of Adequate Size to Ensure the Complete Representation of the Features and Processes which Convey the Property's Significance

HHI and surrounding waters contribute to the integrity of the GBRWHA by providing a buffer for other significant features and processes that are recognised as part of the outstanding universal value of the GBRWHA, particularly the coral reef ecosystem that makes up the Great Barrier Reef itself. Hence, while HHI and surrounding waters may not contain the spectacular features that the GBRWHA is most recognised for, the area is important in protecting aspects such as water quality and coastal processes which may affect coral reef ecosystems and other highly significant features of the GBRWHA. In particular, the estuarine environment surrounding HHI provides a function as sink for nutrients and sediment, thus assisting in protecting the coral reef ecosystem from impacts of catchment runoff.

The project has been designed to avoid impacts on water quality from land based activities (see Section 8.5). Mangrove stands and other key features of coastal ecosystems that are important to attenuating impacts of catchment runoff will not be affected by the project. The assessment of potential impacts on water quality from recreational boating activity presented in Section 8.5 concluded that water quality degradation was not expected. The project is therefore not considered likely to reduce the extent to which the overall coral reef ecosystem and other ecosystems are represented within the GBRWHA.

11.6.4 Suffers from Adverse Effects of Development and/or Neglect

While the statement of the OUV of the GBRWHA confirmed that "*The World Heritage property is and has always been managed as a multiple-use area*", this does not preclude concerns that some types of development may affect the integrity of the GBRWHA.

HHI is not in pristine condition, having been previously logged and grazed in part, however this does not preclude it from being part of the GBRWHA and from contributing to the values and attributes that make up the OUV of the GBRWHA. Regrowth of native vegetation has occurred and most of vegetation communities on HHI that were disturbed by grazing have recovered to the extent that these now meet the criteria to be mapped as remnant vegetation under the Queensland *Vegetation Management Act 1999*. There is no active management of terrestrial habitats and vegetation communities, including critically endangered coastal vine thicket ecological community and internationally/nationally important migratory shorebird habitat on HHI and the adjacent mainland.

Waters around HHI are used as reference sites for Port Curtis Integrated Monitoring Program (PCIMP) and are considered by this program to be "relatively pristine" (Vision Environment 2011). Clearing and development in the catchments of Colosseum Inlet, Seven Mile Creek and Boyne Creek have increased sediment and nutrient transport to the estuary (http://www.ozcoasts.gov.au/search_data/detail_result.jsp accessed 30/03/2013), however results of the PCIMP program indicate that the reference sites meet most of the performance indicators (Vision Environment 2011).

Guidance is not available on the type and scale of development that might be acceptable within the GBRWHA. This assessment has therefore focussed on evaluating the extent to which the development might obscure, degrade, damage or destroy any of the values and attributes of HHI and surrounding waters which contribute to the OUV of the GBRWHA. This evaluation is summarised in Sections 11.2 to 11.5 and did not identify any significant impacts on these values, or diminution of the OUV of the GBRWHA, taking into account measures incorporated into the development to avoid impacts, and also mitigation measures that are committed to by the proponent and/or imposed on the proponent through Queensland Government legislative requirements.

If the proposed managed conservation area is given formal status under the Queensland *Nature Conservation Act 1992*, this will also remove any threat of development of the balance of the special lease and the remainder of HHI (see also Section 8.3.8). This is not currently proposed as an offset as, under the EPBC Act Environmental Offsets Policy, offsets are only required where there is a significant residual impact. However, the proponent notes that an offset of this type was required for the Great Keppel Island Revitalisation Project (EPBC 2010/5521) (Conditions 51 to 58). The proposed conservation area on HHI will have a similar effect as is sought through these conditions for the Great Keppel Island Revitalisation Project.

11.7 Impacts on Ongoing Protection and Management

As identified in Section 7.2.7, protection, management and utilisation of natural resources and management of land use for the land areas of HHI is governed by Queensland legislation. The Queensland Government has not afforded any specific protection to the natural resources and values of HHI beyond that imposed through Queensland legislation on all coastal development. There are no management plans or measures in place for HHI at any level of government.

Should the project proceed, it is a condition of the Queensland Coordinator-Generals' report, and a commitment of the proponent, to convert the balance of HHI, including unused land within the special lease, to a managed conservation area. The Queensland Coordinator-General has recommended to the Minister administering the Queensland *Nature Conservation Act 1992* that the conservation area be given conservation area status or similar under that act. The proponent will develop and implement a management plan for the conservation area for the first 16 years of the development. A funding mechanism will be established through collection of a Special Area Levy by Gladstone Regional Council. Once the PTP has reached full development, the proponent will seek to hand over management of the conservation area to the relevant local government authority, with a continuation of funding through the Special Area Levy. This is discussed further in Section 2.6.6 and 8.3.8.

Within the development footprint, it is a condition of the Queensland Coordinator-Generals' report, and a commitment of the proponent that a Wildlife and Habitat Management Plan be developed and implemented to protect and enhance conservation outcomes for native species. Further detail on matters to be addressed in the Wildlife and Habitat Management Plan is provided in Section 8.3.9.

This will provide for protection and management of the land areas of HHI.

Waters surrounding HHI are protected by virtue of being part of the GBRMP/GBRCMP and are jointly managed by the GBRMPA and Queensland Department of National Parks, Recreation, Sport and Racing. The boundaries of the marine park and coast marine park are shown on Figure 1.4. In addition, parts of the waters surrounding HHI are protected and managed as fish habitat and as a Dugong Protection Area under the Queensland *Fisheries Act 1994*.

The project will not require any change to the level of protection currently afforded to the waters around HHI. Consistency with the management and zoning objectives of the GBRMP is assessed in Section 12.3 and the project is consistent with and will not detract from these objectives.

Consistency with the Queensland *Fisheries Act 1994* objectives and requirements was addressed as part of the Queensland Coordinator-General's assessment and conditions imposed on the development in this regard (Queensland Coordinator-General 2011).

The project is therefore not considered to be inconsistent with, or detract from any of the current protection and management mechanisms that protect GBRWHA values. Further, the proponent has committed to, and the Queensland Coordinator-General has imposed conditions to require conversion of the balance of HHI, including undeveloped areas of the special lease to a managed conservation area. This will increase the level of ongoing protection and management for this part of the GBRWHA. The proponent has proposed a funding mechanism and management arrangements that allow for ongoing management.

SECTION 12
Evaluation of Potentially Significant Impacts on Great Barrier Reef Marine Park

Contents

12. Evaluation of Potentially Significant Impacts on Great Barrier Reef Marine Park

12.1 Introduction

The project takes place adjacent to the GBRMP, with the boundary running along the low tide mark of the northern coastline of HHI (see also Figure 1.4), however does not involve any development within the GBRMP and there is no loss of habitat within the GBRMP.

Indirect impacts on ecosystems or species that contribute to the values of the GBRMP may also impact on the GBRMP, even where these impacts occur outside the GBRMP but affect components that contribute to the GBRMP. For example, impacts on water quality may be conveyed into the marine park by tidal and coastal currents, and impacts on mobile marine fauna may affect occurrence of these animals within the GBRMP.

The analysis undertaken in Section 8.5 determined that impacts on water quality within the GBRMP are not expected. There are no proposed discharges of stormwater or wastewater to waters of the GBRMP. The stormwater management system discharges to the south of HHI and has been designed to mimic the pre-development conditions such that the quantity of stormwater remains unchanged in low and moderate flow events (see also Section 2.4.3, Section 8.5.9 and Appendix D2). Stormwater quality improvement devices that meet Australian and Queensland "water sensitive urban design" standards have been included in the stormwater design and modelling indicates that the quality of runoff will meet or exceed water quality objectives in the receiving environment. There is no runoff from the proposed golf course to waters of the GBRMP.

Shallow groundwater present under the western part of the development, including the proposed golf course could provide a pathway for mobilisation of contaminants if nutrients or pesticides leach to the groundwater. Preliminary irrigation rates have been determined and further work will be undertaken during detailed design to confirm sustainable irrigation rates such that leaching of nutrients and pesticides to the environment does not occur and irrigation and fertiliser/pesticide application rates conservatively set in accordance with modelling results.

A Turf Management Plan will be developed for the proposed golf course that provides for management of nutrient application rates and establishes a monitoring program against conservative trigger levels for nutrient levels in soils, subsoils, stormwater and groundwater. If application rates are in excess of the assimilative capacity of turf and soils, monitoring will allow for early detection of any mobilisation of contaminants and irrigation and fertiliser application rates can be adjusted as required.

Similarly, an integrated Pest Management Plan will be developed for the proposed golf course that avoids use of chemical pesticides wherever possible and where pesticide use cannot be avoided, selects pesticides with low impact environmental fate and utilises the minimum amount necessary to manage pests. The integrated pest monitoring plan will be supported by a monitoring framework that allows for early detection of any pesticide residuals in soils, surface water or groundwater.

The methodology for evaluating the significance of impacts is as set out in Section 1.7.4, based on the approach that impact is the product of the importance of the value and the severity of the change or impact that will occur.

The analysis undertaken in Section 8 identified potentially significant impacts on some marine turtle species, dugong and migratory shorebirds from several pathways. These potentially significant impacts are assessed in more detail in Section 9.3.6 (marine turtles), Section 10.4.8 (dugong) and Section 10.2.6 (migratory shorebirds). It was concluded that, with mitigation measures that are to be applied, significant or unacceptable impacts on these iconic species were not expected. Mitigation measures include existing navigational restrictions of waterways surrounding HHI which will limit access to some areas and limit boat speed and size.

The project will improve access to the Mackay-Capricorn management area of the GBRMP and provide access in an area where only limited access is currently available. This is discussed in more detail in Section 12.2.

An assessment has also been provided of consistency of the project, and associated consequential increases in access to the GBRMP, with the conservation objectives of the marine park. This is provided in Section 12.3.

12.2 Increased Access and Activity

As discussed in Section 8.8, access to and activity within the GBRMP will increase as a result of the project due to introduction of a tourism focussed facility and a boat ramp. Tourists and visitors may access the GBRMP via services operated by commercial tour operators or as independent or recreational visitors.

There are no facilities at the PTP for commercially operated boat-based tourism activities and as such operators would need to operate from nearby Gladstone. Hence, increases in commercial tourism activity will be on a regional level rather than at the local scale.

Impacts from increases in commercial tour operators induced by the project are not considered significant as:

- The region has low visitation levels generally compared to other regions of the GBRMP
- The number of tourists that would visit the project is small in comparison with visitor levels in other areas of the Marine Park
- A Marine Parks permit is required for all commercial tourism activities which allows GBRMPA to regulate sustainable use levels (see also Section 8.8.3).

In relation to recreational or independent visitors, drawing on the analysis presented in the GBRMP Recreation Management Strategy (GBRMPA 2012), and considering the facilities and location of the project, the development is likely to result in localised increases in visitation levels as follows:

- There will be a localised increase in recreational boating activity in the Colosseum Inlet/Boyne Creek/Seven Mile Creek area (see Section 8.8.4). The proposed boat ramp is not located within the GBRMP but, in fine weather, trailerable boats launched at the boat ramp will be able to access the GBRMP. An estimated 50-150 boats may be expected to be launched from the boat ramp over each weekend, however not all of these will access the GBRMP. Also, as discussed in Section 8.8.4), many of the additional boats in the local area will represent relocation of activity rather than increased regional levels of activity. The boat ramp will be constructed in the first one to two years of the development.

- The main activity likely to be undertaken by boats launched at the proposed boat ramp is expected to be fishing. Potential impacts of recreational fishing are discussed in Section 8.7.6 and it was identified that, while there is some uncertainty as to the impacts that recreational fishing has on the Great Barrier Reef ecosystem, there are also a number of existing regulatory in place in relation to recreational fishing.
- Visitors will be able to swim at the main beach adjacent to the Beach and Golf Course Precinct. The GBRMP runs along the low tide mark of this beach.
- At a regional level, predicted increases in recreation al boat ownership and activity arising from the project are small, with an estimated additional 120 boats to be added to an estimated 8,300 boats in the Gladstone region and 46,000 boats in the larger region from Hervey Bay to Rockhampton. A very minor increase in boating activity at a regional level is therefore predicted due to the PTP.

The GBRMPA has identified a range of threats to the GBRMP/GBRCMP associated with recreation activity in the GBRMP, many of which are associated with boating (GBRMPA 2012). No threats were identified in the recreation management strategy as “high” or above. The potential for the project to contribute to threats rated as medium risk is discussed in Table 12.1. Low and very low threats are not evaluated further.

Table 12.1 – Potential for Exacerbation of Threats Associated with Recreation in the GBRMP/GBRCMP

Threat	Evaluation of Contribution from the Project
Interference with species of conservation concern - boat strikes Localised mainly in high use areas	Potential impacts of boat strikes on turtles and dugong are discussed in Sections 9.3.4 and 10.4.4 respectively. Impacts on these iconic species of conservation concern were not identified as significant considering: • Projected levels of boating activity • Many boats using the boat ramp will represent relocation of boating activity at a regional level rather than a regional increase in boating activity • Most boats will be engaged in fishing and hence not highly mobile • Navigational restrictions in the enclosed waters around HHI will naturally restrict boat size and speed • The proposal to impose a boat speed limit • Educational and awareness raising activities. The threat level is not expected to increase.

Threat	Evaluation of Contribution from the Project
Interference with species of conservation concern - disturbance Localised mainly in high use areas	Potential impacts of disturbance on feeding and roosting behaviour of migratory shore birds and feeding behaviour of dugong are assessed in Sections 10.2.4 and Section 10.4.5 respectively. The main sites used by migratory shorebirds in the Mundoolin/Colosseum and Rodds Peninsula area are not located within or adjacent to the GBRMP. In any case, impacts on migratory shore birds were not identified as significant, largely due to navigational restrictions which provide adequate separation distances between boating areas and main feeding and roosting areas. Water quality impacts from recreational boating activity are not considered to be significant. Areas utilised by shorebirds are not likely to be used for swimming. Potential impacts on dugong are not considered significant based on anticipated levels of boating and natural and imposed restrictions on boat speed.
Anchoring on coral and seagrass beds Localised mainly in high use areas	There are no coral reefs in the vicinity of HHI. Potential impacts of anchoring on seagrass beds is discussed in Section 9.3.2. The main seagrass beds accessible from the project are outside the GBRMP and are intertidal and hence limited anchoring is expected. There is a large patch of seagrass to the north of HHI that is within the GBRMP, however, this area will only be accessible from the boat ramp in fine weather. Management and mitigation measures are available and can be implemented if monitoring indicates anchor damage is reducing biomass of the seagrass beds. These include establishing “no anchoring” zones and provision of fixed moorings. These methods have been used elsewhere in the GBRMP.
Recreational take of marine resources Primarily in proximity to regional communities in inshore areas.	Potential impacts of the project on recreational fishing effort are discussed in Section 8.7.6. While fishing effort in waters around HHI will increase at a local scale, a regional scale increase is not expected as a result of the project. Legislative controls are in place under the *Great Barrier Reef Marine Park Act 1995* and the Queensland *Fisheries Act 1994* which place limits on fish take and the fishing methods that may be used in waters around HHI. The proponent will promote awareness of these controls to recreational fishers using the boat ramp. While increasing regional population may place additional pressure on fish stocks near regional communities, the project will cause only a minor increase in regional population (see also Section 14). Overall, the project is not considered likely to increase this threat.
Discharges and spills - waste discharge (including sewage) Localised, mainly in high use areas	Potential impacts of sewage and hydrocarbon releases from recreational boating activities are discussed in Section 8.5.15 and 8.5.16. Given the short duration of most trips and small numbers of people per boat, human waste discharges to the GBRMP are considered likely to be within the assimilative capacity of the marine environment. Legislative controls are in place which prohibit deliberate or accidental releases of hydrocarbons. The proponent will promote awareness of these controls, and the need to avoid discharging human waste, including through signs at the boat ramp and written information. A public toilet will be provided at the boat ramp. The project is not considered likely to increase the threat to the GBRMP from discharges and spills from recreational boats.
Litter and marine debris Widespread	Potential impacts arising from litter and debris from recreational boats and from land based activities is discussed in Section 8.7.4. Legislative controls are in place prohibiting littering. In addition, mitigation measures proposed by the proponent will limit potential for litter to enter the marine environment. These include educational material for all visitors, including boaters, retention of coastal zone vegetation, installation of litter traps in the proposed stormwater system and promotion of biodegradable packaging. With these measures in place, threat to the GBRMP from littering is not expected to increase.

Threat	Evaluation of Contribution from the Project
Clearing or modifying coastal habitats – coastal marine facilities Localised near regional centres	Clearing of less than 200 m^2 of salt pan and mangrove is required for construction of the proposed boat ramp. Clearing for the boat ramp will take place in an area already impacted by the existing causeway. Impacts of clearing of this habitat are discussed in Section 8.3.2 and are considered to be negligible.
Decreased water quality – coastal marine facilities. Localised near regional centres	The only coastal marine facilities associated with the project are the boat ramp and bridge which are not located in or adjacent to the GBRMP and will not contribute to decreased water quality. This is discussed further in Section 8.5.
Interruption of Traditional Owner use and access to resources Localised, mainly in high use areas	The proponent has entered into a Cultural Heritage Management Agreement with the traditional owners (Port Curtis Coral Coast) in relation to the project, and have an approved CHMP. Levels of usage of marine areas surrounding HHI are not likely to be high enough to disrupt traditional owner use.
Lack of compliance – general management arrangements More likely in remote areas	The proponent will provide signs and written material to visitors to the PTP, including recreational boaters, explaining rules and regulations in relation to use of the GBRMP/GBRCMP. The proposed boat ramp will allow enforcement agencies improved access to the waters around HHI for enforcement purposes.
Lack of information for effective management Reef-wide	The proponent will make results of monitoring data collected in relation to the project available to GBRMPA and other management agencies. The proponent will also facilitate access to the boat ramp if required by enforcement agencies or agencies undertaken surveys on fishing effort or other aspects of recreational use of the GBRMP.
Inadequate user understanding of management arrangements Reef-wide	The proponent will provide signs and written material to visitors to the PTP, including recreational boaters, explaining rules and regulations in relation to use of the GBRMP/GBRCMP. This will also include information on requirements imposed by the Queensland Government.

The analysis presented in Table 12.1 indicates that increased activity levels are expected to be well within the sustainable limits of the GBRMP in the vicinity of HHI. Further, increased activity levels would enhance access to the marine park for enjoyment and appreciation of the marine park.

However, a key issue identified in the GBRMP Recreation Management Strategy is lack of quantitative data on the impacts of recreational activity on the marine park. This makes it difficult for GBRMPA to determine sustainable levels of recreational use and may mean that the significance of some of the threats identified in the Recreation Management Strategy have been either over or under-estimated. The following monitoring activities are proposed by the proponent of the PTP:

- Marine water quality monitoring - the monitoring program will include testing for nutrients, faecal coliforms and hydrocarbons
- Marine ecology monitoring program - among other things, this monitoring will identify whether anchor damage is occurring in key seagrass habitats and trigger additional controls if necessary (“no anchor” zone, fixed moorings).

These monitoring programs will identify changes from baseline conditions and trigger further assessment of causes of any degradation that may have been detected. If degradation of water quality and/or habitat is attributable to recreational boating, the proponent will work with GBRMPA, Queensland DNPRSR and other stakeholders to determine additional controls that may be required. The proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

The proponent will also support any surveys or other monitoring activities aimed at understanding recreational use of the GBRMP and the associated impacts that might be undertaken by GBRMPA or Queensland DNPRSR or Department of Agriculture, Forestry and Fisheries.

Noise from land-based activities is not expected to be audible in the GBRMP and hence any increase in land based activities is not expected to affect the use and enjoyment of GBRMP.

12.3 Consistency with Management Plans and Zoning Objectives

12.3.1 Overall Objectives for GBRMP

Section 2A of the *Great Barrier Reef Marine Park Act 1975* sets out the objectives relating to protection of the GBR. The objectives relate both to protecting the environmental, biological and heritage values of the GBR, and also to allowing sustainable use for a range of purposes. An analysis of the extent to which the project is compatible and consistent with these objectives is provided in Table 12.2.

Table 12.2 – Assessment against Objects of *Great Barrier Reef Marine Park Act 1975*

Objective	Response
To provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region	Evaluation of potential impacts of the project has not identified any impacts that might compromise the ecological, biodiversity or heritage values of the GBR.
Allow ecologically sustainable use of the Great Barrier Reef Region for purposes including the following:	
(i) public enjoyment and appreciation	Visitor levels to the Mackay-Capricorn management region of the GBRMP are low, with around 120,000 commercial tourism days in this part of the GBRMP in 2012, accounting for seven per cent of the total commercial tourism visits to the GBRMP (see also Section 8.8.3). There are few tourism oriented developments in this region that provide opportunities for the public to access and enjoy the marine park. With capacity of up to 2,300 persons at full development, the project will provide enhanced access to visitors including international, interstate and Queensland based tourists. As there are few opportunities to access and enjoy coastal areas of the GBRMP in the Mackay-Capricorn management region, the proposed development has potential to enhance public enjoyment and appreciation in a manner that also allows for control of potentially adverse impacts. An assessment of potential increases in visitor levels

Objective	Response
	indicates that it is unlikely that unsustainable visitor levels will occur, either through demand for commercial tourism activities, or through independent recreational visits (see Section 8.8.3 and 8.8.4).
(ii) public education about and understanding of the Region	Section 8.8.5 sets out a number of ways that the project may contribute to public education and understanding of the GBRMP and, more broadly the GBRWHA/NHP. This includes a formal environmental education facility and tourism information centre as well as the ability to provide signs and written information on the values and attributes of the area, and the rules and regulations in relation to sustainable use (see Section 8.8.6).
(iii) recreational, economic and cultural activities	The project will provide an important recreational opportunity for residents in the Gladstone area and broader central Queensland area, providing overnight accommodation for up to 2,300 visitors. There are very limited opportunities for the general public to readily access coastal sections of the GBRMP in this area and one of the attractions of the project will be proximity to and access to the GBRMP. The project is recognised in the *Central Queensland Tourism Opportunities Plan (2009-2019)* as an important development in terms of capitalising on the strengths of natural attractions in the region while addressing shortages in accommodation, recreational activities and opportunities to access natural attractions. The mix of accommodation selected for the project will cater to a wide range of budgets, family types and age-groups. This provides equitable access to the proposed development. The project will contribute to diversification of the local and regional economy which is currently heavily dependent on the resource and industrial sectors. Approximately 700 jobs will be directly generated once the proposed development reaches full capacity. During the 16 year development phase, an average of 260 construction industry jobs are expected to be generated per year. The impact assessment presented in this document demonstrates that adequate design and other mitigation measures are available to avoid or minimise adverse impacts and that the project will not detract from sustainability of the GBR.
(iv) research in relation to the natural, social, economic and cultural systems and value of the Great Barrier Reef Region;	The PTP will include an environmental education facility with discussions underway with several Queensland universities regarding a research basis for this facility. The PTP may also increase access to this area of the GBRMP for the purposes of research activities. Research activities within the GBRMP/GBRCMP are regulated by a permit system. Monitoring data collected by the proponent in relation to environmental values of the GBRMP and GBRWHA/NHP will be made available to GBRMPA and other management agencies.
Encourage engagement in the protection and management of the Great Barrier Reef Region by interested persons and groups, including Queensland and local governments, communities, Indigenous persons, business	The project has a strong ecotourism focus, recognising that it is the natural environment, including proximity to the GBRMP, that will attract visitors to the development. Section 8.8.5 sets out a number of ways in which the development will promote protection and management of

Objective	Response
and industry	the GBRMP and broader GBRWHA. Stakeholders potentially involved in development and operation of the PTP include visitors to PTP, traditional owners, regional government, research institutions and business that establish within the PTP.
Assist in meeting Australia's international responsibilities in relation to the environment and protection of world heritage (especially Australia's responsibilities under the World Heritage Convention)	As discussed in Section 8 and Section 11, the project is not expected to have any significant or unacceptable impacts on the GBRWHA. The project also provides an opportunity to present and promote the values of the GBRWHA, both on a local and regional scale and to allow access to and use of the GBRWHA in a controlled manner. Section 8.8.5 sets out the range of ways in which the project may contribute to presentation of the GBRWHA, promotion of recognition of the values of the GBRWHA and enhanced understanding of protection requirements.

12.3.2 General Use Zone

The waters of the GBRMP and GBRCMP surrounding HHI are zoned for general use (see Figures 7.7 and 7.8). The objective of this zone is "*to provide for the conservation of areas of the Marine Park, while providing opportunities for reasonable use*" (GBRMPA 2003).

There are some restrictions on fishing effort and methods in the general use zone and a permit is required to operate any commercial tourism activity (see also Section 8.8.3).

As discussed in Section 12.2, recreational use of the general use zone of the GBRMP will increase as a result of the project, but this increase is not expected to affect the conservation objectives of the GBRMP. Some of the local increase will represent a shift from other locations rather than an overall regional increase. The project will provide opportunities for the public to use the GBRMP in a controlled manner and is not likely to result in the objective of the general use zone being compromised.

12.3.3 Habitat Protection Zone

Two habitat protection zones are located within 5 km of the northern boundary of the development area:

- Creek Rocks (24-001) lies 1-2 km from the nearest point of HHI, and about 5 km north- east of Tiber Point (see Figure 7.7)
- Seal Rocks (23-067) lies about 5 km north of Tiber Point (see Figure 7.7).

The objective of the habitat protection zone is

a) *to provide for the conservation of areas of the Marine Park through the protection and management of sensitive habitats, generally free from potentially damaging activities; and*

b) *subject to the objective mentioned in paragraph (a), to provide opportunities for reasonable use* (GBRMPA 2003).

The Seal Rocks and Creek Rocks habitat protection zones are located in open coastal waters and, when travelling by boat, are 12-20 km from the proposed boat ramp. Trailerable boats of the size that can be launched at the boat ramp would only be able to access these areas in fine weather, hence significant increases in usage in the habitat protection zones is not expected. This zone is also subject to restrictions on fishing methods and take (see Section 8.7.6). A permit is required for commercial tourism opportunities.

Larger boats operated by Gladstone-based tour operators would be able to access these areas. As discussed in Section 8.8.3, commercial tourism activities in the GBRMP are subject to marine parks permits and this provides a means to regulate the sustainable use of all zones of the GBRMP, including the habitat protection zones.

The conservation of these habitat protection zones is therefore not expected to be compromised by increased access provided by the PTP, or by increased demand for commercial tourism operators which may access the habitat protection zone.

12.3.4 Other Zones

The nearest conservation park zone is at Rodds Peninsula, about 15 km by boat from the proposed boat ramp (see Figures 7.7 and 7.8). Objectives for the conservation park zone are to:

a) *Provide for the conservation of areas of the Marine Park*

b) *Subject to the object mentioned in paragraph (a) provide opportunities for reasonable use and enjoyment, including limited extractive use* (GBRMPA 2003).

The nearest national park zone is also at Rodds Peninsula, and is about 23 km by boat from the PTP boat ramp (see Figure 7.7). The objectives of the national park zone are:

a) *To provide for the protection of the natural integrity and values of areas of the Marine Park, generally free from extractive activities and*

b) *Subject to the objective mentioned in paragraph (a), to provide opportunities for certain activities, including the presentation of the values of the marine park, to be undertaken in relatively undisturbed areas* (GBRMPA 2003).

There are no buffer zones, scientific research zones or preservation zones within 50 km of HHI.

The GBRMP zoning plan places a number of restrictions on fishing and other activities in these zones (GBRMPA 2003).

As both of these zones are some distance from the proposed boat ramp and require the small boats to traverse open coastal areas, significant increases in usage of these areas is not expected. The project is not expected to compromise the objectives of these zones.

PACIFICUS
TOURISM PROJECT

SECTION 13
Cumulative Impacts

Contents

13. Cumulative Impacts

13.1 Methodology

13.1.1 Introduction

Assessment of impacts of the PTP alone has not identified any significant or unacceptable impacts on MNES (see Sections 8, 9, 10, 11 and 12). However, as there is always potential for cumulative impacts from the additive effects of a combination of insignificant residual impacts from one or more projects and as PTP takes place within 15-50 km of a medium sized population centre, major port and designated industrial area, the potential for cumulative impacts will be explored through consideration of whether PTP will contribute to existing and reasonably foreseeable pressures and threats on MNES and related values.

The approach to cumulative impacts is based on the EIS guidelines provided by DotE and also the methodology set out in the International Finance Corporation's (IFC) *Good Practice Note on Cumulative Impact Assessment and Management* (IFC 2013).

This requires consideration of six steps:

1) Scoping Phase I – identifying environmental values and spatial and temporal boundaries
2) Scoping Phase II – identifying other activities and drivers
3) Establishing information on the baseline status of environmental values
4) Assessing cumulative impacts on environmental values
5) Assessing significance of predicted cumulative impacts
6) Designing and implementing programs for managing cumulative impacts (IFC 2013).

13.1.2 Step 1 – Scoping Phase I – Project Related Values and Impacts

Scoping Phase I involves:

- Establishing the environmental values that are present
- Establishing the project-related impacts on these values
- Determining the geographic extent of impacts.

This assessment focusses on MNES as defined under the EPBC Act. The MNES values that are present on and around HHI are described in Section 7. A more general description of environmental characteristics is provided in Section 6.

Project related impacts on MNES values are identified and described in Section 8. More detailed assessment of potentially significant impacts is provided in Sections 9, 10, 11 and 12.

Assessment of impacts of the PTP alone has not identified any significant or unacceptable impacts on MNES. However, the potential for cumulative impacts may arise where there are additive effects from a combination of insignificant impacts from one or more projects or activities.

In terms of geographical extent, there is no clear overlap between impacts of the proposed PTP and broader impacts of development in the region. However, there are two pathways by which insignificant impacts from PTP may combine with impacts from existing and proposed development in the Gladstone region and also more broadly in the Great Barrier Reef ecosystem:

- Any water quality effects may be spread over a large area due to movement of contaminants by coastal currents and tidal movements.
- Some marine fauna that inhabit the coastal zone have large home ranges and may move between areas affected by various projects and activities.

Hence, the geographical overlap will be considered at both a regional and broader level as follows:

- Regional level cumulative impacts of existing activities and development potentially affecting the Port Curtis/Rodds Bay area. This is addressed in Section 13.2.
- Cumulative impacts in the broader context of contribution to threats across the Great Barrier Reef ecosystem. This includes MNES values associated with the OUV of the GBRWHA/NHP, GBRMP and EPBC listed marine threatened and migratory species that depend on the Great Barrier Reef ecosystem and is addressed in Section 13.3.
- As there are some MNES values that are not dependent on the Great Barrier Reef ecosystem, specifically EPBC listed terrestrial threatened and migratory species, a further assessment of the extent to which the proposed PTP might contribute to regional and broader threats to terrestrial biodiversity is also provided in Section 13.4.

13.1.3 Step 2 – Scoping Phase II – External Stressors

Scoping Phase II involves:

- Identifying past, existing or planned activities occurring within the identified geographical boundaries
- Assessing potential presence of natural influences and stressors including extreme climatic events (IFC 2013).

The proposed PTP is located within 15 to 50km of the city of Gladstone, the Gladstone State Development Area, other major industrial developments and the Port of Gladstone. Existing activities and approved developments are discussed in Section 13.2.2 and assessment of the current ecosystem health status of the receiving environment, taking into account these known stressors as well as severer weather-related stressors is provided in Section 13.2.3.

Proposed developments in this area are identified in Section 13.2.4 and potential cumulative impacts from these developments is assessed, particularly in terms of whether PTP adds to existing threatening processes. Section 13.2.5 also discusses regional population growth and associated cumulative impacts.

When considering cumulative impacts on the Great Barrier Reef ecosystem as a whole, existing threats and stressors are identified in the Great Barrier Reef Outlook Report (GBRMPA 2009).

In each case, pressures and threats from natural influences and stressors, including recent severe wet weather events, and potential effects of climate change, are considered.

13.1.4 Step 3 – Baseline Status of Relevant MNES Values

Establishment of baseline status of MNES values present involves:

- Defining the existing conditions of MNES
- Understanding potential reaction of MNES to stress and associated resilience and recovery
- Assessing trends (IFC 2013).

For the MNES values present on and around HHI, including those values that contribute to the OUV of the GBRWHA, existing condition and existing stressors and threats are discussed in Section 7 wherever relevant. Further information on current ecosystem health in the Port Curtis and Rodds Bay area is provided in Section 13.2.3, including commentary on impacts from recent severe weather events.

For the broader Great Barrier Reef ecosystem assessment, the existing condition is based on the Great Barrier Reef Outlook Report (GBRMPA 2009).

13.1.5 Step 4 – Assess Cumulative Impacts on MNES and Step 5 – Assess Significance of Predicted Cumulative Impacts

Assessment of cumulative impacts, and the significance of these impacts on MNES involves:

- Identifying any potential environmental impacts and risks
- Addressing expected impacts on the existing condition of MNES
- Identifying potential additive, synergistic or countervailing effects
- Determining the magnitude of impacts and significance in the context of past, present and future actions (IFC 2013).

For the regional level assessment, the potential for the proposed PTP to contribute to cumulative impacts on MNES is discussed in Section 13.2.6.

For the Great Barrier Reef ecosystem wide cumulative assessment, the assessment is presented in terms of the potential for the proposed PTP to exacerbate or otherwise contribute to existing threats in Section 13.3.

As there are also MNES values present on and around HHI that are not dependent on the Great Barrier Reef ecosystem, an additional assessment of the extent to which the proposed PTP might exacerbate threats to terrestrial biodiversity is also provided in Section 13.4.

13.1.6 Step 6 – Management of Cumulative Impacts

The proponent's role in managing cumulative impacts is discussed in Section 13.5.

13.2 Cumulative Impacts of Regional Development

13.2.1 Introduction

This section examines the cumulative impacts that the proposed PTP may have when considered in conjunction with impacts from existing and potential future development in a regional context.

The proposed PTP is located in the Gladstone Regional Council area, an area which is subject to a range of current and future development pressures. The city of Gladstone, located 30 kilometres north-west of the proposed PTP, has a population of just under 60,000 people and is the fifth largest population centre in the catchment area of the GBR. Gladstone features one of Australia's largest ports and a 29,000 hectare State Development Area designated for industrial and related development (see Figure 13.1).

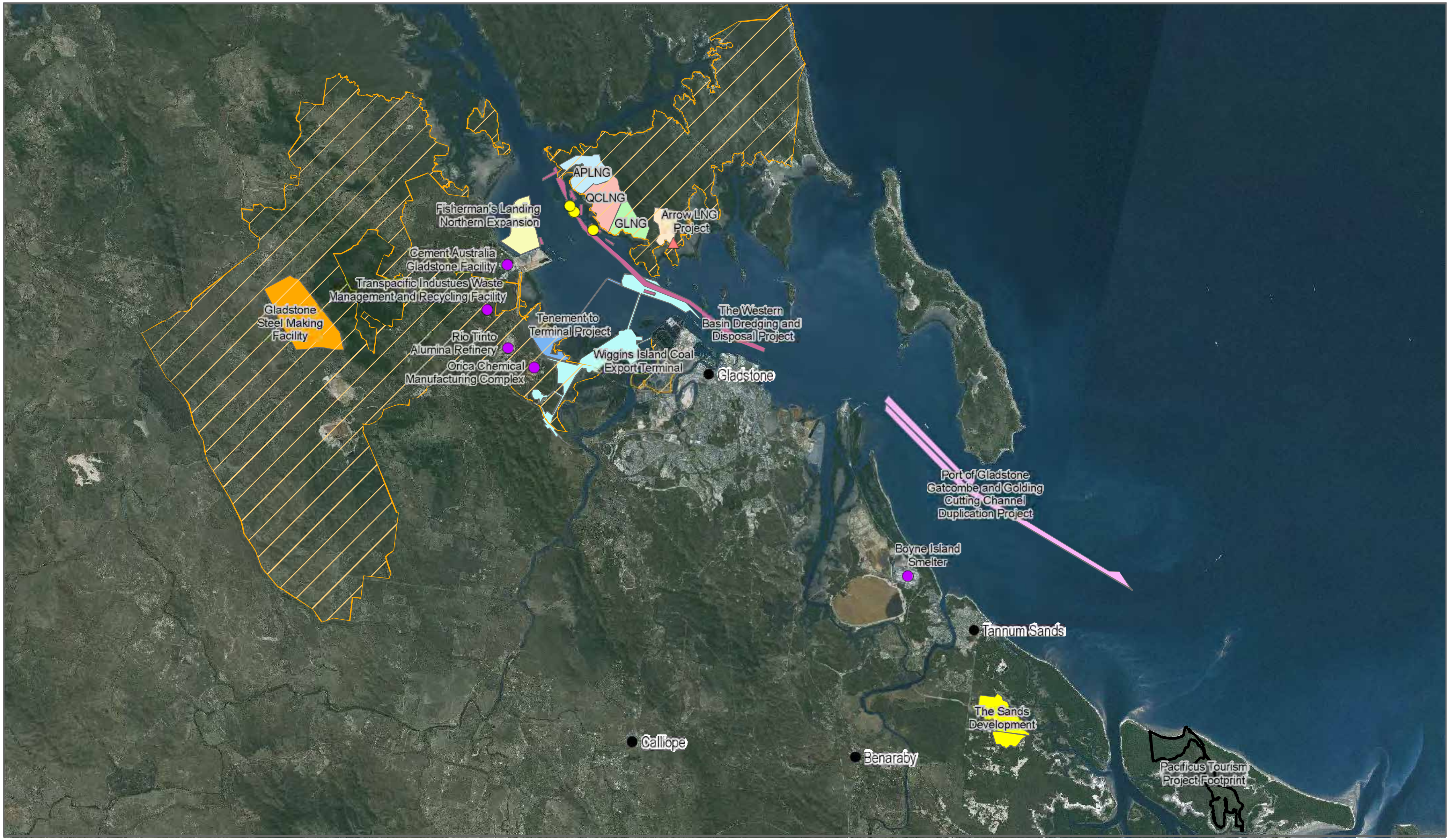
A population centre of nearly 60,000 people, port facility and industrial precinct have the potential to place pressure on environmental resources and values. In addition, future development may increase pressures on environmental resources and values.

This component of the cumulative impact assessment therefore examines:

- Existing levels of development, including projects currently under construction and the extent to which these may have already impacted on environmental resources and values that are important in relation to conservation and protection of MNES values. It should be noted that identification of any particular development or activity does not imply that this development or activity has caused an adverse impact on the environment.
- The current state of coastal and marine ecosystem health in the region
- The potential for insignificant impacts of the proposed PTP to combine with existing levels of impact to cause cumulative impacts on MNES.
- The potential for future development and associated population growth to occur that may also combine with insignificant impacts of the proposed PTP to cause cumulative impacts on MNES.

In selecting the study area for assessment of regional level cumulative impacts, existing and proposed developments in catchments draining to Port Curtis and Rodds Bay were considered. This includes the Boyne River, Calliope River and several smaller coastal creeks that drain towards the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary.

There are no major mines located in catchments draining to Port Curtis and Rodds Bay. Mining activity is located in the adjacent Fitzroy Basin, which drains to the coast at Port Alma, 50 kilometres north of Gladstone and 80 kilometres north of HHI. Hence, pressures from current and future mining activities were not considered at the regional level.



LEGEND

- Towns
- Infrastructure Approx. Location
- Dredge Location
- Arrow LNG Project - Allocated Site
- Gladstone State Development Area

This figure must be read in conjunction with the data disclaimers located at the front of this report. The data acquired for this project is known to be of low spatial resolution and as such no representation or warranties about its accuracy, reliability or suitability can be made. Assumptions and conclusions made from this figure and the associated data must be made with full understanding of the data limitations.

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Figure 13.1 - Regional Development: Current and Future Development Projects

PACIFICUS TOURISM PROJECT

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13.2.2 Existing Development Pressures

13.2.2.1 North and North-West

To the north and north-west of the proposed PTP is the city of Gladstone which is a significant population centre and industrial hub. The current population of the Gladstone Regional Council area is approximately 60,000 people. The city has several wastewater treatment plants that reuse and recycle treated wastewater and also make authorised discharges of treated wastewater to the marine environment.

The Gladstone State Development Area was declared in 1993 by the Queensland Government under the *State Development and Public Works Organisation Act 1971*. The State Development Area is intended to support a range of industrial activity including:

- large-scale, large-footprint industrial development
- industrial development requiring access to strategic port logistics and maritime facilities
- port-related activities and industries necessary to support major industrial development
- liquefied natural gas processing, storage and export facilities
- materials transportation infrastructure and utility and service infrastructure
- gas transportation infrastructure and other compatible infrastructure (http://www.dsdip.qld.gov.au/coordinator-general/gladstone-state-development-area.html).

Current major industrial facilities in the Gladstone State Development Area include:

- Rio Tinto (formerly Comalco) alumina refinery, located about 40 km north-west of HHI
- Orica chemical manufacturing complex, about 38 kilometres north-west of HHI
- Transpacific Industries waste management and recycling facility about 42 km north-west of HHI (http://www.dlg.qld.gov.au/coordinator-general/gladstone-state-development-area.html, accessed 18/04/2013).

Other key industrial developments in the Gladstone area, but outside the State Development Area include:

- Boyne Island Smelter located 17 kilometres north-west of HHI, operated by Rio Tinto and producing 560,000 tonnes of aluminium per annum.
- Cement Australia's Gladstone facility located at Fisherman's Landing, about 40 kilometres north-west of HHI has a production capacity of 1.7 million tonnes of cement per annum.

The Port of Gladstone is one of Australia's largest port facilities with a key focus on coal exports. The Gladstone Ports Corporation (GPC) operates the port, which includes 4,321 hectares of strategic port land as well as wharf facilities. Land use is managed through a statutory land use plan declared under the Queensland *Transport Infrastructure Act 1994*. GPC is also responsible for maintaining shipping channels at the port. In financial year 2012, nearly 84 million tonnes of coal and other commodities were exported through the Port of Gladstone, involving 1461 ships (GPC 2012).

There are also several major construction projects that have received Federal and State environmental and planning approvals and are now underway, including:

- The Western Basin Dredging and Disposal Project, undertaken by Gladstone Ports Corporation (GPC). The project was approved under the EPBC Act in March 2009 (EPBC 2009/4826). Dredging of 26 million cubic metres from the Gladstone Harbour commenced in May 2011 and was 56% complete in April 2013 (http://www.westernbasinportdevelopment.com.au/).
- An additional 20 million cubic metres of dredging that is required for the combined LNG projects on Curtis Island (http://www.westernbasinportdevelopment.com.au/).
- Australia Pacific LNG project. This project was approved under the EPBC Act in July 2009 (EPBC 2009/4976). It involves construction of an 18 mtpa liquid natural gas production plant on the south-western corner of Curtis Island, with a footprint of 230 hectares of land and a sea bed lease of 240 ha, including land reclamation areas. The project is within the Gladstone State Development Area. First production is scheduled to commence in 2015 although construction activities will be ongoing as additional treatment trains are added.
- Queensland Curtis Liquified Natural Gas Project, undertaken by BG International and QGC, also located on the south-west corner of Curtis Island, within the Gladstone State Development Area. The project was approved under the EPBC Act in October 2010 (EPBC 2008/4402. It involves construction of a 12 mtpa liquid natural gas production plant. Vegetation clearing affects just under 200 ha of remnant native vegetation including six hectares of mangroves. Intertidal and subtidal areas are also affected by dredging and construction of temporary and permanent wharf facilities.
- Gladstone Liquified Natural Gas Project, being undertaken by Santos and Petronas, also located on the south-west corner of Curtis Island within the Gladstone State Development Area. The project was approved under the EPBC Act in October 2010 (EPBC 2008/4057 and 2008/4058). The project will produce 4 mtpa of liquefied natural gas and production is expected to commence in late 2015. An area of 125 ha is to be dredged and the land component on Curtis Island comprises about 200 ha.
- The Wiggins Island Coal Export Terminal project, undertaken by a consortium of eight coal mining companies. The project was approved under the EPBC Act in April 2008 (EPBC 2005/2374). First coal shipment is expected in 2015.

Impacts potentially arising from these pressures include:

- Stormwater runoff from urban and industrial areas and construction sites
- Authorised discharges of treated wastewater
- Accidental discharges of wastewater and other contaminants
- Mobilisation of sediment to the coastal and marine environment from dredging and coastal works

- Loss of seagrass and other benthic habitats from dredging and coastal works
- Clearing of terrestrial and coastal vegetation and habitats and modification of coastal ecosystems.

However it should be noted that construction and operation of these developments and activities incorporates a range of mitigation measures to minimise potential impacts and are also regulated through environmental and development approvals. Further discussion on the current health of marine and coastal indicators is provided in 13.2.3 to provide context on the extent to which these potential impacts may be occurring.

13.2.2.2 South

There is very limited development to the south of HHI. Much of the coastline is contained in national park or conservation area which precludes further development. The coastal communities of Agnes Water and 1770 are located about 50km south-east of HHI and have combined populations of about 3,000 people. As development is limited, and these areas drain into the Baffle Creek catchment to the south of HHI, cumulative impacts of the proposed PTP and existing pressures to the south are not considered further.

13.2.2.3 West

Land use on the adjacent mainland and in catchments draining to Port Curtis and Rodds Bay is largely rural, with some rural residential estates. Awoonga Dam, on the Boyne River, is located 17 kilometres west of HHI.

Key impacts from existing development to the west include:

- Stormwater runoff, with the majority from rural areas. This runoff enters Colosseum Inlet/Boyne Creek/Seven Mile Creek and existing water quality and ecosystem health in this estuary reflects the effects of catchment runoff.
- Clearing of terrestrial vegetation and habitats.

13.2.3 Existing Coastal and Marine Ecosystem Health – Port Curtis and Rodds Bay

Cumulative impacts on coastal and marine ecosystems can arise from developments and activities that are more widespread due to the potential for mobilisation and accumulation of contaminants through the ocean and watercourses. It is therefore relevant to consider the existing condition of coastal and marine ecosystems in the vicinity of PTP, Port of Gladstone, Gladstone City and the Gladstone State Development Area in order to determine ecosystem response to existing pressures.

Coastal and marine ecosystem health in the Port Curtis and Rodds Bay is influenced by:

- Stormwater runoff from the urban centres of Gladstone and Tannum Sands, the Gladstone State Development Area and rural development in adjacent catchments
- Authorised discharges of treated wastewater
- Accidental discharges of wastewater and other contaminants

- Mobilisation of sediment to the coastal and marine environment from dredging and coastal works
- Clearing and modification of coastal vegetation and habitats.

Ecosystem health monitoring of the Port Curtis and Rodds Bay marine and coastal areas is undertaken by the Port Curtis Integrated Monitoring Program (PCIMP). PCIMP prepares an ecosystem health report card based on a range of ecosystem health indicators.

Available results from the 2007 and 2008-2010 periods are shown in Table 13.1. Locations of the monitoring zones are shown in Figure 13.2. The grade is based on standardised performance against a range of indicators and is defined as follows:

- Grade A+ = mean standardised score of indicators indicates 95-100% compliance with ecosystem health performance indicators. Grade A+ is considered equivalent to a reference site.
- Grade A = mean standardised score of indicators indicates 90-95% compliance with ecosystem health performance indicators
- Grade A- = mean standardised score of indicators indicates 85-90% compliance with ecosystem health performance indicators
- Grade B+ = mean standardised score of indicators indicates 80-85% compliance with ecosystem health performance indicators
- Grade B = mean standardised score of indicators indicates 0.75-80% compliance with ecosystem health performance indicators.

Table 13.1 - PCIMP Ecosystem Health Grades – 2007 – 2010 (Vision Environment 2011)

Zone	2007 Ecosystem Health Grade	2008-2010 Ecosystem Health Grade
Zone 1 – The Narrows Narrow band of water between Curtis Island and the Gladstone mainland	A	A
Zone 2 – Fisherman's Landing Covers the Western Basin water body between Fisherman's Landing and Curtis Island	B+	A-
Zone 3 – Calliope Wiggins Encompasses the Calliope River and Anabranch in addition to Wiggins Island seagrass meadows and RGT coal wharf	A	A-
Zone 4 – Auckland Creek Encompasses Auckland Creek, adjacent wharves and the Gladstone Marina	A	A
Zone 5 – Mid Harbour Extends from the southern edge of Curtis Island along the inside of Facing Island to Gatcombe Head	A-	A+
Zone 6 – South Trees South Trees Inlet, its associated wharves and tributaries to its convergence with the Boyne River	B+	B+

Zone	2007 Ecosystem Health Grade	2008-2010 Ecosystem Health Grade
Zone 7 – Boyne Tannum Encompasses the lower Boyne River and mouth area	A+	A
Zone 8 – Reference Encompasses Colosseum Inlet and associated tributaries including Wild Cattle Creek, extending to the coastal offshore area and includes HHI	A+	A+

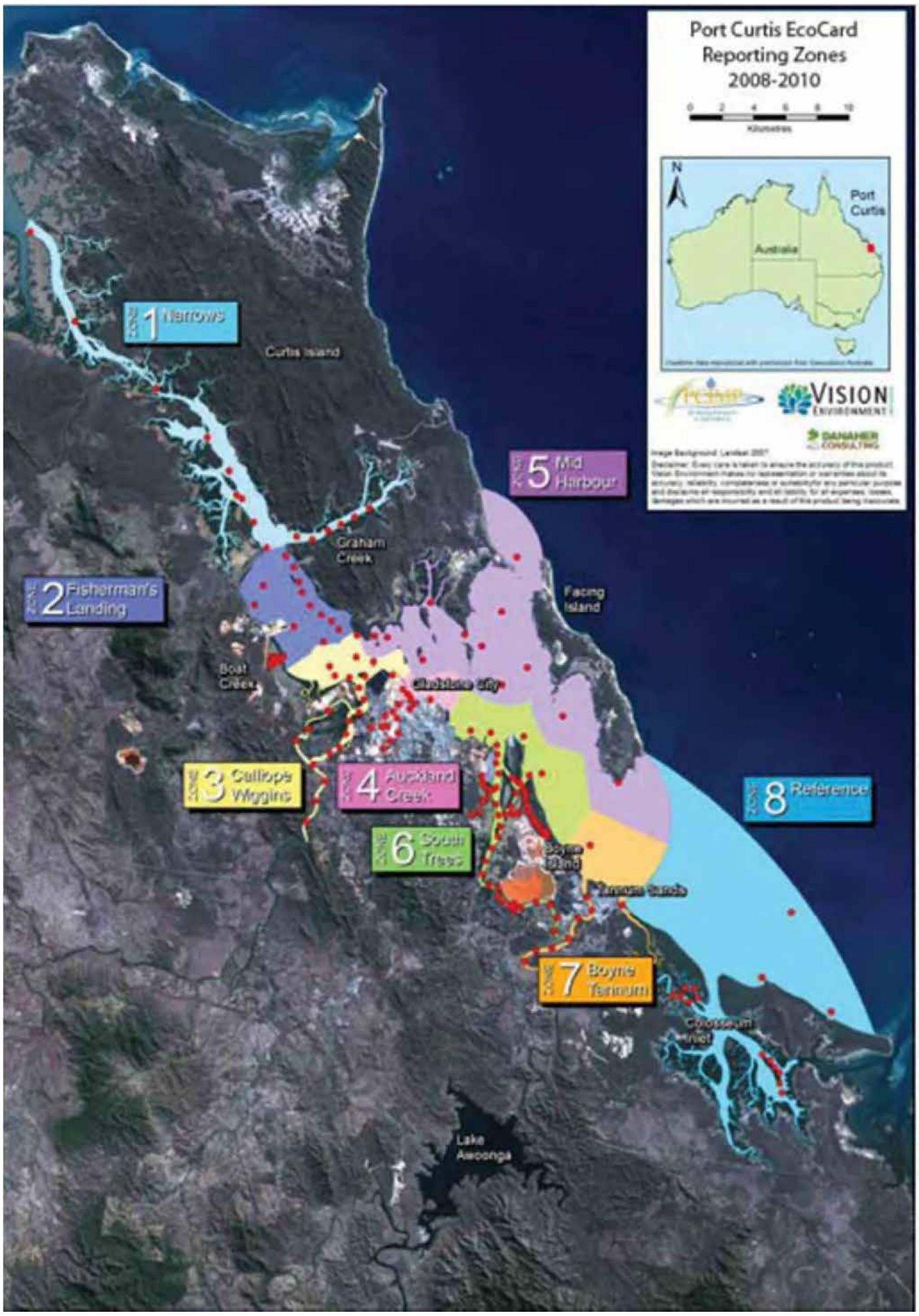

Figure 13.2 - PCIMP Ecosystem Health Monitoring Zones (Vision Environment 2011)

The results from the PCIMP monitoring program show very little change in ecosystem health in the Port Curtis/Rodds Bay area in the period 2007-2010. However, there have been several more recent factors that may have influenced ecosystem health in this area including:

- Significant wet weather events in the 2010-2011 wet season and again in the 2012-2013 wet season. Each of these resulted in significant catchment inputs of freshwater, sediment and other pollutants.
- Major dredging and construction projects in the Port of Gladstone and Gladstone State Development Area, including:
  - Western Basin Dredging and Disposal Project
  - Construction of the Wiggins Coal Terminal and three liquid natural gas plants and associated pipelines from the mainland on the southern end of Curtis Island (Australia Pacific LNG (EPBC 2009/4976), BG International and QGC (EPBC 2008/4406 and 2008/4402), Santos Ltd (EPBC 2008/4057 and 2008/4058)).

A range of monitoring activities and related studies have been carried out by Gladstone Ports Corporation (GPC) and also by and on behalf of the Queensland Government in the period 2011 to present.

GPC has been carrying out a water quality and seagrass health monitoring program since dredging for the Western Basin Dredging and Disposal Project commenced in May 2011, and this was preceded by collection of baseline data. The monitoring data shows the effects of major wet weather events in late January 2013 and late February 2013 on water quality, and also indicates that water quality recovered for most variables, with some reduction in conductivity still apparent. GPC has concluded that the dredging activities, and by default other construction activities, are not causing deterioration of water quality in Gladstone Harbour (GPC March 2013).

James Cook University has also been carrying out seagrass monitoring on behalf of GPC on a monthly basis since 2011. A review of results of quarterly monitoring from 2009 to 2012 was published in March 2013 (McCormack et al, 2013). The analysis found that there have been significant seagrass declines at both impact and control sites and attributed this largely to major flooding events of early 2011. The report noted that it is difficult to determine whether dredging activities have also contributed to seagrass decline but commented that monitoring of light availability to seagrasses undertaken by GPC indicated that, outside of major flood events, light availability to seagrasses did not appear to have been a limiting factor in seagrass abundance and growth (McCormack et al, 2013).

The Queensland Department of Environment and Heritage Protection (EHP) has also conducted a number of reviews of water quality in the Gladstone harbour area. These reviews occurred through an independent Gladstone Harbour Fish Health Scientific Advisory Panel. The panel has reviewed water quality data from Gladstone Harbour and concluded that “water quality results received to date are not unusual, except for extremely low salinity during the 2010–11 wet season” (http://www.ehp.qld.gov.au/gladstone/water-quality.html, accessed 18/04/2013).

On the basis of data available, and independent reviews by suitably qualified individuals and teams, it would appear that pressures on water quality and ecosystem health in the Gladstone area are within water quality and ecosystem health indicators established by the Queensland Government and PCIMP.

Extreme weather events of January 2011 and the 2012/2013 wet season appear to have affected water quality and seagrass health and the full effect of this, particularly on herbivorous species and species higher in the food chain, is not yet apparent. Concerns have been raised regarding health of marine turtles and dugongs, however data is not yet available to address the severity of impacts, or extent of recovery (see, for example http://www-public.jcu.edu.au/news/current/JCU_110255 accessed 14/03/2013).

There is no recent data available on population trends for marine fauna such as fish, marine turtles, and dugong in the Port Curtis/Rodds Bay region. Data on use of roosting and feeding sites in the region by migratory shorebirds has not been compiled and hence, conclusions cannot be drawn regarding cumulative impacts of current pressures in the Gladstone area on migratory shorebirds.

The PCIMP results indicate that, prior to the severe weather events of the 2011 and 2013 wet seasons, the Western Basin Dredging and Disposal Project and LNG related development on and adjacent to Curtis Island, ecosystem health across Port Curtis and Rodds Bay was good, and adverse impacts of development were not apparent.

However, it would appear that the impacts of severe weather events have affected water quality and ecosystem health throughout the Port Curtis and Rodds Bay study area. If impacts of dredging and construction projects have occurred, these are masked by the impacts of severe weather events.

13.2.4 Future Pressures – Development Projects

There is potential for additional development projects to occur in the Gladstone region.

A search of the EPBC Act referrals database (http://www.environment.gov.au/epbc/notices/index.html, accessed 18 April 2013) and the Queensland Government Coordinated Projects website (http://www.dsdip.qld.gov.au/assessments-and-approvals/, accessed 18 April 2013)) identified five development projects within a 50 kilometre radius of the proposed PTP that are currently undergoing assessment. These are described in Table 13.2. Where information on predicted impacts of these projects is available, an assessment of the potential for cumulative impacts to arise in conjunction with the proposed PTP is also presented in Table 13.2.

Based on information available on potential impacts and considering the geographical separation from the proposed PTP and that there are no significant impacts on MNES arising from the proposed PTP, cumulative impacts arising from these projects in conjunction with PTP are not expected.

While there are only a small number of projects currently undergoing assessment in the Gladstone area, given that the Port of Gladstone is one of Australia's most significant export ports, and given the presence of the Gladstone State Development Area and that the area is well serviced by infrastructure and has a large existing labour force, it would be expected that industrial and port-related development will continue in the region. Without details on proposed developments, it is not possible to undertake an assessment of the potential for cumulative impacts to occur in conjunction with the proposed PTP.

However, it is noted that industrial and port related development in Queensland is subject to development approvals processes that incorporate assessment of environmental impacts.

Development within the Gladstone State Development area must undergo assessment under the Gladstone State Development Area Development Scheme (Queensland Government, September 2012). Objectives of the Development Scheme include:

- ensure development recognises and protects environmental, cultural heritage and community values
- ensure the impacts of development on the environment, including cumulative impacts, are minimised to meet the requirements of applicable government policies
- ensure areas of high ecological significance within and adjacent to the GSDA are protected.

Development on Gladstone Strategic Port Land must be assessed against the Port of Gladstone Port Land Use Plan (Gladstone Ports Corporation 2012a). Development that is consistent with the land use plan does not require further assessment, but where development is inconsistent with the Plan, a material change of use is required. The Port Land Use Plan is accompanied by a development code which sets out environmental performance standards that must be achieved for development (Gladstone Ports Corporation 2012b).

Large industrial or port-related projects may also undergo assessment under the Queensland *State Development and Public Works Organisation Act 1971* which requires preparation and public review of an environmental impact statement. Where projects may have significant impacts on MNES protected by the EPBC Act, assessment under that Act will also be required.

Most industrial projects of the type that would be located within the State Development Area require an environmental authority issued under the Queensland *Sustainable Planning Act 2009*, as do port related activities such as dredging and operation of bulk material handling facilities. This authority requires assessment of potential impacts on a range of matters including air quality, noise, water quality, waste management and land contamination. Acceptable outcomes in terms of impacts on environmental values related to these matters are set out in policies under the *Environmental Protection Act 1994*.

In addition, development approvals are required for a range of other impacts such as clearing of remnant native vegetation, works within watercourses, works associated with taking or interfering with surface water and groundwater and tidal works.

With this regulatory framework in place, it is expected that the individual and cumulative impacts of future industrial and port related development in the region will be rigorously assessed, and projects which may, individually or in combination with existing development, cause unacceptable impacts on MNES, or on other environmental values would not receive approval.

Table 13.2 - Cumulative Impacts from Future Regional Development

Project and Location	Description	Status	Relevant Predicted Impacts	Potential for Cumulative Impacts with Proposed PTP
The Sands Development, Tannum Sands Approximately 9 km north-west of proposed PTP.	339 hectares including 120 hectares is proposed for the open space and conservation precinct, which provides a buffer to Wild Cattle Creek Residential community with 2,000 dwelling units	Referred under EPBC Act (2012/6554). Decision that approval not required - 29 January 2013. No information on current status or construction start date	Proposes stormwater management system that minimises pollutants in runoff and matches pre-development flows for the 1 in 100 year ARI. EPBC Act referral (2012/6554) states that significant impacts on MNES are not predicted given proposed controls. Area of terrestrial native vegetation/habitat to be cleared is not specified. Some similar vegetation communities and habitat types to those occurring on HHI but aerial photography indicates development footprint is already disturbed. No impacts on marine and coastal habitats. Boat ramp not proposed (informal boat ramp is already in place). Minimal visibility from GBRWHA Resident population of approximately 4,400 persons at full development.	Cumulative water quality impacts are not expected as both proposals avoid discharges of treated or untreated wastewater and include stormwater management systems designed to principles of WSUD. Note that this does not mean that the stormwater systems for the two developments are identical as WSUD requires design to be adapted as appropriate for site specific conditions and receiving waters. Both proposals are required to offset clearing of remnant vegetation under Queensland legislation. Cumulative impacts of vegetation and habitat loss are not expected. Both proposals include provision of managed conservation areas. The Sands Development does not impact on coastal or marine habitat. The Sands Development will contribute to population increase in the Central Queensland region.
Shell (CSG) Australia Curtis Island Located within Curtis Island Industry Precinct of the Gladstone State Development Area	Production capacity of 16 Mtpa liquid natural gas	Controlled action under EPBC Act (2009/5007) Submissions on Supplementary EIS being assessed by Queensland Government. Construction start date not specified.	EIS concludes that all discharges to surface water will comply with regulatory requirements. Clearing of 250ha of native vegetation, most of which will require offsetting under Queensland legislation. No clearing of EPBC Act listed ecological communities. Vegetation provides suitable habitat for some EPBC Act listed threatened species. Loss of ephemeral watercourses. Loss of 58ha of salt marsh, 5ha of intertidal soft bottom habitat and 6 ha of	Cumulative impacts on water quality not expected due to controls proposed by both projects, and separation distance. Biodiversity impacts from vegetation clearing and clearing of salt marsh, intertidal flats and mangroves for the Shell Australia project will be addressed through offsets required under Queensland government legislation. PTP will also be required to offset terrestrial vegetation clearing and requires negligible work in the coastal/intertidal zone.

Project and Location	Description	Status	Relevant Predicted Impacts	Potential for Cumulative Impacts with Proposed PTP
			mangroves. Potential habitat for water mouse. Vegetation and habitat loss is to be offset under Federal and Queensland government requirements. Increase in shipping traffic will increase risk of boat strike; this is to be managed through speed limits and a Shipping Activity Management Plan.	Both projects have committed to boat/ship speed controls. Potential for cumulative impacts is assessed as negligible.
Tenement to Terminal development Located on the western coastline of Gladstone Harbour.	25 Mtpa coal export terminal, including: • dedicated 14-kilometre dual-gauge rail line • rail in-loading facilities and balloon loop • coal stockyard • two new berths and associated dredging • out-loading wharf loading and jetty facilities.	Project is a controlled action under the EPBC Act (2012/6348), requiring assessment by environmental impact statement. Guidelines were issued in August 2012 but the EIS is not yet available.	No information available.	Information against which to assess cumulative impacts is not available. Guidelines for the Tenement to Terminal Development require the proponent to address cumulative impacts.
Port of Gladstone Gatcombe and Golding Cutting Channel Duplication Project The project duplicates parts of the existing Gladstone harbour approach channel. The closest point to HHI is 6 km north of Point Tiber.	The project involves: • new channel with a length of 9.12 km, depth of RL -16.1m and width of 200m (duplicating the existing Gatcombe and Golding Cutting Channel) • investigation of onshore and offshore locations for disposal of approximately 12 million m3 of dredged spoil material • relocation of existing, and placement of new, navigational aids for the channel duplication.	Project is a controlled action under the EPBC Act (2012/6558), requiring assessment by environmental impact statement. Guidelines were issued in April 2013 but the EIS is not yet available.	No information available.	Information against which to assess cumulative impacts is not available. Guidelines for the Port of Gladstone Gatcombe and Golding Cutting Channel Duplication Project require the proponent to address cumulative impacts.

Project and Location	Description	Status	Relevant Predicted Impacts	Potential for Cumulative Impacts with Proposed PTP
Gladstone Steel Making Facility	5 Mtpa production rate, with full production achieved in 2018. Total footprint is 850 hectares, located within the Gladstone State Development Area. This includes a private haul road transporting product to an existing port facility (Fisherman's Landing).	Project is not a controlled action (EPBC 2009/4786). The project is undergoing assessment as a Coordinated Project (for which an EIS is required) under the Queensland Government under the *State Development and Public Works Organisation Act 1971*. The EIS was released for public comment in January-February 2013.	No significant impacts on MNES identified. Marine and coastal water quality or habitat impacts limited to construction of berths at Fisherman's Landing. Clearing of 215 hectares of remnant vegetation and 203 hectares of remnant regrowth vegetation. The proponent will offset cleared vegetation under Queensland legislative requirements. Shipping will increase by 209 ships per year. Assessment in the EIS concluded that this would have a minor impact on the GBRWHA, GBRMP and marine megafauna when considered in the regional context. No mitigation measures were identified.	If approved, the project will increase shipping activity. The EIS noted that vessels would generally operate at six knots. Otherwise, cumulative impacts not expected due to separation between projects.

13.2.5 Future Pressures – Population Increase

The Gladstone region is one of the fastest growing regions in Australia. The estimated resident population in June 2011 was 59,402 persons and the average annual growth rate in the period 2010-2011 was 2.3%, compared to a Queensland annual average growth rate of 1.1% (OESR). Population forecasts indicate projected population for Gladstone Regional Council area of 98,000 by 2026 and 112,000 by 2031 (http://www.oesr.qld.gov.au/products/tables/proj-pop-lga-qld/index.php, accessed 18/04/2013).

PTP makes a minor contribution to population growth, with the residential population component consisting of less than 3% of the forecast population growth. At full development, 16 years after commencement of the project, the residential population will be an estimated 1,200 people. Around 700 full time jobs will be generated, and some workers may live at PTP while others will live elsewhere in the Gladstone Regional Council Area. Population growth forecasts take into account population increases attributable to likely developments as well as background population growth. The prospect of development on HHI was first raised when the special lease was issued in 1991. HHID, the predecessor to PTP, was declared a significant project in 2006 and in 2009, tourism and related development on HHI was recognised in the Central Queensland Tourism Opportunities Plan. The EIS for HHID which was released in 2007 contained information on likely permanent and temporary population and this has not changed significantly for PTP (see also Section 14.3.4).

Population increase has the potential to place additional pressures on ecosystems and habitats of the GBRWHA/NHP and GBRMP. Key pressures arising from existing population centres and associated urban development are:

- Discharges of treated wastewater which contain nutrients and other contaminants
- Stormwater runoff, with entrained nutrients, sediments, hydrocarbons and other pollutants
- Loss of coastal and intertidal habitat due to land reclamation and clearing for development
- Recreational activities including swimming, boating and fishing (GBRMPA 2009).

Future population growth and urban development will not necessarily result in proportional increases in contaminants released through treated wastewater discharges and stormwater runoff. Current regulatory and policy frameworks require water quality issues to be addressed as part of the development approval process for urban development, with planning schemes specifying standards for wastewater and stormwater management. New technologies and guidelines are available for treatment and recycling of treated wastewater and removal of pollutants from urban stormwater.

It is expected that new urban developments will adopt principles of water sensitive urban design in relation to stormwater and, where new wastewater treatment systems are required, utilise closed circuit technologies. This is the case for the proposed PTP and also the proposed "Sands

Development" at Tannum Sands (EPBC Referral 2012/6554, determined as not a controlled action in January 2013).

This means that future population growth and urban development can occur with minimal impacts on water quality provided that legislative and policy controls are maintained at current levels and are applied to future development.

Impacts of development on coastal and intertidal habitats are also strictly controlled under Queensland legislation and, where coastal development may impact the GBRWHA or other matters of national environmental significance, the Commonwealth EPBC Act. Under Queensland legislation, development approval is required to:

- disturb coastal wetlands and any other wetlands identified as being of high ecological significance in relation to location on a GBRWHA catchment
- undertake any works in the coastal zone, defined as lands below highest astronomical tide and other areas defined as coastal management areas
- clear any mangroves or other marine plants.

Legislation and associated policies set out the matters which must be considered in the assessment of applications for development approval and these matters include consideration of impacts on the environment. Offsets are required for clearing of any marine plants and of remnant native vegetation.

Provided that these requirements remain in place and are enforced, a net loss in coastal habitat and associated biodiversity is not expected to occur as a result of future development associated with population growth.

Pressures from increased levels of recreational activity may be more difficult to manage. As discussed in Section 12.2, GBRMPA has identified threats from recreational activities to Great Barrier Reef ecosystems, including EPBC listed threatened species, as moderate, low or very low, but has noted that there is a lack of information on moderate risks such as impacts of recreational boating and fishing (GBRMPA 2012). In its Recreation Management Strategy, GBRMPA notes the potential for impacts from some recreational activities to increase with population increase. GBRMPA also notes that these impacts are concentrated on major population centres.

As discussed in Section 8.8.4, the population increase attributable to PTP is expected to contribute about 120 boats to an existing 46,000 registered boats in the Gladstone Region (Hervey Bay to Rockhampton) and 8,300 boats in the immediate Gladstone area. In terms of cumulative impacts associated with existing and forecast levels of boat ownership, this is insignificant. The main effect of PTP on recreational boating will be to provide improved access to the waters around HHI. This is not a cumulative effect however, but rather, a redistribution of activity and associated impacts have been addressed in Sections 8 to 12.

GBRMPA has the ability to control impacts of activities in the GBRMP/GBRCMP through zoning plans and permits. However, lack of information on impacts of recreational activities may make it difficult for GBRMPA to set sustainable limits on these activities, particularly in the short to medium term.

13.2.6 Summary of Regional Cumulative Impacts

Assessment of current development pressures and ecosystem stress levels indicates that ecosystem health in the Port Curtis/Rodds Bay area remains within acceptable levels when considered against water quality and ecosystem health standards established by independent bodies. Evaluation of the proposed PTP has also not identified any significant or unacceptable impacts on water quality or ecosystem health.

It must be recognised that the full effects of recent weather related stresses on ecosystem health may not yet be apparent. However, the proposed PTP is not expected to increase the stressors on marine fauna such as dugongs and marine turtles that are dependent on seagrass ecosystems, provided that controls on recreational boating activity, particularly boat speed and anchoring over seagrasses, are put in place. Hence, cumulative impacts of PTP with recent severe weather events, or future severe weather events, are not expected.

The proposed PTP will result in a small population increase when considered against population forecasts for the Gladstone Regional Council, and will provide overall economic stimulation to the region which will in turn support employment in the Gladstone region (see also Section 14). This in turn may create pressure for new residential development, however as discussed in Section 13.2.5, development approval controls are in place and new technology for stormwater and wastewater management means that legacy issues associated with poor quality stormwater runoff and discharge of nutrient loads from treated wastewater can be avoided in new urban developments.

The population increase associated with PTP will not, in itself, lead to a significant increase in regional levels of recreational boating activity, however, the provision of a boat ramp at the development will increase the intensity of recreational boating activity in waters around HHI. Management measures are discussed in Section 13.5.

13.3 Potential for Exacerbation of Threats to Great Barrier Reef Ecosystem

13.3.1 Introduction

Human activities have placed a number of pressures on the Great Barrier Reef ecosystem. Many of these pressures are the result of cumulative impacts of a number of developments and activities that take place across the entire ecosystem, rather than the impacts of individual developments and activities (GBRMPA 2009).

The location of the proposed PTP in the GBRWHA/NHP and adjacent to the GBRMP means that consideration must be given to the extent to which PTP might contribute to threats to the Great Barrier Reef ecosystem and habitats, including the resilience of these ecosystems. The Great Barrier Reef ecosystem encompasses a wide range of reef and non-reef habitats including mangrove, intertidal and subtidal mudflat, intertidal and supratidal salt flat and intertidal and subtidal seagrass bed habitats that are present in the waters around HHI.

This component of the assessment therefore focusses on the potential for the proposed PTP to contribute to threats to the Great Barrier Reef ecosystem and its component habitats, and hence also to the following MNES:

- Listed threatened marine and coastal species, including marine turtles and water mouse
- Listed marine and coastal migratory species, including dugong and migratory shorebirds
- The OUV of the GBRWHA and the values of the GBRNHP
- The GBRMP.

Cumulative impacts may arise in relation to:

- Direct contributions, that is, the extent to which the proposed PTP might contribute directly to the identified threat
- Ecosystem resilience impacts, that is, the extent to which impacts of proposed PTP may make ecosystems more vulnerable to other threats.

In its most recent Great Barrier Reef outlook report, GBRMPA identified and assessed risks to the Great Barrier Reef ecosystem (GBRMPA 2009). Risks apply across the entire ecosystem and fall into four main categories:

- Climate change related issues
- Coastal development and water quality related issues
- Direct use - resource extraction related issues
- Other direct use related issues.

13.3.2 Climate Change Related Issues

Table 13.1 presents the threats and risk levels associated with climate change related issues to the Great Barrier Reef ecosystem.

Climate change related impacts from sea level rise, sea temperature increase and ocean acidification are all identified as very high risks to the Great Barrier Reef ecosystem and altered ocean currents and altered cyclone activity are identified as medium risks.

The proposed PTP makes a very minimal direct contribution to the greenhouse gas emissions that in turn result in climate change. Incentives to utilise electricity sustainably are provided through the Australian government's carbon tax. Further, the proponent has committed to a range of energy efficiency measures in design, as described in Section 2.2. These will be implemented through building codes in the Plan of Development.

As climate change effects appear to be inevitable (GBRMPA 2009), it is also important to consider the synergistic effects that may occur if climate change impacts make ecosystems more vulnerable to other threats, or development-related stressors exacerbate the vulnerability of ecosystems to climate change effects.

Potential changes in the physical environment associated with climate change include:

- Increased sea temperature
- Acidification of oceans
- Sea level rise, which in turn may increase inundation levels of coastal habitats and result saltwater intrusion into freshwater habitats
- More severe storms with associated physical damage
- Reduced rainfall runoff from catchments, however, individual runoff events may be more severe due to increased intensity of storms.

The Great Barrier Reef Outlook Report identifies the risks to the Great Barrier Reef habitats and species groups from a range of climate change scenarios. Table 13.3 provides an assessment of threats to various habitat types and species groupings and the potential for the proposed PTP to exacerbate these threats.

Table 13.3 - Potential for the Proposed PTP to Exacerbate Climate Change Impacts

Risk to Habitat / Species Groups from Climate Change	Potential for Cumulative Impacts from PTP
The risk to corals and coral reef ecosystems is high to extreme (GBRMPA 2009). Increased sea temperatures are linked to coral bleaching and acidification of the oceans is linked to reduced calcification and hence coral building (GBRMPA 2009).	There are no coral reef ecosystems in close proximity to the proposed PTP, with the nearest coral reefs being 50 kilometres offshore. There are some corals growing on rocky reefs to the north of HHI (see Figure 6.35). Due to the distance from coral reef ecosystems, and the design of stormwater and wastewater systems to avoid degradation of water quality in adjacent coastal and marine waters, it is not expected that the proposed PTP will exacerbate vulnerability of coral reef ecosystems to climate change risks.
Coastal habitats also have low to moderate vulnerability to climate change (GBRMPA 2009). Key issues include sea level rise, changes to rainfall patterns and flood events, and increasing sea temperature. Mangroves exhibit a wide tolerance to changes in sea level, salinity and storms and can be expected to adapt provided that changes occur slowly and other threats are minimised. Under conditions of sea level rise and reduced freshwater inputs, there may be a transition from less salt tolerant to more salt tolerant species of mangroves. Wind from large storms may also destroy or damage trees (McLeod and Salm, 2002).	As climate change occurs, it can be expected that the mangrove, other coastal and seagrass habitats in the vicinity of HHI will be able to adapt to changed conditions provided that the changes occur gradually, and there are no additional stressors on these habitats. The proposed PTP is not identified as having any impact on mangrove, salt flats and intertidal and subtidal mud flats. While a very small area of each of these habitat types will be disturbed for construction of the proposed bridge and boat ramp and upgrade of the mainland causeway, the area disturbed is less than 0.005% of the available habitat in the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary system. The proposed PTP has been specifically designed to avoid indirect impacts that might place stress on coastal and intertidal/subtidal ecosystems (see also discussion in Section 8.5). Further, monitoring proposed by the proponent will assist in identifying any external stressors on these systems. It is therefore not expected that the proposed PTP will exacerbate the vulnerability of these ecosystems to

Risk to Habitat / Species Groups from Climate Change	Potential for Cumulative Impacts from PTP
	climate change.
Seagrass ecosystems have low to moderate vulnerability to climate change risks, depending on the severity of climate change (GBRMPA 2009). Key issues for seagrass ecosystems from climate change include rising sea levels, changing tidal regimes, increased exposure to and damage from ultraviolet radiation, changes in oxygen levels in sediments, increases in sea temperatures and increased storm and flooding events (Bjork et al, 2008).	As discussed in Section 8.3.7 and 9.3.2, potential impacts to intertidal seagrass beds in Seven Mile Creek have been identified arising from anchoring by recreational boats. While the severity of the impact is expected to be low, the proponent will monitor the seagrass beds and implement corrective action if seagrass health, abundance or productivity appears to be affected. Corrective action will be in the form of establishing a no-anchoring zone above the seagrass beds. With regular monitoring and corrective action if required, the seagrass bed will be able to be retained and should not become any more vulnerable to climate change impacts.
Island vegetation is sensitive to changes in rainfall patterns and rising temperatures (GBRMPA 2009)	The proponent is proposing to manage the balance of native vegetation on HHI as a conservation area. This will mean that the proposed PTP will not increase current stress levels on this vegetation, and the associated habitat it provides, and may reduce stress through weed control programs and selective rehabilitation. Cumulative impacts of the proposed PTP and climate change threats on island vegetation are therefore not expected.
Climate change presents a moderate to high risk to fish, with the main issue being loss of coral reef dependent species if coral reef habitats are degraded (GBRMPA 2009)	As discussed above, there are no significant coral reef ecosystems within 50 kilometres of the proposed PTP, with some coral cover on nearby rocky reefs. The proposed PTP is therefore not likely to exacerbate climate change related threats on coral reef ecosystems and the fish that depend on these.
Climate change also presents a moderate to high risk to marine turtles as increasing temperatures may affect nesting success (GBRMPA 2009)	Low density and intermittent turtle nesting occurs on one of the beaches of HHI. As discussed in Section 9.3, a number of measures are proposed to ensure that turtle nesting activities are not affected by the proposed PTP. As HHI is located towards the southern boundary of marine turtle nesting areas, it is possible that, even with temperature rises, temperatures in the region will not exceed the upper tolerance of turtle eggs. Regardless, the proposed PTP will not create any additional threat to turtle nesting success.

The analysis presented in Table 13.3 indicates that there is no potential for the proposed PTP to increase stress levels on the Great Barrier Reef ecosystem such that habitats or species groupings become more vulnerable to the effects of climate change.

13.3.3 Coastal Development and Water Quality Related Issues

An assessment of the potential for the proposed PTP to contribute to coastal development and water quality related threats identified in the Great Barrier Reef Outlook Report is shown in Table 13.4. The assessment indicates that the proposed PTP is not expected to contribute to any of the identified threats, and is not expected to increase the risk level to the Great Barrier Reef ecosystem. This is because of the design measures incorporated into the proposed development, and proposed approaches to managing wastewater, stormwater runoff and storage, handling and use of potential contaminants.

Table 13.4 - Potential for Proposed PTP to Contribute to Coastal Development and Water Quality Related Threats

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
Nutrients runoff	Very High	Nutrient inputs to the Great Barrier Reef are dominated by runoff from agricultural lands (Brodie et al 2008, http://kurrawa.gbrmpa.gov.au/corp_site/info_services/publications/sotr/water_quality/introduction.html) Historically, urban development in catchments draining to the Great Barrier Reef has also contributed to nutrient levels in estuarine and coastal waters through: Entrainment of nutrients in stormwater runoff Discharges of treated wastewater. Sewage discharges currently account for about three to four per cent of total nitrogen and less than one per cent of total phosphorus entering the Great Barrier Reef. Golf courses have also been associated with high levels of nutrient runoff due to the use of fertilisers. The proposed PTP has been designed so that nutrient levels in stormwater runoff are within water quality objectives for the receiving environment, through use of stormwater quality improvement devices (see Section 8.5.8 and Appendix D2). Wastewater will be treated and recycled, with no direct discharge to the environment (see Section 8.5.8 and Appendix D1). Recycled wastewater will be used for irrigation of the proposed golf course and other landscaped areas, thus significantly reducing the need to apply additional fertilisers. A comprehensive turf management plan will be developed for the proposed golf course to monitor and manage nutrient levels in soils and runoff water so that over-application of nutrients and fertiliser does not occur. This is discussed further in Section 2.6.3 and 8.5.7. With these design measures and management approaches, degradation of water quality and coastal habitats due to nutrients in runoff from the proposed PTP is not expected. Therefore, the proposed PTP does not contribute to this threat or increase the level of risk.
Pesticides runoff	Very High	The selection, use and management of pesticides at the proposed PTP is discussed in Section 8.5.12. Pesticide use at the proposed golf course will be minimised through turf management approaches that will reduce vulnerability of turf to pest insects and weeds. Where pesticides are required, these will be selected based on an assessment of environmental fate, in particular the risk of pesticides being mobilised to, and persisting in, the coastal and marine environment. Where pesticides are required for other aspects of pest control, the mode of use, and typical pesticides used are such that risk of mobilisation to the coastal and marine environment is very low. It is not expected that the proposed PTP will contribute to, or increase the risk level of this threat. The proponent will monitor pesticides in coastal waters and sediment adjacent to HHI and if monitoring detects potentially toxic levels of pesticides, pesticide use and management will be reviewed.

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
Crown of thorns starfish outbreaks	High	Crown of thorns starfish are a risk to coral reef ecosystems. While there are no significant coral reef ecosystems within 50 kilometres of HHI, the Great Barrier Reef Outlook Report identifies that increased severity and frequency of outbreaks may be associated with human impacts on the Great Barrier Reef. Possible contributing factors include increased nutrient levels which advantage crown of thorns starfish larvae and reduced larvae predation due to removal of certain fish from the food chain. As discussed above, the stormwater and wastewater management systems for the proposed PTP have been designed to avoid increased nutrient levels in adjacent waters and hence, the proposed PTP is not expected to contribute to increased frequency or severity of crown of thorns starfish outbreaks through this mechanism. Increased tourist levels may increase demand for deep sea fishing charter activities operating from nearby Gladstone, however this activity is regulated through a permit system administered by the GBRMPA and this should prevent unsustainable levels of fishing on reef ecosystems offshore of HHI and Gladstone.
Clearing coastal habitats	High	A very small area of coastal habitat is required to be cleared or disturbed for the proposed bridge and boat ramp and to upgrade an existing causeway across salt flats on the mainland. The area to be disturbed is less than 0.001% of the total habitat area available in the Colosseum Inlet/Boyne Creek/Seven Mile Creek estuary. Otherwise, the proposed PTP has deliberately avoided any development in coastal habitats. Further, a range of measures have been incorporated into the design and management approach to prevent degradation of coastal habitats through changes in runoff quality and quantity and access by visitors to the proposed PTP. The proposed PTP will therefore not contribute to this threat, or increase the risk level.
Sediment runoff	High	Sediment inputs to the Great Barrier Reef are dominated by runoff from agricultural lands (Brodie *et al.* 2008, http://kurrawa.gbrmpa.gov.au/corp_site/info_services/publications/sotr/water_quality/introduction.html) Historically, urban development and other development in catchments draining to the Great Barrier Reef has also contributed to sediment levels in estuarine and coastal waters through erosion and sediment mobilisation processes. The proposed PTP has been designed so that sediment levels in stormwater runoff are within water quality objectives for the receiving environment, through use of stormwater quality improvement devices (see Section 8.5.8 and Appendix D2). During construction of the proposed PTP, it is estimated that less than 50 hectares of land will be exposed to erosive forces each year. Vegetation clearing and earthworks in steep areas will be undertaken in the dry season wherever practicable. Erosion and sediment control practices will be required through conditions of development approval and will follow best practice guidelines in place at the time. With these design measures and management approaches, degradation of water quality and coastal habitats due to sediment runoff from the proposed PTP is not expected. Therefore, the proposed PTP does not contribute to this threat or increase the level of risk.
Large oil spill	Moderate	As discussed in **Section 8.5.11**, it is possible that petrol, diesel and/or outboard fuel may be available for sale at the proposed PTP, in which case, there would be quantities in the order of 10,000-20,000 litres of fuel stored on HHI. Rigorous standards are in place for the design, installation and management of fuel storages and adherence to these standards reduces the likelihood of a fuel spill occurring to “rare”. Similarly, dangerous goods codes

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
		apply to the transport of fuel, including design of vehicles to reduce likelihood of rupture of fuel tanks. In the event that a large spill did occur, most of the spilt material would remain on land and minimal quantities would enter the coastal or marine environment. The overall risk associated with storage and dispensing of fuel at the proposed PTP is assessed as very low. The proposed PTP does not contribute to this threat or increase the level of risk.
Large chemical spill	Moderate	As discussed in **Section 8.5.13**, only minor quantities of chemicals will be stored and utilised at the proposed PTP. Hence, there is no risk of a large chemical spill occurring. An analysis of the potential for environmental harm to arise from small chemical spills identified that there is negligible risk to the marine and coastal environment from chemical spills. The proposed PTP does not contribute to this threat or increase the level of risk.

([1]) Assessed risk levels from Great Barrier Reef Outlook Report (GBRMPA 2009)

13.3.4 Direct Use – Resource Extraction Related Issues

An assessment of the potential for the proposed PTP to contribute to threats identified in the Great Barrier Reef Outlook Report from resource extraction is provided in Table 13.5.

Table 13.5 - Potential for Proposed PTP to Contribute to Direct Use – Resource Extraction Threats

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
Fishing - top predators	Very High	See discussion below. Data collected by Queensland Department of Agriculture, Forestry and Fisheries indicates that top predators are not target species for recreational fishing in the Rockhampton coastal waters region (DAFF 2013).
Bycatch of species of conservation concern	High	The proposed PTP will result in a small increase in recreational fishing activities, however, these recreational fishing activities do not typically result in by catch of species of conservation concern (marine turtles, dugong). As the waters around HHI are within the Rodds Bay Dugong Protection Area, there are already restrictions in place on the use of mesh nets by both commercial and recreational fishers. The proposed PTP is not likely to increase the risk of bycatch of turtles, dugongs or other species of conservation concern.
Poaching species of conservation concern	High	Both turtles and dugong are present in waters around HHI and are existing targets for poachers (GBRMPA 2009). The proposed PTP will increase access to waters around HHI through provision of a formal boat ramp, however this will also increase the level of boating activity somewhat, which may discourage activities of poachers. The proposed PTP is not expected to contribute to this threat.
Fishing - spawning aggregations	High	See discussion below. There are no known spawning aggregations in the waters around HHI. The proposed PTP is not expected to increase this threat.
Death of discarded catch	High	See discussion below. This issue relates more to commercial fishing activity (GBRMPA 2009), however any increase in recreational activity will also increase discarded catch as a recreational fishers discard around half of what is caught (DAFF 2013).

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
Illegal fishing	High	This threat relates largely to illegal fishing by foreign fishing vessels (GBRMPA 2009). However, while not highlighted in the Great Barrier Reef Outlook Report, recreational fishers may also fish illegally when restrictions on fishing methods and bag limits are not observed. The proponent will not be in a position to enforce fishing related laws but will make information on the requirements available to recreational fishers using the proposed boat ramp at PTP, and assist enforcement officers to access the area.
Fishing - herbivores	Moderate	See discussion below. The proposed PTP is not expected to increase risk levels associated with this threat.
Traditional hunting	Moderate	The waters around HHI are subject to a Traditional Use of Marine Resources Agreement between the Port Curtis Coral Coast Group and the GBRMPA. This regulates traditional hunting in the waters around HHI. The proposed PTP will not change any aspect of this agreement, and hence does not contribute to this threat.
Physical fishing impacts	Moderate	Physical fishing impacts are largely related to trawling (GBRMPA). Hence, the proposed PTP will not contribute to this threat.
Fishing - low order predators	Moderate	See discussion below. The proposed PTP is not expected to increase risk levels associated with this threat.
Fishing - filter feeders	Moderate	See discussion below. The proposed PTP is not expected to increase risk levels associated with this threat.
Fishing - detritivores	Moderate	See discussion below. The proposed PTP is not expected to increase risk levels associated with this threat.

([1])Assessed risk levels from Great Barrier Reef Outlook Report (GBRMPA 2009)

An assessment of the potential for the proposed PTP to increase recreational fishing effort is provided in Section 8.7.6. The assessment notes that the provision of a boat ramp will increase recreational boating activity in waters surrounding HHI, and that about 84% of recreational boating activity is associated with recreational fishing.

In terms of the threat categories identified by GBRMPA (2009), there are no spawning aggregations known to occur in waters around HHI, and higher order predators are not typical target species in the area (see also Section 6.6.8). Most of the fish species reported to be caught by recreational fishers in the Rockhampton coastal waters region are lower order predators, with a small proportion of filter feeders and herbivores.

The assessment in Section 8.7.6 concluded that significant impacts on fish stocks in the waters around HHI were not expected as a result of the proposed PTP, partly due to the relatively small numbers of additional recreational fishers that would be introduced and also due to controls on fishing methods and bag limits that are in place through the GBRMP zoning plan (GBRMPA 2003) and *Queensland Fisheries Act 1994*.

Overall the proposed PTP is not expected to contribute to increased threat levels from resource extractive uses of the Great Barrier Reef ecosystem.

13.3.5 Other Direct Use Related Issues

An assessment of the potential for the proposed PTP to contribute to threats identified in the Great Barrier Reef Outlook Report from direct use other than resource extraction is provided in Table 13.6.

Table 13.6 - Potential for Proposed PTP to Contribute to Direct Use – Other Threats

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
Marine debris	High	Section 8.7.4 identified potential for marine debris arising from the proposed PTP to impact on marine turtles and a more detailed analysis was undertaken in Section 9.3.5. Analysis of potential impacts on migratory shorebirds was provided in Section 10.2. These assessments concluded that with measures to prevent litter from land entering the marine environment, and laws in place regarding littering on land or from boats, potential for risk of turtle and migratory shorebird entanglement to increase was not significant. The proponent is also committed to encouraging commercial outlets at the proposed PTP to avoid plastic packaging or utilise biodegradable packaging and will make educational information available to visitors on the dangers to marine turtles from littering. The proposed PTP is not predicted to increase the risk levels associated with this threat, provided that the identified mitigation measures are implemented.
Grounding large vessels	Moderate	This threat is of no relevance to the proposed PTP. The proposed PTP will not result in an increase in large vessels.
Exotic species – hull fouling	Moderate	Given that there will not be any marina or mooring facilities available at the proposed PTP, there is no risk associated with foreign vessels visiting the proposed development.
Exotic species – ballast water	Moderate	Given that there will not be any marina or mooring facilities available at the proposed PTP, there is no risk associated with foreign vessels visiting the proposed development.
Exotic species – aquaculture	Moderate	The proposed PTP does not involve aquaculture, nor will it facilitate the development of aquaculture in adjacent waters.
Boat strike	Moderate	Section 8.7.3 identified the potential for boat strike from recreational boats using the proposed boat ramp to impact on turtles and dugong. This was further assessed in Sections 9.3.4 and 10.4.4. Natural navigational conditions in waters around HHI will tend to restrict boat speed, particularly across shallow seagrass beds where dugongs and turtles may be foraging, and in narrow channels. In addition, there are statutory six knot speed limits in the vicinity of a boat ramp and the shoreline under the Queensland Transport Operations (Marine Safety) Regulation 2004. Finally, the proponent will work with Maritime Safety Queensland to extend the six knot speed limit to sensitive habitat areas. This is also a recommendation of the Queensland Coordinator-General (Coordinator-General, 2011). Similar mitigation measures were imposed on the GKI Revitalisation Project (EPBC 2010/5521). This measure, together with provision of educational awareness material to recreational boat users will minimise any increased risk to dugongs and turtles from boat strike. As such, the proposed PTP is not expected to increase the threat risk level associated with boat strike.
Dredging	Moderate	The proposed PTP does not require any dredging.

Threat	Risk (GBR)([1])	Potential for PTP to increase risk level
and spoil dumping		
Barriers to river flow	Moderate	The proposed PTP will not create any barriers to river flow. It is proposed to partially breach an existing causeway across the tidal watercourse Boyne Creek.
Anchoring on coral	Moderate	There are no coral reef ecosystems accessible by boat from the proposed PTP.
Vessel waste discharge	Moderate	The Great Barrier Reef Outlook Report identifies this as an issue associated with larger vessels than those likely to be utilising the proposed boat ramp at PTP. However, discharge of human wastes from small recreational boats may also affect water quality and this was assessed in Section 8.5.15. It was concluded that any human waste discharges from small boats would be within the assimilative capacity of the estuarine receiving environment. Hence, the proposed PTP is not considered to increase the risk level associated with this threat.

The assessment provided in Table 13.6 indicates that the proposed PTP is not expected to increase the risk level of threats associated with direct use of the Great Barrier Reef ecosystems.

13.4 Potential for Exacerbation of Threats to Terrestrial Biodiversity

Terrestrial biodiversity in Australia has been affected by direct and indirect impacts since European settlement. The cumulative impacts of vegetation clearing and habitat modification has led to extinction of some species, and significant declines in populations of a number of species and the extent of ecological communities (DEWHA 2009, NRMMC, 2010).

Australia's Biodiversity Conservation Strategy 2010-2013 (NRMMC 2010) identifies the following threats to biodiversity:

- Habitat loss, degradation and fragmentation
- Invasive species
- Unsustainable use and management of natural resources
- Changes to the aquatic environment and water flows
- Changing fire regimes
- Climate change.

The potential for the proposed PTP to contribute to each of these threats to terrestrial biodiversity is evaluated in Table 13.7. Table 13.7 also considers the potential for the proposed PTP to impact on biodiversity within the GBRWHA as this contributes to the OUV of the GBRWHA (see also Section 11.5).

Table 13.7 - Potential for the PTP to Contribute to Biodiversity Threats – Terrestrial

Threat	Potential for PTP to Increase the Threat Level
Habitat loss, degradation and fragmentation	The proposed PTP will result in some loss of native vegetation, however this is not expected to result in a net loss of biodiversity at a local level as: • The development footprint has been designed so that examples of all vegetation communities and habitat types are retained in viable form (see Section 8.3.2 and 11.5) and will be protected in a managed conservation area if the proposed PTP goes ahead • The development footprint has been designed to avoid direct and indirect impacts on important ecological communities and habitats including the critically endangered coastal vine thicket community and migratory shorebird habitat. Floristic diversity and terrestrial habitat diversity within the GBRWHA is retained. There are no impacts on habitat that is important for EPBC listed threatened species and impacts on EPBC listed threatened or migratory species are assessed as negligible or low (see Section 9.2 and 10.2 and 10.3). Under Queensland legislation, clearing of regional ecosystems requires vegetation offsets. The proponent has identified potential offsets within 40 km of HHI, however, these are yet to be submitted to the Queensland Government for agreement. Vegetation that is not disturbed for the proposed development will be actively managed as a conservation area (see also Section 8.3.8) and this will prevent degradation of vegetation communities and habitat values. The range of management measures to be employed is set out in Section 8.3.8. As PTP will take place on an island, regional scale habitat fragmentation would only occur if HHI provided a "stepping stone" for migratory movements of animals and if this stepping stone was disrupted. This is not the case as over 80% of habitat on HHI is to be retained, including all migratory shorebird habitat. On this basis, impacts on biodiversity from vegetation clearing have largely been avoided and residual impacts will be offset. Management of the remainder of HHI as a conservation area will increase the security of particular habitats and ecological communities, including an ecological community listed as critically endangered under the EPBC Act.
Invasive species	As discussed in Section 8.4.2 and Section 8.6.4, there is some existing weed and pest animal invasion on HHI and management measures will be required to prevent proliferation of weeds in areas disturbed by development. Management measures will also be employed to prevent introduction of further weed species and pest animals to HHI. This will include weed hygiene and inspection programs for all vehicles, equipment and materials used in construction. The proposed PTP will not provide facilities for vessels from international origins. It is not expected that any materials will be imported from overseas for construction and if this was the case, such materials would be required to undergo Australian quarantine requirements. Hence there is no potential pathway for new invasive species to be introduced from overseas. As HHI is an island, even if weed or pest invasion occurred, there is very limited potential for spread to nearby land areas. Overall, the proposed PTP will not increase the threat to terrestrial biodiversity in Australia, Queensland, the Central Queensland region or the GBRWHA from invasive species.
Unsustainable use and management of natural resources	The proposed PTP does not involve extraction of natural resources. The natural resources and values of HHI are recognised as a key attraction for the proposed PTP and controlled access to some areas of the island will be allowed for low impact recreational activities revolving around nature appreciation. However, natural resources of HHI will be retained and managed as a conservation area.

Threat	Potential for PTP to Increase the Threat Level
Changes to the aquatic environment and water flows	The proposed PTP will not contribute to this threat to terrestrial biodiversity. There are no permanent aquatic ecosystems on HHI. Drainage occurs via ephemeral waterways. The proposed stormwater system for PTP has been designed to minimise changes to flow in ephemeral waterways and the quality and quantity of water discharged to adjacent coastal ecosystems. This is discussed in Section 8.5.8. As discussed in Section 8.5.6, there are no discharges of treated or untreated wastewater.
Changing fire regimes	The proposed PTP has the potential to increase the occurrence of bushfire in remnant vegetation on HHI. This has been assessed in Section 8.4.10, which identified that there are some vegetation communities on HHI that are vulnerable to increased bushfire risk, including the critically endangered coastal vine thicket. Other vegetation communities will benefit from a controlled burning regime. Management of bushfire will be addressed in the management of the proposed conservation area. Managed interfaces will be provided around the coastal vine thicket and other areas managed in accordance with recommended fire regimes. Controls will also be put in place to minimise accidental fires, including controls on cigarette smoking. Overall, with active management of fire regimes in vegetation communities to be included in the managed conservation area, there is likely to be an overall reduction in the threat of changing fire regimes.
Climate change	Climate change impacts on terrestrial biodiversity may arise from: • Increased temperatures • Reduced rainfall • More intense weather events • Sea level rise and incursion of salt water into freshwater systems. While the detailed responses of Australian plants, animals and ecosystems to climate change effects are not well understood, DEWHA noted that climate change effects "can disrupt seasonal food supplies and other resources, life cycle events, development, mortality, breeding and fertility, such that entire reproductive strategies become less successful" (DEWHA 2008). The proposed PTP will make very little contribution to climate change in terms of greenhouse gas emissions, and the introduction of an emissions trading scheme by the Australian Government provides an incentive to minimise greenhouse gas emissions. While any contribution that PTP might make to reducing per capita inputs of greenhouse gas emissions to the atmosphere is not, in itself, likely to reduce the impacts of climate change on ecological health and biodiversity, by managing and potentially reducing pressures from other sources, PTP may be able to improve the resilience of terrestrial ecosystems to the impacts of climate change. Various indirect effects of the proposed PTP on native vegetation and habitats on HHI have been identified and evaluated in Section 8.4 and where management is required, these measures have been identified and will be included in the management plan for the actively managed conservation area (see Section 8.3.8) and the Wildlife and Habitat Management Plan that is required for management of remnant vegetation and habitats within the proposed development footprint (see Section 8.3.9). These measures are expected to be effective in, as a minimum, avoiding increased pressures on terrestrial ecosystems and may in fact lead to improvement in the ecosystem health of terrestrial ecosystems on HHI. These management approaches will generally increase the resilience of ecosystems and habitats to climate change effects by removing or reducing threats such as weed invasion and predation. The proposed PTP will also include water management ponds that will be available for wildlife and may provide an effectively permanent source of water. Overall, while the biodiversity management approach proposed for the PTP will not reduce the threat of climate change itself, active management of remnant vegetation and habitats may increase resilience of these to climate change effects.

On the basis of the assessment in **Table 13.7**, it does not appear that the proposed PTP will contribute to existing threats to terrestrial biodiversity and active management of remnant vegetation and habitats on HHI may increase resilience of these areas to threats from climate change and extreme weather events. The proponent is required to, and is committed to, managing biodiversity within the footprint of the proposed PTP and on the balance of HHI as follows:

- An actively managed conservation area will be declared over the balance of HHI, including the remainder of the special lease, and a management plan will be developed for this conservation area to maintain and enhance biodiversity values
- A Wildlife and Habitat Management Plan will be developed for remnant vegetation and habitat within the PTP footprint.

13.5 Management and Monitoring of Cumulative Impacts

The assessment of the potential for the proposed PTP to contribute to cumulative impacts or exacerbate threats to the Great Barrier Reef ecosystem did not identify any significant contribution to cumulative impacts or existing threats. This is due to three key factors:

- MNES values present or represented on and around HHI are generally low to moderate, few highly important values
- The proposed PTP has been designed to avoid and minimise impacts on moderate and high importance MNES values
- Where impacts on MNES values cannot be avoided, the proponent proposes mitigation and management measures to avoid significant impacts.

The proponent therefore does propose any additional mitigation and management measures in relation to cumulative impacts over and above those already described in this environmental impact statement.

The proponent does recognise that population increases in the Gladstone Regional Council may lead to increased levels of recreational boating and fishing over and above that assessed in this environmental impact statement and that provision of a boat ramp at PTP will lead to local intensification of recreational boating activity. The proponent has committed to a number of education and awareness raising measures, and to having a speed limit imposed in key marine and coastal habitat areas. The proponent will seek to work with GBRMPA and relevant Queensland Government agencies with management responsibilities in relation to impacts of recreational boating and in particular will support management of compliance and associated behaviours of recreational boaters and fishers.

The proponent has also committed to supporting GBRMPA and Queensland DNPRSR to develop an area specific management plan for management of recreational boating impacts on waters around HHI if water quality and ecosystem health monitoring indicates that adverse impacts are arising due to intensity of use. Area specific management plans are a key management tool used by GBRMPA for management of intensively used areas (GBRMPA 2012).

The proponent is willing to participate in regional level monitoring program and to this end, if the proposed PTP goes ahead, will approach the Port Curtis Integrated Monitoring Program with regards to becoming a contributing member.

The proponent will also seek to work with GBRMPA, PCIMP and the Port of Gladstone in relation to marine and coastal monitoring activities so that data collected by the proponent is compatible and consistent with broader data collection approaches and can be shared and compared.

13.6 Consequential and Facilitated Impacts

13.6.1 Identification of Consequential and Facilitated Impacts

Consequential and facilitated impacts may arise associated with:

- Increased access to HHI and surrounding waters which in turn may allow activities to occur which are currently precluded
- Population increase
- Increase in demand for goods and services due to the proposed development.

13.6.2 Opportunities for Further Use and Development Arising from Increased Access

The assessment presented in Section 8 has identified that the proposed boat ramp will increase access to waters around HHI to recreational boating activity. Assessment of potential impacts is provided in Sections 8.7.6, 8.8.4, 9.3.4 (marine turtles), 10.4.4 (dugong) and 10.2.4 (migratory shorebirds). The conclusion of this assessment was that significant or unacceptable impacts on MNES were not expected, particularly given existing and proposed controls.

As discussed in Section 6.7, there has previously been a mineral sand exploration permit over part of HHI. The permit expired and no application for renewal has been made. Any future proposal to mine mineral sands on HHI would be subject to approval under the Federal EPBC Act and the Queensland *Environmental Protection Act 1994*. The Queensland *Environmental Protection Act 1994* would require an environmental impact statement to be prepared and it is to be expected that a similar level of assessment would be required under the EPBC Act given the location of HHI within the GBRWHA/NHP, and that much of the sand resource lies under the critically endangered coastal vine thicket ecological community. This assessment process would allow both Federal and State governments to assess the proposal and, if unacceptable impacts on the environment generally or MNES were identified as occurring, refuse to approve the action.

Pressure for other types of development on HHI is unlikely to arise. Outside the special lease, tenure is state land and this is therefore not available for development. Further, the proponent has committed to surrendering the remainder of the special lease and creating a conservation area across the balance of HHI. The Queensland Coordinator-General has made this a condition of approval and has also recommended that the Queensland minister for nature conservation declare the balance of HHI a conservation area under the Queensland *Nature Conservation Act 1993*. As outlined in Section 8.3.8, this would preclude further development on HHI.

While the proposed boat ramp at PTP will provide access to shallow tidal waters surrounding the island to trailerable boats, it will not provide access for larger vessels. The waters around HHI are shallow, with shifting sandbars and changing channels. These waters are not suitable for deep draft vessels and hence, increase in recreational use of the area by larger boats which require marina berths is not expected. Hence, a consequential increase in marina demand in the region is not expected.

13.6.3 Consequential Impacts of Population Increase

As discussed in Section12.2.1, the Gladstone Regional Council area is forecast to grow from a 2011 population of just under 60,000 persons to an estimated 112,000 persons by 2031 (OESR, medium series). The Queensland Office of Economic and Statistical Research estimates populations based on a range of assumptions including, for an area such as Gladstone, potential for major industrial and related projects.

It is not expected that population increase associated with the proposed PTP will trigger the need for development of any new community services or facilities that might in turn have adverse impacts on MNES. As discussed in Section 14.3.4, the proposed PTP makes a small contribution to the overall population growth forecasts, and population increase associated with the economic stimulation provided by PTP is not likely to outstrip the forecast population increase. Assessment and approval of the project by the Queensland Coordinator-General, in conjunction with Queensland Government Departments in areas of housing, health, education and community services did not identify any significant impacts on social and community services and facilities.

13.6.4 Increase in Demand for Goods and Services

Increase in demand for goods and services will arise due to the proposed PTP. Goods and services might include, for example, supply of food, beverages and souvenirs, recreational equipment, supply of operation and maintenance services, supply of cleaning services, supply of transportation services and supply of gardening and landscaping services.

Increased demand for goods and services is a benefit of the project as it will stimulate economic activity, however environmental impacts may arise if this results in substantial new development of facilities or premises associated with supply of goods and services in or close to environmentally sensitive areas.

As PTP is located close to a large population centre and also close to a National Highway, it is not anticipated that any potential suppliers of goods or services to the proposed PTP would seek to locate close to the proposed PTP in order to provide such goods and services. The proposed PTP is therefore not expected to become a node for future development.

Any increase in production arising from demand created by the proposed PTP would most likely occur in Gladstone or other existing centres. Given the scale of the proposed PTP in comparison to the existing population, it is unlikely that significant additional development related to production of goods required to service the proposed PTP will occur; rather, existing facilities may expand production. Expansions of existing production facilities, or new production facilities if required, would be subject to development approval requirements.

The proposed PTP will increase tourist numbers in the Central Queensland region. This may consequentially increase demand for commercial tourism activities in the GBRMP. As discussed in Section 8.8.3, commercial tourism activities in the GBRMP require a permit under the *Great Barrier Reef Marine Park Act 1975*. This permit system is administered by GBRMPA and this allows GBRMPA to consider sustainable tourism levels when assessing permits. Commercial tourism activities in the Mackay-Capricorn management area of the GBRMP are lower than in other areas (GBRMPA 2009), and any increases arising from the proposed PTP are expected to be well within sustainable limits. Increased demand for commercial tourism activities associated with the GBRMP will provide economic opportunities in the Gladstone region.

Gladstone already has a marina and associated facilities to support boat based commercial tourism and hence, an increase in demand for these activities is not likely to lead to a demand for further coastal or marine infrastructure.

Increased tourism numbers will also mean increased visitation levels at other tourist attractions in the region. A review of available and planned tourism attractions in the Central Queensland Tourism Opportunity Plan indicates that land based activities currently available are not likely to impact on MNES. Should new tourism activities centred on MNES be developed, these would potentially require assessment under the EPBC Act. The Central Queensland Tourism Opportunity Plan identifies that existing tourist activities are possibly underutilised, and the proposed PTP will also provide tourist and recreational activities as part of the development, hence significant new demand for tourism activities is not expected to arise. Consequential impacts on MNES from an increase in tourism related activities are therefore not expected.

Gladstone is well serviced in terms of private and public transport, including a commercial airport, train station and bus services which can provide access to the region for tourists. The proposed PTP is not expected to cause any increase in demand for these services.

SECTION 14
Social and Economic Issues

PACIFICUS
TOURISM PROJECT

Contents

14. Social and Economic Issues

14.1 Regional Profile

14.1.1 Demographic Profile

PTP is located on HHI, within the GRC area. Amalgamation of Gladstone City, Calliope Shire Council and Miriam Vale Shire Council occurred in 2008 forming GRC. GRC encompasses a diverse region with Gladstone City at its centre. The city is a port and industrial centre, with the social and community facilities expected of a major regional city.

The region contains a variety of residential areas, including Gladstone, satellite towns around the city, coastal tourism centres and rural and rural-residential communities. The main urban centres are:

- Gladstone is main urban centre of the region with a population of 35,000
- The twin towns of Tannum Sands and Boyne Island (population of 12,000) form a coastal community immediately south of Gladstone
- Calliope (population of 1,800) is a dormitory town, west of Gladstone City
- Agnes Waters and 1770 (population of 3,000) are coastal tourist centres 120 km south of Gladstone.

Other smaller centres include Benaraby (population 600) and Miriam Vale (population 360) to the south of Gladstone and Mount Larcom and the village of Yarwun to the north.

Other major regional centres in central Queensland are Rockhampton, with a population of 76,000, located 110 km to the north of Gladstone, and Bundaberg with a population of 71,000, located 160 km to the south.

In 2011 there were 57,891 people in GRC with 52% being male and 48% female. This is significantly different to the Queensland population breakdown of 49.6% males and 50.4% females (ABS Census 2011).

The GRC population has a higher proportion of people in the 25-44 and 45-64 age groups than the Queensland average. This is then reflected in a lower proportion of people aged 65+ years (Table 14.1). This profile is reflective of the employment opportunities in the region and the role it plays in provide an accommodation base for the industrial, port and resources sectors.

Table 14.1 – Age Profile – 2011 Census

Age group	Gladstone (%)	Queensland (%)
0-14 years	22.9	20.2
15-24 years	12.8	13.6
25-44 years	28.8	27.8
45-64 years	26.3	25.3
65+ years	9.1	13.2

Source: ABS Census, 2011

According to the 2011 Census, 20% of the people living in the region were born overseas, which is lower than the proportion of Queensland 26.3%.

The proportion of Aboriginal and Torres Strait Islander people in 2011 was 3.5% of the population (2,015) which is comparable to the state average of 3.6% (ABS Census 2011).

Since 2006 the unemployment rate in the region has fallen from 5.4 % to 4.5%, indicating that there is currently almost full employment in the region. The most common occupations are Technicians and Trades Workers 22.4%, Machinery Operators and Drivers 13.7%, Labourers 12.9%, Professionals 12.7%, and Clerical and Administrative Workers 11.6% (ABS Census 2011). This occupation profile identifies that proportionally there are significantly more Technicians and Trades Workers, Machinery Operators and Drivers, and Labourers in the GRC area than in Queensland. The median weekly personal, family and household incomes for the GRC area are all higher than the Queensland medians.

Gladstone's average household size has remained almost constant at 2.7 people per household

14.1.1 Community Facilities, Services and Infrastructure

Gladstone Regional Council continues to have problems providing equitable services across the region. Rapid population growth continues to have service demand impacts, particularly in the past 2 years with the commencement of construction of major coal-seam gas plants and the upgrading of Gladstone Harbour. There has also been inadequate state and federal government funding to support the commensurate growth in demand for services.

14.1.2 Local and District Shopping/Commercial and Community Facilities

A summary of local and district shopping/commercial and community facilities in proximity to HHI are outlined in Table 14.2.

Table 14.2 - Local Shopping and Community Facilities (by Location)

Miriam Vale Township	Bororen Village	Tannum Sands/Boyne Island
• Council office and Community Health Service • Tourist information centre • Community centre, bowling club, QCWA, golf course, park and oval • Police station • Primary school • Church • Post office, railway station and show grounds • Sporting oval • Parks and a playground.	• Primary school • Church • Post office, railway station and show grounds • Sporting oval and a playground • General store • Service station • Motel accommodation	• Banks: National, ANZ, Commonwealth and Westpac • Shopping centre including two major supermarkets • Takeaway food shops • Restaurants • Clothing stores • Post office, sports • Sports complex, bowling club, golf driving range, skate way centre • Tourist information centre • Parks and reserves

14.1.3 Emergency Services

The emergency and health services available in the Gladstone region are described in Table 14.3.

Table 14.3 - Services and Locations in the Gladstone Region

Service	Location
Emergency Services	
Queensland Ambulance Service	Miriam Vale, Agnes Waters, Calliope, Boyne Island, Gladstone
Emergency rescue helicopter	Bundaberg, Rockhampton
Police	Miriam Vale, Agnes Waters, Calliope, Gladstone, Tannum Sands
Fire and rescue	Miriam Vale, Calliope, Boyne Island, Gladstone
Volunteer fire and rescue	Agnes Water/1770, Turkey Beach, Tannum Sands, Bororen, Captain Creek, Colosseum, Rosedale, Wartburg, Foreshores and Lowmead
State Emergency Services	Miriam Vale and Gladstone/Calliope
Volunteer Marine Rescue	1770
Health	
Hospital	Gladstone Hospital
Community health service	Agnes Waters

14.1.4 Education Facilities

The region includes a number of educational facilities, including primary and secondary schools and tertiary education institutions. Table 14.4 shows primary and secondary schools in the region, with student enrolment numbers. There are 18 primary and preschools in the region offering education for students to Year 7. Three schools provide education for both primary and secondary students, and three schools provide education for secondary students, in Years 8-12.

Table 14.4 - Primary and Secondary Schools in the Gladstone Region

School Name	Preschool and Primary School Students (Prep-Year 7)	Secondary School Students (Year 8-Year 12)	Total Students
Agnes Water State School	267		267
Wartburg State School	65		65
Bororen State School	45		45
Lowmead State School	14		14
Rosedale State School	79	172	251
Miriam Vale State School	84	35	119
Tannum Sands State School*	634		634
Calliope State School	429		429
Boyne Island State School	323		323
Benaraby State School	142		142
Ambrose State School*	55		55
Yarwun State School	49		49
Ubobo State School*	26		26
Builyan State School	13		13
Nagoorin State School	7		7
Mount Larcom State School	65	50	115
Tannum Sands State High School		1,052	1,052
Kin Kora State School	765		765
Gladstone West State School*	729		729
Clinton State School*	688		688
Gladstone South State School	325		325
Gladstone Central State School	305		305
Rosella Park School (Special School)*	61		61
Gladstone State High School		1,072	1,072
Toolooa State High School*		965	965

* includes full-time and part-time student numbers
Source: Education Queensland (www.education.qld.gov.au)

Tertiary educational institutions include Central Queensland Institute of TAFE and Central Queensland University. While Central Queensland Institute of TAFE is expanding due to increasing demand, enrolment in Central Queensland University is relatively stable. The closest traineeship opportunities are available through local employers and are supported by neighbouring TAFE colleges and training bodies such as the Gladstone Area Group Apprentices Ltd.

14.1.5 Recreational and Cultural Facilities

A variety of recreational activities operate in the region, including fishing, bushwalking, scuba diving, netball, rugby league, little athletics, horse riding, cricket, motor-cross, tennis, and lawn bowls. Popular visitor and recreational activities include:

- Guided tours to the GBR and nearby wilderness areas
- 4W Driving and camping
- Shore, estuary and offshore fishing
- Beach swimming and surfing
- Snorkelling and scuba diving
- Exploring the townships and local hospitality
- Boating in the dugong sanctuary at Rodds Harbour.

Hummock Hill Island is a popular fishing and boating area, and is also used for camping. Recreational uses of the Island and surrounds are described in Table 14.5.

Table 14.5 - Location and Associated Recreational Activities

Location	Recreational Activity
Rodds Bay	Dugong sanctuary, migratory birds, national park, camping
Boyne Creek	Fishing, boating, dugong/ turtle/ bird sighting
Colosseum Inlet	fishing and crabbing, recreational boating, camping
Hummock Hill Island	Camping, fishing, recreational boating
Sandfly Creek	Camping, fishing, prawning
Seal Rock	Fishing, diving
Seven Mile Beach	Fishing
Wild Cattle Creek	Boat Ramp, Fishing

14.1.6 Tourism Facilities

Tourism is a key industry in the both the central Queensland and Gladstone regions (see Section 5). For the year ending June 2012 domestic overnight visitors spent $710 million, domestic day visitors spent $267 million and international visitors spent $81 million, totalling nearly $1.1 billion or $2.9 million/day

Standard visitor surveys conducted by Tourism Queensland found the most appealing aspects of the Gladstone region to be the beaches and water (30%), scenery and natural environment (15%), climate (13%) and quiet and peaceful area (11%). Key areas of interest for visitors include the southern GBR, including Lady Musgrave Island/Reef and Fitzroy Reef, and national parks (i.e. Deepwater National Park, Eurimbula National Park and Sir Joseph Banks Conservation Park).

The Gladstone region offers a range of tourist accommodation options, including resorts, hotels and motels, apartments and holiday homes, backpackers, and camping and caravan sites. These are mostly concentrated in Agnes Waters, 1770 and Gladstone. A limited amount of tourist accommodation is also available in Boyne Island and Tannum Sands.

There are 28 establishments in the region, with 15 rooms or more, offering 990 rooms as tourist accommodation. The majority of these are located in Gladstone and are primarily occupied by business travellers. There are also many accommodation establishments that offer less than 15 rooms (B&B, backpackers and apartments). A review of various tourist and holiday accommodation websites indicates that there are about 120 tourist accommodation establishments in the region.

Sixteen caravan and camping are located in the GRC area, including six in Gladstone.

14.1.7 Supply of Housing and Accommodation

There is currently a shortage of accommodation and rental housing supply in the Gladstone region. The pressure for housing is mainly due to population growth from the expansion of industries including the development of major coal seam gas projects in Gladstone. It is anticipated that over 9,000 additional allotments/entitlements will be required within GRC over the next 20 years.

Recent industrial development activity coupled with the desirability of Agnes Water/1770 and other regional locations, is currently contributing to escalating property prices, which can lead to housing affordability issues. Similar situations are also being encountered in regional mining centres as a result of increased workforce's service the requirements of the resource boom.

The rural areas of GRC are also susceptible to the effects of rapid growth pressures such as social displacement and the subsequent implications for local housing markets. The loss of accessible, affordable housing and shortages of rental accommodation is a major social issue in Gladstone. Dwelling approvals have increased dramatically in the last 4 years. In Gladstone Regional Council area there were 1,110 residential buildings approved to be built in the financial year 2011-12 (http://profile.id.com.au/gladstone/building-approvals accessed 30 April 2013). Construction can take up to 12 months in the Gladstone area once subdivision is approved, due to the shortage of skilled construction sub-contractors. Increases in stock notwithstanding, housing supply in the Gladstone region is under intense pressure.

14.1.8 Access and Mobility

The Bruce and Dawson Highways service the local and regional road network. Gladstone is situated approximately 15 km from the Bruce Highway. Boyne Island, Tannum Sands and Miriam Vale are located approximately 20 km, 25 km and 70 km south of Gladstone respectively. Calliope, approximately 20 km southwest of Gladstone, is accessible via the Dawson Highway. The extensive road network into Gladstone provides three access points to the Bruce Highway and extractive industry areas of central Queensland.

Queensland Rail operates daily services from Brisbane to Maryborough and Bundaberg, with links to the hinterland including Miriam Vale which is also serviced by the Tilt Train. Major airports servicing the region include Gladstone and Rockhampton. These provide regular passenger and freight flight connections to Brisbane, Sydney, Melbourne, Mackay, Townsville and Cairns.

Community consultation as part of the preparation of the Gladstone Region Community Plan (GRC 2011) indicated community desires for improved public transport between townships in the immediate vicinity of HHI, in particular Turkey Beach, Baffle District and the Rosedale, Lowmead and Berajondo areas. Improved daily public transport to Gladstone and Bundaberg were also identified as important, to enable improved mobility and commuter access for residents in Miriam Vale, Agnes Water and 1770.

School transport was also identified as an issue. Education Queensland currently provides free school bus services for school students (up to year 10) in the Turkey Beach and the Foreshore's area to the nearest state school. These include Bororen State School (Turkey Beach) and Miriam Vale High (Foreshore's area). Many families are also sending children to schools in Tannum Sands. A private bus company current runs this school bus route, however parents have indicated a desire for Education Queensland to consider providing bus services to these schools.

Other transport issues that received a strong community response during Council's community consultation process for the Gladstone Region Community Plan and included:

- Need for improvement to and upgrading of inter-township roads (i.e. sealed, all weather standard)
- The need for a link road connecting Turkey Beach to Agnes Water
- Need for local pedestrian and cycle networks, including national park trails (GRC 2011).

14.1.9 Local Communities

Hummock Hill Island is 40 minutes by road from the major regional centre of Gladstone. The only road access to the Island is from the Bruce Highway via Turkey Beach Road, Foreshores Road, Clarkes Road and over a causeway across Boyne Creek. The causeway is only trafficable on low spring tides.

The communities closest to the Island are:

- A rural residential subdivision of about 20 homes (Foreshores Estate) at the end of Foreshores Drive
- Holiday houses at Bangalee on the northern side of Colosseum Inlet
- A small settlement of around seven dwellings at Mundoolin Rocks east of Clarks Road.

The nearest townships to HHI are:

- Turkey Beach, a small coastal community, 25 km east of HHI, with about 200 permanent residents, a general store and public boat ramp

- Bororen on the Bruce Highway 20 km from HHI, which has a shop and a service station.

A farming community of 600-700 families resides within a 20 km radius of the project.

There is an extensive network of volunteer and special interest groups in the surrounding areas. These include marine rescue groups, tourism, commerce, environmental, community progress associations and ratepayer groups. Other interest groups include social clubs, dance groups, quilting and craft, seniors' organisations, Country Women's Association and Landcare.

14.2 Consultation

14.2.1 Previous Consultation

14.2.1.1 Stakeholders

During the preparation and display of the EIS for the HHID (2005-2007) an extensive community consultation program was undertaken. The program:

- Notified the community that the EIS had been lodged for assessment by the Queensland Coordinator-General and call for written submissions on the EIS by community members
- Provided information to stakeholders and community members to enable their review of the EIS and project reference design
- Obtained input from local councils, Queensland Government and Commonwealth agencies on the EIS
- Satisfied the statutory requirements of the SDPWOA in relation to the exhibition of the EIS and invitation for written submissions.

Consultation was focused on the local and regional communities surrounding the Island, as well as key stakeholders. The 'affected' and 'interested' stakeholders consulted are detailed in Table 14.6.

Table 14.6 - Stakeholders

Stakeholders	Profile
Residents and landowners surrounding HHI	• Property owners along access roads including Turkey Beach Road, Foreshores Road, Clarks Road, Intrepid Drive • Nearby Foreshores and Turkey Beach communities and Mundoolin Rocks property
Local Government	• Gladstone City Council • Miriam Vale Shire Council • Calliope Shire Council • Gladstone Regional Council
Emergency Services	• Department of Emergency Services: o Queensland Ambulance Service o Queensland Fire & Rescue Service o Disaster Management o Emergency Management Queensland – Helicopter Services

Stakeholders	Profile
	o Volunteer Marine Rescue • Queensland Police Service
Members of Parliament	• State Member for Gladstone • Federal Member for Hinkler
Commercial Fishers	• Owners of commercial fishing licences operating in and around HHI
Recreational Groups	Recreational fishing clubs using the area in and around Hummock Hill Island for recreational purposes: • Gladstone Sports Fishing Club
Central Queensland Regional Community	The broader central Queensland community with an interest in the development, its potential impacts and residential and tourism opportunities
Environmental Groups and Organisations	Local environmental groups with an interest in the development: • Agnes Water Landcare • Baffle Creek Catchment Management Group • Capricorn Conservation Council • Curtis Coast Environmental Protection Association • Gladstone Region Local Marine Advisory Committee • Miriam Vale Rural Science and Landcare • Tannum Boyne Coastcare
State Government Departments and Agencies	These agencies and departments have input to the project, for example project approvals, or where aspects of the project impact their areas of jurisdiction: • Environmental Protection Agency • Department of Primary Industries and Fisheries • Department of Natural Resources and Water • Department of State Development • Department of Main Roads
Commonwealth Government Departments and Agencies	Department of the Environment and Heritage/Department for the Environment and Water Resources/SEWPaC
Schools	Schools in the immediate catchment of Hummock Hill Island include: • Bororen State School • Miriam Vale State School
Business / Industry	• Gladstone Economic and Industry Development Board • Gladstone Port Authority
Indigenous Groups, Traditional Owners	These groups include Aboriginal parties (Gidarjil) with an interest in HHI. The Gidarjil people have been involved in the development of the CHMP
Other	• Gladstone Aerodrome • Surf Lifesaving Queensland • Miriam Vale Tourist Information Centre • Gladstone Area Promotion and Development • Discovery Coast Community Health Service

14.2.1.2 Consultation Process

A three-tiered consultation approach was undertaken incorporating:

- Key stakeholders identified via a desktop study and initial interviews with elected representatives and referral agencies
- All ‘affected’ and ‘interested’ persons offered the opportunity to participate in the study
- Feedback collated and considered in conjunction with the relevant technical contact.

Consultation will continue into the detailed planning, design, construction and operation phases of the PTP.

14.2.1.3 Communication Mechanisms

The consultation strategy established a number of communication mechanisms to inform key stakeholders about the development and seek their input into the EIS. The key communication tools used were:

- Face-to-face meetings with ‘affected’ and ‘interested’ persons
- Advertisements and media activity in key local, metropolitan and national news media
- Newsletters and fact sheets
- Information and feedback tools including project website, freecall 1800 number, reply paid mail service and project email
- Public displays
- Meetings with relevant advisory bodies.

A range of communication and consultation activities were undertaken with community members and stakeholders to assist their review of the EIS. These included:

- Hard copies of the EIS were distributed to local government offices at Miriam Vale, Calliope and Gladstone and libraries at Miriam Vale, Calliope, Gladstone and Boyne Island
- Publication of the EIS on the HHI Development website, CD copies (available free of charge) and hardcopies of the EIS (available for purchase)
- Advertisements were placed prior to the public displays, three appeared in the Bundaberg News Mail, two in the Gladstone Observer, and in The Australian
- 6000 letters inviting the community and stakeholders to the public displays were delivered to residents in the Miriam Vale and Calliope districts
- Access to information and feedback tools including the HHI Development website, freecall 1800 number, reply paid mail service and project email
- Information sessions were held during the public consultation period
- Briefings to local councils, Queensland and Commonwealth Government agencies.

14.2.1.4 Individual Meetings

A number of meetings of approximately 30-45 minutes duration were held with 'affected' and 'interested' persons to discuss any individual concerns, gain an understanding of any potential impacts and to discuss potential mitigation options. The people consulted and their issues were documented and issues raised have been addressed in the EIS.

The stakeholders identified in Table 14.7 were identified and contacted for individual consultation meetings.

Table 14.7 - Stakeholders Contacted for Individual Meetings

1)	Agnes Water Landcare	16)	Gladstone City Council
2)	Baffle Creek Catchment Management Group	17)	Gladstone Economic and Industry Development Board
3)	Calliope Shire Council	18)	Gladstone Port Authority
4)	Capricorn Conservation Council (written comment)	19)	Gladstone Region Local Marine Advisory Committee
5)	Commercial fishers - Gary & Brad Otto	20)	Gladstone Sports Fishing Club (contact provided by Sunfish Queensland)
6)	Curtis Coast Environmental Protection Association	21)	Miriam Vale Rural Science and Landcare
7)	Department of Education, Training and the Arts	22)	Miriam Vale Shire Council
8)	Department of Primary Industries and Fisheries	23)	Miriam Vale State School
9)	Department of Natural Resources and Water	24)	Miriam Vale Tourist Information Centre
10)	Discovery Coast Community Health Service	25)	Queensland Ambulance Service
11)	Emergency Management Queensland – Helicopter Services	26)	Queensland Fire and Rescue
12)	Emergency Services – Disaster Management	27)	Queensland Police Service
13)	Environmental Protection Agency	28)	Surf Lifesaving Queensland
14)	Gladstone Aerodrome	29)	Tannum Boyne Coast Care
15)	Gladstone Area Promotion and Development Limited	30)	Volunteer Marine Rescue

14.2.1.5 Direct Mail Correspondence

'Affected' persons in the immediate vicinity of HHI were sent personalised, addressed mail on 16 April 2007 providing information on the project and the EIS process. The letter extended an invitation to the public display at Turkey Beach on Saturday, 21 April 2007 and also included a map of the Island with a concept plan overlay.

A total of 194 landowners in the following locations were sent direct mail correspondence:

- Turkey Beach Road
- Foreshores Road
- Clarks Road
- Intrepid Drive
- Bells Road
- Harbour Drive

14.2.1.6 Advertisements

Advertisements for the draft Terms of Reference were placed in The Courier Mail, The Gladstone Observer and The Australian newspapers on 18 November 2006. The advertisement was organised by the Coordinator-General and included information on the project and how to make comment on the draft Terms of Reference. The advertisement included relevant contact details within the office of the Coordinator-General.

Advertisements to support the planned public display at Turkey Beach on 21 April 2007 were placed in the Public Notice section of The Gladstone Observer and The Morning Bulletin from Wednesday, 18 April 2007 to Saturday, 21 April 2007.

14.2.1.7 Media Activity

A press release was distributed to central Queensland media (print and electronic) on Thursday, 19 April 2007 to publicise the development and the impending public display on Saturday, 21 April 2007 at Turkey Beach. The development and public display was covered by local news service WIN News (Rockhampton) as part of its 6pm bulletin on 19 April 2007.

14.2.1.8 Community Enquiries

The public consultation program included feedback avenues via telephone (freecall 1800 number), letter (reply paid), email and website (www.hummockhill.com.au). Enquires received are detailed in Table 14.8.

All feedback has been documented in an online communication database throughout the life of the development. Consultation staff continued to respond to any enquiries about the development and the EIS process between Phases 1 and 2.

Table 14.8 - Enquiries Received

Correspondence Type	Count
Public display enquiry	32
Meeting	13
Feedback form	9
Project enquiry line (1800 number)/telephone call	9
Email	6
Letter	4
Website sessions (online traffic/volume)	574

A summary of project website usage and downloads, between May and October 2007, is provided in Table 14.9.

Table 14.9 - Website Usage

Type	Total
Number of visitors to website (sessions)	574
Number of hits recorded	2,847
Number of .PDF files downloaded	101
Number of times "EIS Process" PDF downloaded	25
Number of times "EIS Draft Terms of Reference" PDF downloaded	52

14.2.1.9 Advisory Agency Briefing

Advisory Agencies (Table 14.10) were invited by the Coordinator-General to attend a briefing about the project on 13 December 2006 in Gladstone.

Table 14.10 - Advisory Agencies

1) Department of Communities	11) Department of State Development, Trade and Employment
2) Department of Education, Training and the Arts	12) Department of Transport
3) Department of Emergency Services	13) Environmental Protection Agency
4) Department of Health	14) Queensland Police Service
5) Department of Housing	15) Department of Environment and Water Resources
6) Department of Local Government, Planning, Sport and Recreation	16) Miriam Vale Shire Council
7) Department of Main Roads	17) Calliope Shire Council
8) Department of Mines and Energy	18) Civil Aviation Safety Authority
9) Department of Natural Resources and Water	19) Air Services Australia
10) Department of Primary Industries and Fisheries	

14.2.1.10 Public Displays

Approximately 60 people attended the first public display on Saturday, 21 April 2007 during preparation of the Draft EIS, The display was held at the Turkey Beach Rural Fire Brigade. The venue was selected following discussion with Miriam Vale Shire Council on the most appropriate location to target 'affected' and 'interested' persons. SKM consultation staff and the proponent were available to discuss the project and to provide additional information to visitors in an informal and relaxed environment.

The public display material included:

- An aerial photo of the site of the development and concept plan overlay including lease and environmental boundaries
- A map of the Island delineating land use and key areas of development
- Posters providing details on the project, the EIS process, environmental management and approach to project sustainability.

The second series of public displays, held during while the Draft EIS was on public display in January 2008, were located to engage as many stakeholders as possible. The displays were held at:

- Turkey Beach Rural Fire Brigade – Tuesday, 22 January 2008
- Miriam Vale Community Centre – Wednesday, 23 January 2008
- Benaraby Progress Hall – Thursday, 24 January 2008.

Advertisements were placed prior to the public displays, including three in the Bundaberg News Mail and two in the Gladstone Observer. 6000 letters inviting the community and stakeholders to the public displays were delivered to residents in the Miriam Vale and Calliope districts.

Nineteen people attended the staffed public displays, with a further five people seeking out the Draft EIS document at Gladstone Library, Gladstone City Council and Calliope Libraries.

The public displays were designed to allow the consultation staff and the proponent to discuss and present information on the development and to answer questions in an informal and relaxed environment. The materials used at the public display were designed to support the EIS by providing stakeholders with information about the Development as well as encouraging their involvement in the EIS process. The public display materials included:

- An aerial photo of the site of the development and concept plan overlay including lease and environmental boundaries
- A map of HHI delineating land use and key areas of development
- A series of nine posters providing details on the development, the EIS process, environmental management and outcomes of the Draft EIS
- A map of the 'Town Centre Precinct'
- A map of the Golf Course or 'Open Space Precinct'

- A map of the 'Village Centre Precinct'
- Copies of the Draft EIS.

Although there was not a high degree of community response to this round of public displays, the comments received reflected support for the project and interest in the future development.

14.2.1.11 EIS Submissions

Thirty-eight submissions were received by the Coordinator-General in response to the public displays and the Draft EIS. Of these submissions, nineteen were from government agencies or local Councils, fifteen were from individuals, three were petitions and one was from a non-government organisation. The list of submitters is provided in Table 14.11.

Table 14.11 – EIS Submissions Received

Submission Number	Submitter	Submission Number	Submitter
1	Civil Aviation Safety Authority	20	L. Woodsworth
2	Civil Aviation Safety Authority	21	Petition – multiple submitters
3	R. Woodburges	22	Petition – multiple submitters
4	P. Higgins	23	Petition – multiple submitters
5	J. Munn	24	Burnett Mary Regional Group
6	T. and S. Andreata	25	Environmental Protection Agency
7	K. Petrie	26	Department of Mines and Energy
8	I. Simmons	27	Department of Education Training and the Arts
9	Curtis Coast Environmental Protection Association	28	Department of Primary Industry and Fisheries
10	Department of Housing	29	Department of Main Roads
11	J. Arens	30	Queensland Transport
12	Department of Housing	31	Department of Natural Resources and Water
13	R. Robinson	32	Queensland Health
14	R. Woodburgess	33	Department of Communities
15	B. Atfield	34	Gladstone City Council
16	C. Atfield	35	Department of Environment, Water, Heritage and the Arts
17	G. Atfield	36	Calliope Shire Council
18	N. Atfield	37	Miriam Vale Shire Council
19	D. Atfield	38	Department of Emergency Services

The key issues raised in the submissions received about the HHI EIS were:

- The sequence of development in the local region
- Impact of increased boating activities including boat strike to turtles and dugong
- Clearing of coastal dunes
- Stormwater runoff and impacts on marine habitats
- Extent of clearing of native vegetation
- Habitat fragmentation
- Provision of essential services
- Anthropocentric impacts on native fauna species.

A Supplementary EIS Report was prepared that:

- Provided comments and clarification of the HHI Development description in the EIS
- Summarised the submissions and provide technical responses to the issues raised in the submissions
- Provided conclusions with regards the key issues raised in the submissions
- Provided recommendations to the Coordinator-General in relation to the development.

The majority of consultation with ‘affected’ and ‘interested’ persons elicited positive responses and general support for the proposed development. Where issues were identified, the proponent addressed these issues and described impact mitigation measures.

Key outcomes from the public consultation process achieved the initial objectives including:

- Opportunities for ‘affected’ and ‘interested’ persons to contribute to the process
- Provided qualitative measures of community support and relative levels of concern about particular issues
- Assisted the EIS project team to understand and respond to community issues where necessary
- Captured feedback and incorporated into the environmental assessment and proposed mitigations.

The current PTP proposal is for a very similar tourism project to the HHID proposal already approved by the Queensland Government. The two projects are of similar spatial extent and have similar infrastructure, tourism components and residential facilities. The issues raised by respondents during the community consultation program for HHID are considered to be valid for the PTP.

The consultation that commenced in 2005 will be continued for the remainder of the development program for the PTP. This program includes detailed planning, design, construction and operation of the project.

14.2.2 PTP EPBC Act EIS Consultation

The Draft EIS for PTP was made available for public comment from 16 December 2013 to 24 January 2014. Access to the Draft EIS was made available as follows:

- A printed copy was placed at the State Library of Queensland, Cultural Centre, Stanley Place, South Bank Brisbane
- A printed copy was placed at Gladstone Regional Council offices, Goondoon Street, Gladstone
- The Draft EIS was available for download at http://www.pacificus.com.au
- Printed copies of the Draft EIS were made available for purchase and electronic copies were made available free of charge and could be obtained by telephoning a free-call number, or emailing an information request to the proponent.

As of the closing date for public comments, submissions had been received from:

- Gladstone Regional Council
- Dillons Lawyers on behalf of the Port Curtis Coral Coast (PCCC) registered native title group.

Copies of submissions are provided in Appendix J. Amendments have been made to this EIS in response to comments made by Gladstone Regional Council, and cross referencing is provided against the comments in Appendix J to show how these comments have been addressed. The submission from PCCC did not require any amendments to the EIS as the comments were in relation to the existing Cultural Heritage Management Plan rather than matters of national environmental significance.

The comments did not identify any impacts on MNES that had not already been addressed in the EIS, nor did consideration of the comments lead to any changes in overall conclusions as to the significance of impacts on MNES values. Some clarifications were made in response to comments received from GRC.

14.3 Social Impacts

14.3.1 Consultation Outcomes

Consultation undertaken for the HHID EIS identified the following issues in relation to potential social impacts:

- Potential for increased traffic on existing roads, including Turkey Beach Road, Foreshores Road and Clarks Drive, and the need for speed limits (road and water) to minimise wildlife accidents
- Potential impact of aircraft noise on nearby residents
- Possible degradation of landscapes and visual amenity
- Loss of open space and recreational opportunities on and around the Island, including fishing, and camping

- Capacity of schools and community facilities, including health facilities, to meet the demands of an increased population
- Access for and provision of emergency services
- The need for a mixed range of residential housing and/or lots to be provided which cater for varying levels of affordability
- Potential for adverse impacts on the local housing market, which is already under pressure.

A number of benefits relating to the project were also identified during community consultation:

- Potential for improved access to and utilisation of HHI
- Potential for increased property value for nearby landowners
- Improved tourism and recreational opportunities
- Increased residential development to support employment growth in the region
- Potential employment opportunities for local residents during the construction and operation phases of the project.

14.3.2 Impact on Local Community Values and Lifestyles

A total of 194 landowners were identified in locations closest to HHI, including at Turkey Beach Road, Foreshores Road, Clarks Drive, Intrepid Drive, Bells Road; and Harbour Drive. These included permanent residents and property owners using their properties for holiday accommodation (either for themselves, or for a small proportion, to tourists).

Community values in the area surrounding HHI, as identified through the EIS consultation process, relate to the area's natural assets, community lifestyle including access to quiet townships and local social networks, and access to extensive natural recreational areas. HHI has a high frequency of visits from local community members, for recreation activities such as camping and fishing.

The PTP would change the access to and recreational use of HHI and the nearby coastline during construction, and intensify the level of activity in the area. This is not expected to affect community networks and cohesion in existing coastal settlements, but may impact on the quiet lifestyle of existing residents. During construction, recreation access to the island and parts of its coastline may be inhibited.

The upgrade of Clarks Road would not directly impact properties, however, the upgraded road would improve access for properties on Clarks Road.

In the longer term, the project would improve the range of facilities available to nearby residents, including retail and hospitality outlets for their use, and contribute to economic vitalisation in the immediate area. The Island community is expected to retain a 'small-town' coastal lifestyle with the convenience of access to a range of community services and facilities, including recreation, retail, emergency services, community hall and meeting places.

PTP community would have particular characteristics, including a higher than the Queensland average proportion of people aged over 65 years, and a proportion of short-stay residents and long stay visitors. As such it would be important to encourage participation by new residents and where appropriate, visitors, in the development of social networks, community facilities and community events, to encourage a sense of community. It would also be important to encourage participation by other local and regional residents in island events and activities, to build a wider sense of community and inclusion. This will be achieved in part through the provision of social and community infrastructure as part of the PTP.

The project is planned to be an open community (as opposed to a gated community) allowing public access to all parts of the Island to create an inclusionary atmosphere.

The project includes redevelopment of the Island's grassed airstrip to accommodate private single turboprop aircraft. Less than six aircraft movements a day are anticipated for this facility. Noise issues associated with aircraft movements are discussed in Section 6.8.

14.3.3 Impact on Properties and Business

There are no existing houses on Hummock Hill Island, and therefore no direct impacts to any dwellings.

The project will provide a range of options for holiday properties and houses for permanent residents, as detailed in the Section 2. The PTP would increase the availability of residential properties in the area and provide existing local residents with access to a range of residential property options, including affordable units through to high value headland homes.

It is expected that the PTP would benefit existing landowners in adjacent areas through increases in equity and/or land values of existing properties. However, an increase in property prices in the vicinity of the project may impact on housing affordability for prospective property owners. This may reduce opportunities for entry into the property market, particularly for lower income earners.

A number of existing tourism businesses, including accommodation providers, are located in the region, including Agnes Water/1770 and Tannum Sands. The project would increase competition for these facilities. However, it is proposed that the PTP would offer a range of different tourism products currently not available within the region, improving the range of options available to visitors. The consultation process indicated that local residents are supportive of the additional tourism facilities to be provided by the PTP.

Existing commercial crab fishing operations may be impacted by the project through increased competition from recreational fishers, due to improved access through the construction of boat ramps on the island. However, some commercial fishing operators have also identified possible businesses opportunities arising from increases in the number of tourists, including the provision of recreational fishing services and facilities.

14.3.4 *Impact from Increased Local Population*

HHI has been designated for development since the Special Lease SL 19/52155 was issued in 1991. The SL issued in 1991, gives the proponent the potential to develop the land for business, industrial, commercial, residential, tourism and recreational purposes on the proviso that an environmental impact statement is prepared to address potential impacts and demonstrate that impacts can be managed. The composition of PTP reflects the range of uses envisaged under the Special Lease comprising a mix of tourist and permanent residential accommodation and associated facilities. The project was declared a significant project in 2006 and the proposed development on HHI has also been envisaged in the Central Queensland Tourism Opportunities Plan which was released in 2009. This plan was prepared in consultation with stakeholders such as State government agencies and Gladstone Regional Council that might be required to allow for the associated population increase in forward planning.

The estimated HHI island population to full development is detailed in Table 14.12.

Table 14.12 – Expected Population of PTP

People	2017	2025	2030
Permanent Residents	45	615	1,210
Tourists/short stay residents	280	2,160	2,740
Total	325	2,775	3,950

The tourist and permanent residential accommodation mix was proposed and approved as part of the State EIS for the HHID with a total of 790 dwellings permitted with the percentage of these available for permanent residents not to exceed 30%. This mix has been specified in Schedule 2 Condition 1 of the Queensland Coordinator-General's Report (February 2011). The businesses created as part of PTP are expected to employ around 700 people who will be offered the opportunity to own a dwelling and live on the island. As a comparison Hamilton Island has 1,500 permanent residents and accommodation for 3,500 tourists.

The increase in the population within the GRC area resulting from the full development of PTP represents only 3% of the current median forecasts of population growth in the region. As noted above, the concept of development on HHI is longstanding, and this provides opportunity for agencies responsible for planning for population growth to take the PTP into consideration.

In particular, a new Gladstone Planning Scheme is being prepared and is expected to be released for public comment in m id-2014 and finalised in mid-2015. As the Coordinator-General's Report was issued in February 2011 granting state approval there has been an opportunity for GRC to incorporate HHI in its calculations for growth in the proposed new planning scheme.

Social impacts associated with infrastructure and service provision are discussed further in the following sections. Environmental impacts associated with the increased population are addressed throughout the EIS, and particularly in Sections 8.4.6, 8.4.7, 8.4.8, 8.4.10, 8.4.11, 8.5.15, 8.5.16, 8.6.3, 8.6.4, 8.7, 8.8, 11.4.4 and 12.2.

The PTP population is likely to add to the population base from which volunteer workers and community group members can be drawn, and increase the vitality of community organisations and networks.

14.3.5 Impact on Indigenous Community Values

Hummock Hill Island is an important landscape for local Indigenous people, due to the cultural values that are attached to it, including dreaming stories and ceremonies.

Sites on HHI were found to have Indigenous artefacts and markers during Cultural Heritage surveys for the project (Section 6.10). While uses of these sites are infrequent, access is important to local Indigenous people. A CHMP has been developed to protect significant Indigenous sites, and the master plan for the development has taken these areas into consideration.

Opportunities exist during both the construction and operation phases for training and employment initiatives for local Indigenous people. Skills and experience gained in this process would be transferable to other projects in the region, such as in the Gladstone State Development Area and the wider construction industry.

Consultation with existing Indigenous businesses and enterprises will be undertaken to identify opportunities for local Indigenous people in the construction and operation phases of the project. An Employment and Training Strategy will be prepared to identify the skills required for construction and operation and trainings needs to enable local employees to gain the necessary skills. This will include strategies to maximise employment and training opportunities for local Indigenous people.

14.3.6 Impact on Workforce and Employment Opportunities

The development of the major infrastructure and urban services is projected to occur over a 16 year period, commencing in 2015. This would include construction of including roads, access bridge, water supply, sewerage, storm water systems, solid waste facilities, power supply, golf course, boat ramp and maintenance facilities. Construction of all buildings is also expected to be completed within this period, including hotels, resort and permanent accommodation retail and commercial buildings, research centre and cultural centre.

The PTP is expected to generate direct and indirect employment opportunities during both the construction and operation phases.

It is estimated that construction will generate an average of 260 direct and indirect jobs per year, and a peak employment of 460 persons (see Section 2.8.7). At a State level, the project is estimated to directly and indirectly generate almost 4,700 person years of employment in construction, with an average of 300 jobs per year, and a peak employment of 550 persons. Employment opportunities expected to be generated during construction include both skilled and unskilled positions, including in engineering design, construction supervision and trades, earthmoving, equipment operation, transport and building and landscaping.

Following construction, employment opportunities would also arise from tourism and commercial activity generated by the project. It is estimated that the number of created directly and indirectly by the PTP is expected to rise steadily to the peak level in 2025, in the order of 700 persons. At a state level, the tourism expenditure is estimated to directly and indirectly generate up to 850 jobs per annum by 2025. Employment opportunities generated during the project's operation are expected to include administration and management (i.e. resort and facilities management), service-orientation (i.e. hospitality, retail, tourism operators), environmental management and landscaping.

Construction workers are likely to be sourced within the region. There is currently strong competition for skilled and semi-skilled workers throughout the region, particularly from Gladstone industrial development and mining industries. However by 2015 demand for workers on the current major industrial projects in Gladstone will be reducing and skilled tradesmen and unskilled should be available for the project construction.

The proponent will undertake skills training opportunities during construction, and facilitate a range of business and employment opportunities following construction within the village/town centres and resort facilities. It is anticipated that employment options available as a result of the project during both construction and operation would increase job opportunities, employment diversity and training opportunities in the area.

14.3.7 Impacts on Housing and Accommodation from Project Construction

The Miriam Vale, Gladstone and Calliope region is currently experiencing significant housing shortages resulting from increases in population and economic growth associated with the mining, port development, and manufacturing sectors, with this being reported extensively in local media (examples include http://www.abc.net.au/news/2012-05-25/housing-shortage-worsens-in-gladstone/4034512, http://www.gladstoneobserver.com.au/news/housing-shortage-hits-youth/1361459/ and http://www.gladstoneobserver.com.au/news/gladstone-on-the-brink-of-a-housing-shortage/519646/).

The lack of affordable housing and rental housing is a matter of concern for Queensland housing and local community groups. Housing supplies in the region are inadequate to meet the growing needs of the population, particularly housing provision for low income households.

Maximising the use of local labour would help to minimise the influx of workers during construction and minimise impacts on the local rental housing market, and subsequent impacts on low income households. However, the existing availability of appropriately skilled and qualified workers, may impact on the ability for construction workers to be sourced locally. Early consultation with local accommodation providers should be undertaken to ensure that accommodation demands can be managed, particularly during peak tourist times, such as the Easter and Christmas holiday periods in Miriam Vale and the winter months in Gladstone.

An Accommodation Management Strategy will be prepared in consultation with the Department of Housing to ensure that adequate housing is available for construction workers and their families, and to ensure that potential housing-related impacts on the broader community are appropriately managed. The Accommodation Management Strategy will consider the timing and development of other major projects in the region to ensure that the cumulative impacts on housing are managed in a coordinated manner. The Accommodation Management Strategy will also consider the need for the provision of a worker village, to meet the housing demand of the project's construction.

In the longer term, surrounding areas have considerable capacity to expand housing development to meet future workforce demand in the region. This capacity is contained in a number of other residential developments currently being developed or proposed in southern part of the GRC area. These include residential subdivisions at Turkey Beach and "Foreshores" estate. It is likely that the construction workforce would contribute to demand for and potentially accelerate the rate at which subdivisions are brought to the market.

14.3.8 Impacts Housing and Accommodation from Project Operation

The PTP will provide a small net increase in residential land in the area. Based on the medium PIFU projected dwellings by local government area, it is anticipated that over 20,000 additional dwellings would be required for the GRC area over the next 20 years (OESR 2011). The project is planning to develop a mix of housing options which can be taken up for permanent accommodation with a range of dwelling types would cater to a variety of needs and affordability.

It is estimated that the number of jobs created directly and indirectly by the PTP is expected to rise steadily to the peak level in 2025, in the order of 700 persons. It is anticipated that the operational staff would be sourced locally, either from residents living within the development or within the region. It is expected that housing provided by the project would meet the housing demands of operational staff that may relocate to the area. Maximising the use of local labour would help to minimise the number of workers required to relocate to the region, and minimise impacts on the local rental housing market. It is expected that incorporation of affordable housing within the project would meet the housing demands of operational staff that relocate to the area.

As the PTP will generate the need for permanent accommodation on the island and will also supply the accommodation, it is not expected that the project will impact on the wider accommodation needs of the region.

14.3.9 Impacts on Tourist Accommodation

The construction phase is expected to result in a level of increased demand for temporary accommodation options, such as motels, apartments and other guest accommodation, in localities close to the HHI worksite. However the extent of this temporary accommodation required will be minimised through the use of local labour. The use of some of the available, under-utilised tourist accommodation for temporary workforce accommodation would provide some economic benefits for accommodation owners by providing a base load demand. The small part of the workforce required to be housed in temporary accommodation would also increase demand for goods and services to local businesses such as local shopping, personal and related services, and entertainment and leisure facilities.

Early consultation with local accommodation providers and tourism development associations will be undertaken to ensure that demands on tourist accommodation can be appropriately managed, particularly during peak tourist times, such as the Easter and Christmas holiday periods in Miriam Vale and the winter months in Gladstone.

Tourist accommodation with beach access in the region is limited to Agnes Waters/1770 and Tannum Sands. Outside these centres the range of available tourist accommodation that satisfies the preferred activities of tourists and has easy access to key transport routes such as the Bruce Highway, is very limited.

Upon completion the PTP will provide a range of tourism accommodation options over a range of affordability, including camping grounds, caravan parks, holiday apartments, a five star hotel and resort/ convention centre. This would increase the range of tourist accommodation options in the region.

14.3.10 Impacts on Community Services and Facilities

14.3.10.1 Construction

Potential impacts on community services and facilities could occur as a result of an increase in population during the construction phase, with workers relocating to the area, however, it is anticipated that the majority of the workforce will be sourced from the region.

An increase in the population during the construction phase could increase demand for these services and facilities, placing additional pressure on existing services and potentially impacting service levels, however the number of new individuals and families moving to the region is anticipated to be minor. Consultation will be undertaken with relevant Queensland Government departments, GRC and community service providers prior to construction commencing.

An increase in the number of children in the region as a result of the construction workforce could impact on child care services and local schools, particularly smaller schools in the area. However the construction workforce will be sourced within the region to the maximum extent and therefore impacts on education should not be significant.

14.3.10.2 Operation

When completed, HHI is expected to deliver a range of community facilities benefiting HHI residents and existing communities in the area. Prior to project completion, however, new HHI residents and construction staff would have to rely on some existing services within the local community. This would occur until the completion of these facilities within the PTP.

The Island is removed from existing established emergency and health facilities. Local services are currently reaching capacity, and therefore a lack of services may be an issue due to low response times and perceptions of isolation[1].

Development of a combined emergency services facility, incorporating ambulance, police, surf-lifesaving, and rural fire brigade, would reduce risk to health and safety due to inadequate access to emergency services. Consultation with the relevant emergency service providers will be undertaken during the detailed planning for emergency services facilities, to ensure compatibility with longer-term plans of the relevant agencies.

The PTP proponent has liaised with the Queensland Police Service concerning the provision of policing services to the PTP community. Presently, Police are stationed at Tannum Sands and have presence at Agnes Water and Rosedale. The Queensland Police Service often negotiates with developers on provision of support to the Service to establish a Police presence within a new development which may include land for a Police Station or for the construction of residences for Police Officers to be based on HHI. Discussions will continue with the Queensland Police Service on this matter, to reach agreement on the provision of Police within the project community.

Bushfire risks, management regimes and control services would need to be established for the project. It would also be necessary to establish safeguards in relation to beach use and marine stingers, and these are noted in the mitigation measures outlined in Section 14.5.

14.3.10.3 Services for Seniors

Older people (65+) require access to a range of community facilities, including aged care and health services, such as medical centres, and allied health services, and recreational facilities.

Consultation and communication with relevant Queensland Government departments will be undertaken during the detailed planning stage of the project to ensure that the facilities and services provided meet the needs of the community. Proximity to Gladstone will allow access to medical and government services and private practitioners specialising in servicing and supporting retirees' financial and other needs.

14.3.11 Public Transport

Investigations undertaken during the preparation of the HHID EIS and this project identified a need for improved public transport between townships in the immediate vicinity of HHI, in particular Turkey Beach, Baffle District and the Rosedale, Lowmead and Berajondo areas. There are currently no plans by Queensland Transport or GRC to provide public transport access to the area near the Island, as existing population levels do not warrant services.

As the population increases, public transport access would be required to ensure young residents, school students, seniors, low income households and people with disability have access to services on the mainland. Public transport is particularly important as the projected population may consist

[1] According to the QPS, towns with two thousand people usually have a police presence.

of higher than average number of older people that may depend on such services. The project will provide a bus service from PTP to Tannum Sands and Gladstone.

14.4 Economic Impacts

Two economic studies have been undertaken for the development of HHI as part of the 2008 EIS process. These studies were by Focus Economics in 2006 and Sinclair Knight Merz in 2008. The PTP is of similar size and scope to the previously approved proposal with the same tourist and residential components. The overall findings of the two previous economic studies therefore remain valid for the current proposal.

14.4.1 Focus Economics

The study by Focus Economics (2006) examined the potential economic impacts of the project and the cost of potential impacts on the natural environment. The economic impact assessment was based on two approaches:

- A cost-benefit analysis that assessed whether the benefits of the project justified its expected costs
- Assessment of the opportunity cost of the project, comparing the proposal with an alternative that preserves the natural environment in its current state.

The study found that almost 3,000 person years of direct employment would be generated in the region during construction of the project, with an average of 190 jobs per year during the 16 year development period and a peak employment of 350 persons. Once indirect effects are also taken into account, construction was estimated to generate almost 4,200 person years of employment in construction, with an average of 260 jobs per year and a peak employment of 460 persons. At a state level, the project was estimated to directly and indirectly generate an average of 300 jobs per year, and a peak employment of 550 persons.

The study found that substantial employment opportunities would also arise from the tourism activity generated by the project. It was estimated that in the period to 2035, a total of approximately 14,500 person years of employment would be created directly and indirectly. The number of jobs created were expected to rise steadily to peak in 2030 at of the order of 700 persons. At a state level, the tourism expenditure was estimated to directly and indirectly generate up to 850 jobs per annum by 2030.

Tourism expenditure was estimated to make a direct contribution to regional value-added of $810 million ($290 million in NPV terms). The total direct and indirect contribution to regional value-added was estimated as $1,060 million ($380 million in NPV terms).

As for construction, the estimated impacts for the state were higher than at the regional level. It was estimated that the tourism expenditure generated by the project would make a total direct and indirect contribution to Queensland’s value-added of $1,240 million ($450 million in NPV terms).

The benefits-costs of the project were assessed by comparing the value-added generated by the project with the cost incurred in generating this value-added. The costs included the investment in the development itself and in supporting an expansion in tourism, plus the environmental and social costs. It was estimated that the net benefits from the project for the region were approximately $80 million (in NPV terms, at a real discount rate of 6%). That is, the project benefits were estimated to substantially outweigh project costs. The positive net benefit at a state level was found to be robust to sensitivity analysis as shown in Table 14.13.

Table 14.13 - Regional Benefit-Cost Analysis

	NPV in $ million (in 2006 prices), at a real discount rate of		
	6%	8%	10%
Benefits	**526**	**410**	**326**
Construction – tourism related	88	75	65
Construction – residential elated	58	51	45
Tourism expenditure	380	283	215
Costs	**447**	**374**	**318**
Construction – tourism related	210	181	156
Construction – residential elated	136	119	105
Other investment – tourism related	99	74	56
Additional preventative measures (environmental)	1	1	1
Benefit less costs	**79**	**35**	**7**

At a state level, the net benefits of the project were estimated through economic multiplier analysis as approximately $115 million (in NPV terms).

The study concluded that the potential benefits for the local and regional economies of the HHID would be substantial. Over the life of the project (and in net present value terms) the project could inject hundreds of millions of dollars of income into the regional economy. This would provide substantial job opportunities and funding for expanded publicly and privately provided community services. This result is largely driven by additional tourism activity the development would create for the region, and the economic stimulus provided by the construction work on the development.

14.4.2 SKM - Hummock Hill Island Net Benefit Assessment

The Queensland Environmental Protection Agency submitted a response to the HHID EIS which raised a number of issues in regards to the economic assessment. In addition to specific comments about the methodology applied to the economic assessment, the Environmental Protection Agency noted that the coastal sand dunes on the proposed site are considered an ‘area of state significance’ which triggered Policy 2.8.1 of the State Coastal Management Plan. The Policy requires that ‘*if a use or activity that has adverse effects is to occur within “areas of state significance”, it must have a demonstrated net benefit for the state as a whole*’.

A Cost Benefit Analysis was subsequently undertaken by SKM to assess and quantify the costs and benefits associated with the project at a state level. Cost Benefit Analysis is an accepted methodology for assessing the net benefits accruing to society as a whole as a result of a project. It identifies (and where possible quantifies) the financial, economic, social and environmental costs and benefits of project options relative to a do nothing option (referred to as the base case). A Cost Benefit Analysis also attempts to quantify environmental assets, which are classified as 'non-market goods'. In cases where it is not possible to quantify an identified impact in dollar terms, the impact is considered in a qualitative assessment framework.

The key outputs from a Cost Benefit Analysis included:

- Benefit cost ratio– a ratio of all the quantified direct benefits and costs associated with each option assessed. A ratio greater than one indicates that the benefits are greater than the costs and that the project provides a net benefit to the state. Benefit cost ratio's provide decision makers with a tool to compare the 'value for money' from different options of varying investment costs – i.e. it provides a tool to assess how many dollars of benefit an option provides for every dollar of cost
- Net Present Value – the present value net benefits associated with a project (i.e. present value benefits less present value costs). Unlike the benefit cost ratio, a Net Present Value comparison may be biased towards larger projects.

The economic Cost Benefit Analysis model was developed to determine the net benefit associated with the full development as proposed in the project master plan, and the net benefit associated with that part of the HHID that is located in the area mapped as significant coastal dunes by the Environmental Protection Agency. This is the area of land identified by the Environmental Protection Agency under Policy 2.8.1 of the Coastal Plan.

The Cost Benefit Analysis methodology only considers the direct costs and benefits and therefore does not allow the use of multipliers. This is consistent with the Queensland Treasury Cost Benefit Guidelines (2006). Further, the Cost Benefit Analysis methodology considers the effect of real resource costs and benefits, and excludes, for example, taxes and subsidies, which are regarded as transfer payments from one part of the economy to another. The Cost Benefit Analysis considers the costs and benefits of the project relative to the base case[2].

In this case, the assessment sought to evaluate the overall state impact of the development and the incremental impact of the development on the island's coastal dunes.

[2] CBA is an analytical tool to aid decision-makers in the efficient allocation of resources. It identifies (and where possible quantifies) the financial, economic, social and environmental costs and benefits of project options relative to a do nothing option (referred to as the base case).

The Cost Benefit Analysis considered three options relative to the base case (i.e. do nothing option):

- **Option A:** the full development as outlined in the Master Plan
- **Option B**: the full development (i.e. Option A), excluding the development in the 100 Ha of sand dunes
- **Option C:** Whilst not a discrete option, Option C is equivalent to the difference between Option A and Option B, and therefore isolated the costs and benefits directly attributable to the development on the dunes.

The costs and benefits considered in the Cost Benefit Analysis were classified into the following categories:

- Land development and building development costs
- Environmental costs (which factor in the value of the affected sand dunes)
- Operating expenditure (maintenance and operation)
- Land and building development revenue
- Tourism revenue (which includes tourism accommodation expenditure and non-accommodation expenditure).

A summary of the results from the Cost Benefit Analysis is provided in Table 14.14.

Table 14.14 - Summary of the Economic Analysis Results

	Present Value (2007/08 dollars)		
	Option A	Option B	Option C (Option A-B)
Land Development costs	$120.8 m	$ 84.2 m	$ 36.6 m
Building Development Costs	$804.1 m	$ 553.2 m	$ 250.9 m
Environmental Costs	$1.2 m	$ 0 m	$ 1.2 m
Operational Expenditure	$32.6 m	$ 22.8 m	$ 9.8 m
Total Cost	$958.6 m	$ 660.2 m	$ 298.4 m
Sale Revenue – Land	$351.2 m	$ 241.7 m	$ 109.5 m
Sale Revenue - Building	$997.3 m	$ 686.0 m	$ 311.2 m
Total Tourism Benefits	$151.2 m	$ 92.4 m	$ 58.8 m
Total Benefits	$1,499.7 m	$1,020.2 m	$ 479.5 m
Net Present Value (Net Benefits)	$ 541.1 m	$360.0 m	$ 181.1 m
Benefit Cost Ratio	1.6	1.5	1.6

* discounted over a 30 year period from commencement of construction

The Cost Benefit Analysis concluded that the HHID tourist community would provide a net benefit to the State. For every dollar of state cost, the HHID would deliver 1.60 dollars of state benefit. The BCR remained at 1.6 when only the costs and benefits that are directly attributable to the development proposed for the sand dunes were considered. The majority of the cost and benefits associated with the development were identified and quantified in the Cost Benefit Analysis. However there were also some impacts (both costs and benefits) which were difficult to quantify in dollar terms. For example, the development would improve the availability and access to social infrastructure, leisure and recreation activities for existing residents in the Gladstone region. Further, the development would address some of the need for regional infrastructure and housing in the region.

The study found that the HHI development would contribute significantly to tourism within the central Queensland region, providing flow on effects to the regional economy. By 2024, around $95 million per annum in tourism expenditure will result from the development.

14.5 Mitigation Measures

14.5.1 Construction Period

Changes to the social environment during construction would be managed by the Proponent so as to ensure that any impacts are avoided, reduced or mitigated.

14.5.1.1 Community Impacts

Early consultation and communication residents in adjacent townships will be undertaken to raise community awareness of construction activities, potential changes arising from construction activities (i.e. to road access and access to recreational uses) and proposed environmental management measures.

Consultation with local Indigenous organisations will also be undertaken to identify and facilitate training and employment opportunities associated with the project and to ensure access to places and sites of importance is maintained.

Table 14.15 outlines environmental objectives, performance criteria and mitigation measures required to address general social impacts of the project during construction. These have also been incorporated into the Environmental Management Plans.

Table 14.15 - Summary of Social Impacts and Mitigation

Social - Construction	
Environmental Objective	Avoid or mitigate and manage construction impacts on local residents and visitors to the Island.
Performance Criteria	• Local residents and visitors to the Island are notified in advance of construction activities, changes arising from construction activities (i.e. to local access), and possible management measures • Local residents and visitors have access to a communication and complaints process to address and respond to social impacts.
Mitigation Measures	Provide a communication program targeted to local residents and visitors to the Island, and including: • Regular construction updates • Advice on construction schedules • The results of monitoring required by the EMP. Develop, promote and implement an effective complaints response system for receiving, handling and responding to complaints received during construction of the project, including: • Provision and promotion of a phone contact with construction management staff during hours of construction • A follow up procedure which notifies complainants within 24 hours of the intended response to the issue raised.
Monitoring	Evaluate effectiveness of construction, liaison and mitigation strategies.
Reporting	Report to the complainant within 24 hours of what action, if any, would be undertaken in response to the issue raised. Provide monthly reports (publicly accessible on request) regarding communication activities, residents' complaints and resolution of complaints.

14.5.1.2 Business Impacts

During project design local businesses in the GRC area will be contacted to provide prequalification as contractors to maximise the benefit of local input into the project.

The following strategies will be undertaken to mitigate potential impacts and maximise potential benefits of the project for commercial fishing operators through continued consultation with operators to identify particularly issues associated with the construction and operation of the project, and to identify specific strategies to minimise potential impacts.

14.5.1.3 Employment Impacts

An Employment and Training Plan will be prepared that includes:

- A skills audit of existing local community to identify gaps in skills and workforce capacity required for construction
- Identification of the skills required for construction and operation and trainings needs to enable local employees to gain the necessary skills
- Identification of opportunities to work through State and Federal government apprenticeship and training programmes to address skills shortages and benefit community

- Identification of opportunities to facilitate skills development for local residents through local training facilities such as Central Queensland TAFE and other local training providers, to enable local residents' employment in construction and operational aspects of the project
- Facilitation of employment opportunities suitable for older people, including part-time or casual employment.

14.5.1.4 Housing and Accommodation Impacts

The following mitigation measures will be undertaken to address potential housing and accommodation impacts from the construction stage of the project:

- An Accommodation Management Strategy will be prepared in consultation with the relevant State agencies
- Encourage local employment through up-skilling of existing unskilled workers
- Where possible, tourist accommodation will be used for the accommodation of short-term construction workers, with consideration of existing tourist accommodation demands.

14.5.2 Operation Period

14.5.2.1 Community Impacts

The proponent will facilitate development of community groups, support networks and events to build social capital within the community. It will be important to integrate residents of PTP with residents in surrounding communities, including encouraging participation by other local and regional residents in PTP events and activities, to build a wider sense of community and inclusion. This may include promotion of HHI events or activities to regional communities, or participation in existing regional events and activities (i.e. Gladstone Harbour Festival, Gladstone Seafood Festival, Gladstone Annual Show, SUNfest, etc.) through sponsorship, displays at community events, or organisation of complementary events (e.g. as part of Council's Clean Up Australia Day activities).

Public access to services and facilities will be promoted to both local and regional residents.

14.5.2.2 Community Services and Facilities

Consultation with local community organisations and government agencies will be undertaken to identify the likely demand emanating from the project's population and co-operative methods of addressing local needs. It would also be necessary to consult with the relevant government agencies regarding access to early-years services, child care and family support services. The project would provide a number of community facilities, accessible to both PTP residents and adjoining communities. The facilities included within the development are:

- A medical centre
- Emergency services, including fire brigade facilities
- Education facilities, including a preschool/ kindergarten, research centre and cultural heritage centre
- A community centre

- A conference centre
- A surf lifesaving facility
- A public bus service
- Restaurants and retail facilities, including post office
- Sport and recreation facilities, including playing fields, tennis courts, picnic areas, and walking and bike paths.

Community recreation facilities would include sporting fields, public parks, 18 hole golf course and country club, tennis courts, cycling paths, a lawn bowls green, beaches, boating facilities, camping grounds etc.

The establishment of these facilities will be supported by the Proponent by either the development of the facility in some instances, and operation and maintenance during the development period for an agreed period of time or subsidies to operators.

It is expected that the project would support the establishment of a primary school and will allocate land for a school if required by the Queensland Government. The potential need for a primary school would need to be determined when the balance between permanent and temporary residents is ascertained.

The following mitigation measures are recommended to maximise potential benefits and manage or avoid potential impacts on community services and facilities:

- Further analysis of the threshold levels for the provision of on-Island services, to be undertaken in conjunction with relevant Local and State Government agencies
- Consultation and communication with relevant Local and State Government agencies to identify and gain commitment for provision of and contribution to social infrastructure requirements to meet the expected increase in population, including upgrading of emergency services
- Consultation and communication with the Department of Emergency Services to identify and agree provision for emergency services
- Liaison with Rockhampton and/or Bundaberg emergency helicopter services to be included on the helicopter landing register and to develop protocols
- Consultation and communication with health authorities regarding needs of older residents, including health care, and to identify and agree on-Island health service responses, including home care services
- Develop a medical clinic and work with private health care professionals to provide incentives for the establishment of facilities for a general practitioner. In addition, the Resort hotels will provide a level of primary health care support for its visitors
- incorporate universal design and Crime Prevention through Environmental Design principles to into the design of residential, commercial and community facilities and outdoor spaces

- Consultation and communication with Surf Lifesaving Queensland to investigate and determine the level of provision of private, funded or volunteer surf lifesaving services
- Investigate and establish required beach safety measures, including lifeguard tower, and potential need for swimming enclosure to avoid marine stingers
- The proponent will provide a bus service between PTP and Gladstone, via Tannum Sands during the development period to provide transport for workers and school children.

14.5.2.3 Services for Seniors

The PTP will provide formal and informal recreational activities for older people and participation in ongoing educational opportunities offered at the Island's education precinct.

Proximity to Gladstone will provide access to medical and government services and private practitioners specialising in servicing and supporting retirees' financial and other needs, providing public transport access is available.

Designs for community services and facilities will be disabled-and aged-friendly, to ensure continued mobility and access for older people.

SECTION 15
Conclusions

Contents

15. Conclusions

15.1 MNES Values Potentially Affected

The PTP is a controlled action with the following controlling provisions:

- Sections 12 and 15A - World Heritage properties
- Sections 5B and 15C National Heritage places
- Sections 18 and 18A - Listed threatened species and communities
- Sections 20 and 20A - Listed migratory species
- Sections 24B and 24C – Great Barrier Reef Marine Park.

The individual species, ecological communities and other values that contribute to these overarching MNES were identified in Section 7 and the importance of each individual value or component was assigned using pre-determined rankings of lower, moderate or highest importance set out in Section 1.7.4. As this assessment is focussed specifically on MNES, there is an underlying assumption that each MNES value has some importance since all MNES values are protected under legislation. Therefore, there is no “negligible importance” criteria, and even the “lower importance” criteria is relative to the inherent overall importance of MNES.

The following values of highest importance were identified:

- Migratory shorebird habitat on the south-eastern mud- and salt-flats of HHI form part of a Mundoolin/Colosseum/Rodds Bay conglomeration of sites that are internationally important with respect to the eastern curlew and nationally important with respect to other migratory shorebirds. This value contributes to the following controlling provisions:
  - Sections 12 and 15A - World Heritage properties
  - Sections 5B and 15C National Heritage places
  - Sections 20 and 20A - Listed migratory species
- About 190 hectares of the critically endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia is present on HHI. This value contributes to:
  - Sections 12 and 15A - World Heritage properties
  - Sections 5B and 15C National Heritage places
  - Sections 18 and 18A - Listed threatened species and communities

The following values of moderate importance were identified:

- Marine turtle and dugong foraging habitat occurs in waters around HHI and flatback turtles nest intermittently and in low numbers on the beach to the east of the headland. These values contribute to:
  - Sections 12 and 15A - World Heritage properties

  - Sections 5B and 15C - National Heritage places
  - Sections 18 and 18A - Listed threatened species and communities (marine turtles)
  - Sections 20 and 20A - Listed migratory species (marine turtles and dugong)
- Two other vegetation communities that are not well represented within the GBRWHA/NHP, being a 10 hectare patch of *Eucalyptus melanophloia* woodland and 385 hectares in total of *Eucalyptus tereticornis* and *E. crebra* dominated forests. These contribute to the floristic diversity of the World Heritage and National Heritage controlling provisions.
- Overall contribution to the OUV of the GBRWHA (*important and significant natural habitats for in-situ conservation of biological diversity)* is also assessed as moderate.

All other values that were identified as present or likely to be present were considered of lower importance. The values are described and evaluated in Section 7.

15.2 Impact Assessment

15.2.1 Significance of Identified Impacts

Potential impacts of PTP on MNES values were identified and evaluated using a methodology based on international best practice, adapted to assessment of impacts on MNES. The approach and methodology is set out in Section 1.7. Results of the impact assessment are set out in Sections 8 to 12 and summarised in Table 15.1. The results take into account mitigation measures proposed to avoid or mitigate impacts. Table 15.1 also identifies those impacts where there may be some uncertainty in the prediction of impacts and where additional validation is required.

Table 15.1 – Summary of Significance of Impacts on MNES Values

Potential Impact	Importance of MNES values potentially impacted(1)	Impact Severity(2)	Significance	Comments
Direct impacts on terrestrial, intertidal and marine habitat and ecological communities				
Direct disturbance to vegetation communities and habitat from terrestrial vegetation clearing	Lower importance	Low	Not significant	Footprint has been designed to avoid all values of highest importance
Direct disturbance to marine habitat from construction of the proposed bridge and boat ramp	Lower to moderate importance	Negligible	No impact	Works are very minor in nature

Potential Impact	Importance of MNES values potentially impacted(1)	Impact Severity(2)	Significance	Comments
Fragmentation of terrestrial habitat	Lower importance	Low or negligible	Not significant	Wildlife corridors are retained and enhanced
Fragmentation of marine habitat	Lower to moderate importance	Negligible	No impact	Design of bridge and boat ramp, avoids any impediment to flows and movement of marine fauna
[Partial] Removal of the causeway	Moderate importance	Benefit	Benefit	May enhance movements of marine megafauna such as dugong, particularly at low tide
Anchor damage	Moderate importance	Low	Not significant	Some uncertainty in predicting extent of anchoring over seagrass beds. Monitoring required and a no-anchor zone to be established if impacts are detected. Impacts will be fully reversible in 2-3 years if detected early.
Protection of habitat through an actively managed conservation area	Lower-Highest importance	Benefit	Benefit	Removes or reduces threats to highly important terrestrial values
Preparation and implementation of Wildlife and Habitat Management Plan within the development footprint.	Lower importance	Benefit	Benefit	Provides for maintenance of biodiversity within development footprint
Indirect impacts on terrestrial vegetation and habitat				
Weed infestation and proliferation	Lower importance	Negligible	No Impact	Well established weed prevention and management measures exist and can be effectively implemented for this project
Changes in overland flow characteristics	Lower to highest importance	Negligible	No impact	Stormwater system has been designed so that there is no change in overland flow characteristics outside the development footprint
Changes in groundwater recharge and discharge characteristics	Lower importance	Low	Not significant	
Deposition of dust	Lower to highest importance	Negligible	Not significant	Buffers between development footprint and higher and moderate importance values will avoid impacts
Noise-related disturbance that may affect use of habitat	Lower importance	Low (construction and operation)	Not significant	Highest importance habitats (migratory shorebirds) are remote from development footprint

Potential Impact	Importance of MNES values potentially impacted(1)	Impact Severity(2)	Significance	Comments
Aircraft	Highest importance	Negligible	Not significant	A horizontal and vertical exclusion zone 1000m is proposed around important migratory shorebird habitat. Monitoring will verify effectiveness of this and exclusion zone can be adjusted as required.
Disturbance from human activity:				
• Land based	Low to moderate importance	Low	Not significant	Highly important migratory shorebird habitat is not accessible on foot. Further access controls to turtle nesting beach east of headland can be provided if necessary.
• Boat based	Lower to moderate importance Highest importance	Low Negligible	Not significant	Boat speed limits will minimise disturbance to marine fauna. Recreational boats will be unable to get close enough to important migratory shorebird habitat to disturb roosting and foraging activities.
Microclimatic changes at edges of vegetation patches	Lower to highest importance	Negligible	Not significant	A buffer zone of 80-100m is provided for between the development footprint and remnant vegetation.
Artificial light	Lower to moderate importance	Low (negligible?)	Not significant	Retention of vegetation and natural topography will assist in blocking light pill to moderately important habitats. Further attenuation can be undertaken at source if required. Highly important migratory shorebird habitat is too remote to be affected.
Increased bushfire risk	Lower to moderate Highest importance	Low Negligible	Not significant	A fire management program will be implemented as part of the Wildlife and Habitat Management Plan (footprint) and actively managed conservation area (balance of HHI). A buffer zone of 80-100m is provided for between the development footprint and remnant vegetation including highest importance vegetation.

Potential Impact	Importance of MNES values potentially impacted[(1)]	Impact Severity[(2)]	Significance	Comments
Impacts on water quality				
Disturbance and subsequent oxidation of acid sulfate soils during construction	Low to moderate	Negligible	No impact	Quantities to be disturbed are minor and well established, effective management measures are available.
Release of sediment from bridge and boat ramp construction	Low to moderate	Negligible	No impact	Quantities to be disturbed are minimal and represent re-suspension of sediments rather than introduction of new sediment load
Sediment release during construction on land	Low to moderate	Negligible	No impact	Land area to be exposed to erosive forces is typically less than 50 ha at any one time. Well established and effective management measures are available.
Disposal of groundwater intercepted during excavations (construction)	Low	Negligible	No impact	Quantities generated are low and effective treatment and disposal options are available
Wastewater treatment and reuse:				(note there is no routine discharge of treated wastewater)
• Emergency releases	Low to moderate	Negligible	No impact	Emergency releases will occur very rarely and loads of contaminants will be very small such that effects are minor and reversible within less than one month
• Reuse, including irrigation	Low to moderate	Negligible	No impact	Modelling has indicated that no impact will occur however monitoring of soils, surface water runoff and groundwater is required to validate modelling outcomes and manage irrigation. Statutory requirement to undertake environmental and health risk assessment and prepare and implement a recycled water management plan.
Management of nutrients at the proposed golf course	Low to moderate	Negligible	No impact	Minimal additional fertiliser required due to use of recycled water. Monitoring of soils, surface water runoff and groundwater is required to validate modelling outcomes and manage irrigation.
Contamination of stormwater	Low to moderate	Negligible	No impact	Best practice water sensitive urban design approach has been used to design stormwater system. Modelling indicates that stormwater runoff will meet receiving water quality guidelines.

Potential Impact	Importance of MNES values potentially impacted(1)	Impact Severity(2)	Significance	Comments
Changes in overland (freshwater) flow characteristics	Lower to moderate importance	Negligible	No impact	Stormwater system has been designed so that there is negligible change in flows in ephemeral watercourses
Saline (brine) waste	Lower to moderate importance	Negligible	No impact	Brine waste will be disposed of via an evaporation pond with no discharge to the environment.
Hydrocarbon contamination of surface and groundwater	Lower to moderate importance	Negligible	No impact	Established regulatory controls and standards exist to minimise risk of releases to the environment. Quantities to be stored and used are such that even if a spoil does occur, impacts would remain localised.
Contamination of surface water and groundwater by pesticides	Lower to moderate importance	Negligible	No impact	Regulatory controls in place requiring safe use of pesticides. If pesticides are required, will be selected based on minimising environmental fate.
Contamination of surface water and groundwater by other hazardous materials	Lower to moderate importance	Negligible	No impact	Quantities and types of materials to be used are such that risk to the environment from spills is very low.
Removal of the causeway	Lower to moderate importance	Negligible	No impact	Minor, short terms re-suspension of sediment, expected to be reversible within less than one week.
Human waste discharges from recreational boats	Lower to moderate importance	Negligible	No impact	Some uncertainty as to the impacts of recreational boating on water quality. Levels of use unlikely to be high enough to cause concerns but monitoring will be undertaken and if adverse effects identified, the proponent will work with regulators and resource managers to develop and implement management plans.
Hydrocarbon discharges from recreational boats	Lower to moderate importance	Negligible	No impact	Some uncertainty as to the impacts of recreational boating on water quality. Levels of use unlikely to be high enough to cause concerns but monitoring will be undertaken and if adverse effects identified, the proponent will work with regulators and resource managers to develop and implement management plans.
Impacts on individual terrestrial threatened and migratory species				
Injury or mortality during vegetation clearing activities	Lower importance	Low (negligible?)	Not significant	50% of mature habitat trees are to be retained and a spotter catcher will be used to manage native fauna during clearing. A pre-clearing survey will be undertaken for threatened plants. Identified plants will be avoided or relocated where practicable.

Potential Impact	Importance of MNES values potentially impacted[(1)]	Impact Severity[(2)]	Significance	Comments
Injury or mortality from vehicle strike	Lower importance	Low (negligible?)	Not significant	Road design will comply with Queensland Department of Transport and Main Roads Fauna Sensitive Road Design Manual (DMR 2000, DTMR 2010).
Increased predation	Lower importance	Benefit	Benefit	As part of the Wildlife and Habitat Management Plan and managed conservation area, predator reduction programs will be undertaken. Cats will be banned at PTP and dogs allowed under strict controls.
Direct impacts on marine threatened and migratory animals				
Injury or mortality from impingement or entrainment in the desalination plant intake	Lower to moderate importance	Negligible	No impact	Low rate of intake flow and size and design of intake means that impacts are negligible.
Injury or mortality from boat strike	Lower to moderate importance	Low	Not significant	Existing navigational conditions will restrict boat speed and the proponent will work with regulatory agencies to impose a six knot boat speed limit in sensitive habitat areas. Education and awareness raising will also be undertaken
Entanglement with litter and debris	Lower to moderate importance	Low	Not significant	Design of footprint and stormwater system limits inputs of litter from land based activities. Littering from boats is prohibited. Education and awareness raising will be undertaken and proponent will promote use of biodegradable packaging. If litter build up occurs, proponent will undertake clean-up activities.
Underwater noise from boat ramp and bridge construction	Lower to moderate importance	Low (negligible?)	Not significant	Noise from pile driving will occur over a one to two month period and will be intermittent.
Increased recreational fishing effort	Lower to moderate importance	Low	Not significant	Some uncertainty as to the impacts of recreational fishing. Increased effort will occur at a local level (colosseum Inlet/Boyne Creek/Seven Mile Creek) but will be insignificant at a regional level. Levels of use in local area unlikely to be high enough to cause concerns. Legislative controls are in place in relation to catch size and fishing methods and proponent will promote awareness of these. If adverse effects identified, the proponent will work with regulators and resource managers to develop and implement management

Potential Impact	Importance of MNES values potentially impacted(1)	Impact Severity(2)	Significance	Comments
				plans.
Upgrade of zoning of Rodds Bay Dugong Protection Area	Lower to moderate importance	Benefit	Benefit	Proponent will purchase four commercial fishing licences if State government decides to go ahead with the zoning upgrade.
Increased levels of activity in the GBRWHA/NHP and GBRMP				
Increase in commercial tourism activity	Lower – highest	Negligible	Not significant	GBRMPA and Queensland DNPRSP administer a permit system for commercial tourism activities which ensures sustainable levels of activity
Increase in recreational boating activity	-	-	-	Impacts assessed above: • Disturbance to marine fauna and migratory shorebirds • Water quality impacts • Boat strike and entanglement of marine megafauna • Recreational fishing effort.
Research activities	Lower – highest importance	Negligible	Not significant	GBRMPA and Queensland DNPRSP administer a permit system for research activities which ensures sustainable levels of research
Environmental awareness and appreciation	Lower – highest importance	Benefit	Benefit	Various environmental awareness and appreciation activities will promote the importance of MNES values and how to protect these. An environmental education facility is also proposed. Tourism activities will be required to meet Ecotourism Australia accreditation requirements and promote sustainable user and enjoyment of the GBRWHA/NHP, GBRMP and environment generally.
Changes in landscape character and visual amenity				
Changes in landscape and visual character generally	Lower importance	Low	Not significant	Retention of vegetation and topographic features and strict building design codes will minimise visual impact of PTP
Changes in views within the GBRWHA/NHP	Lower importance	Low (negligible?)	Not significant	Retention of vegetation and topographic features and strict building design codes will minimise visual impact of PTP

Potential Impact	Importance of MNES values potentially impacted(1)	Impact Severity(2)	Significance	Comments
Impacts on geological and geomorphological features and processes				
Destruction, modification or obscurement of landform features	Lower importance	Negligible	No impact	The development footprint and approach avoids modification to landform features
Changes in geomorphological processes	Lower importance	Negligible	No impact	Apart from the boat ramp and bridge, there is no development in or adjacent to the dynamic coastal zone. The bridge and boat ramp will be designed to avoid impacts on coastal processes.
Destruction or modification of an example of a continental island	Lower importance	Negligible	No impact	There will be no change to the status of HHI as a continental island.

(1) Including contribution that these values make to the OUV of the GBRWHA
(2) Taking into account measures to avoid or mitigate impacts

No significant or unacceptable impacts were identified. Direct and indirect impacts on highest importance MNES values, and those values that make a major contribution to OUV of the GBRWHA are avoided completely through the layout of the development footprint and availability of buffers between these values and areas of activity.

Direct impacts on moderate importance MNES values, including those values that make a moderate contribution to the OUV of the GBRWHA are largely avoided. About 40% of the extent of *Eucalyptus tereticornis* and *E. crebra* dominated forests will be cleared however the remnant patches are of adequate size to remain viable.

There are a small number of direct impacts on lower importance MNES values but the severity of impacts is low and significant impacts are not expected. No diminution of the contribution that these values make to the OUV of the GBRWHA is expected.

Indirect impacts on moderate and lower importance MNES values are all low or negligible due to design features of the PTP and the availability of established and reliable mitigation measures to manage unavoidable impacts.

There is some uncertainty as to the prediction of impacts on yakka skink and brigalow scaly foot, both of which are listed as vulnerable under the EPBC Act. While these animals have not been identified in surveys to date, survey methods do not fully meet guideline requirements and it is possible that these small, cryptic reptiles have been missed. Additional habitat assessment and survey is proposed and if these reptiles are identified, habitat will either be avoided, or the animals will be translocated. As the success of translocation can be difficult to guarantee, the proponent will involve recognised brigalow belt reptile specialists in development and implementation of relocation plans and will also control predators prior to translocation, as this is identified as the key reason why translocation programs fail.

There is also some uncertainty regarding prediction of impacts associated with recreational boating. Increases in recreational boating activity are largely associated with regional population increases, but the proposed PTP will provide improved access to the waters around HHI compared to what is currently available. GBRMPA has identified that recreational boating impacts in high use areas adjacent to major population centres pose a moderate threat to the Great Barrier Reef ecosystem but acknowledges that information on the actual effects of recreational boating is lacking. The proponent has proposed a number of mitigation measures in addition to existing regulatory controls on recreational fishing, littering and contamination of waters. The proponent has also committed to undertaking a marine water quality monitoring program and marine ecosystem monitoring program. If these programs identify degradation of water quality and/or habitat, and this is attributable to recreational boating, the proponent will seek to work with GBRMPA, Queensland DNPRSR and other stakeholders to determine additional controls that may be required. The proponent will support development of an area specific management plan, which is one of the key management tools used by GBRMPA for management of intensively used areas (GBRMPA 2012).

Otherwise, the level of confidence of impact predictions is high. Modelling has been used where necessary to demonstrate effectiveness of mitigation measures, particularly in relation to wastewater treatment and management, irrigation with recycled water and stormwater management. Monitoring is also proposed to validate model predictions and effective corrective actions are available where monitoring indicates that objectives are not achieved.

For other impacts, the high level of confidence arises because the impact mechanisms are well understood, the severity of the impact is negligible or low and there are well established and effective mitigation measures available to control residual impacts.

15.2.2 *Summary of Impacts on MNES*

Table 15.2 provides a summary of impacts on the individual matters of MNES identified as being present or likely to be present on and around HHI.

Table 15.2 - Summary of MNES Impacts

MNES Value	Importance	Summary of Impacts
GBRWHA/NHP Criterion vii: contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	HHI and surrounding waters feature a minor expression of some aesthetic values based on the presence of low profile coastal panoramas, with some disturbance due to industrial development at nearby Boyne Island. Lower importance, minor contribution	Visual impact assessed as low and acceptable. Retention of vegetation, location of the development footprint and building height restrictions and design requirements will minimise visual impact. These requirements are enforced through the Plan of Development. No significant or unacceptable impacts, no significant reduction in contribution to the OUV of the GBRWHA.
GBRWHA/NHP Criterion viii: Outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features	HHI and in surrounding estuarine waters feature minor expressions of coastal geological and geomorphological changes and estuary formation, an example of a continental island and geological and geomorphological processes influencing formation of coastal beaches and sand dunes, intertidal mud flats and tidal creeks. Lower importance, minor contribution	Bridge and boat ramp will be designed to avoid any changes to tidal flows and coastal processes. This is a proponent commitment. No other development in the coastal zone. Stormwater management system designed to avoid changes to surface water runoff characteristics. No significant or unacceptable impacts, no significant reduction in contribution to the OUV of the GBRWHA.
GBRWHA/NHP Criterion ix: Outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals	HHI and surrounding waters feature minor expression of the relationship between coastal geomorphic processes and environmental processes, including erosion and accretion processes in relation to sand banks and beaches. There is minor evidence of Aboriginal and post-settlement use of HHI. Lower importance, minor contribution	No changes to existing coastal and geomorphological processes as development is avoided in the coastal zone. Links between geological and biological processes will be retained. Aboriginal cultural heritage material will be managed through a cultural heritage management plan. No significant or unacceptable impacts, no significant reduction in contribution to the OUV of the GBRWHA.
GBRWHA/NHP Criterion x: Contains the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding	Minor expression of biodiversity, supporting a wide range of plants and animals typical of the Capricorn/Mackay region, including some threatened species and a threatened ecological community Regionally important expression of shallow	No direct or indirect impacts on critically endangered ecological community Littoral Rainforest and Coastal Vine Thickets of Eastern Australia or migratory shorebird habitat. No direct impacts on marine habitats. No indirect impacts on habitat arising from water quality degradation. Minimal regional increase in recreational boating activity but intensification of use of waters around HHI due to provision of a boat ramp.

MNES Value	Importance	Summary of Impacts
universal value from the point of view of science or conservation	intertidal and subtidal mangrove, seagrass and mud flat habitats Regionally important expression as habitat for dugong and some species of marine turtle Internationally (eastern curlew) and nationally (all other species) important expression of values for migratory shorebirds Regionally important expression of floristic diversity, contains a critically endangered threatened ecological community **Moderate importance** – biodiversity generally, moderate contribution to the OUV of the GBRWHA **Highest importance** - migratory shorebird habitat and critically endangered regional ecosystem	Recreational boating impacts on water quality, habitat and marine megafauna are assessed as low but ongoing monitoring and surveillance required due to lack of information on impacts of recreational boating. The proponent will work with Queensland Government to impose a boat speed limit in and around marine megafauna habitat areas. Representative examples of all terrestrial vegetation communities and habitat types are retained and will be protected and managed in a conservation area No significant or unacceptable impacts, no significant reduction in contribution to the OUV of the GBRWHA.
Integrity of GBRWHA: • includes all elements necessary to express its outstanding universal value • is of adequate size to ensure the complete representation of the features and processes which convey the property's significance • suffers from adverse effects of development and/or neglect	HHI and surrounding waters include elements that make a major contribution to the OUV of the GBRWHA. The development footprint has been disturbed by grazing and logging in the past and is not located in an area with wilderness values. Some level of use of waters around HHI already occurs.	The range of values and elements that contribute to the OUV of the GBRWHA are not lost, obscured, or diminished. Some modification to terrestrial habitat will occur, however all identified values are retained in viable form. The role of HHI and surrounding waters in buffering the Great Barrier Reef ecosystem is unchanged. Access to the GBRWHA will increase due to the project and this provides an opportunity to present this section of the GBRWHA to the public. The PTP has been specifically designed to avoid adverse effects of development.
Management and protection of GBRWHA	Management of the land use and natural resources of HHI falls within Queensland jurisdiction. Management and protection of waters around HHI is through joint management of the Great Barrier Reef Marine Park Authority, in respect of the GBRMP component and the Queensland Government in respect of the GBRCMP component.	The proposed PTP received approval from the Queensland Government in February 2011, through the release of a Coordinator-General's report under the *Queensland State Development and Public Works Organisation Act 1971*. The proponent will seek to work with GBRMPA and Queensland Government in relation to management of activities taking place in waters around HHI, including provision of education and awareness-raising.

MNES Value	Importance	Summary of Impacts
Water mouse *Xeromys myoides.* Vulnerable	Suitable habitat is present and previous record exists on the east of HHI and adjacent mainland. Lower (moderate?) importance	Clearing of less than 0.1ha of mangrove habitat in an already disturbed area. No other indirect impacts on habitat. No additional fragmentation as bridge and boat ramp are located in an already disturbed area. Potential for reduced predation through actively managed conservation area. No significant or unacceptable impacts.
Black-breasted button quail *Turnix melanogaster* vulnerable	Suitable habitat is present and there have been sighting of "platelets" and scats characteristic of quail species including the black-breasted button quail. Lower (moderate?) importance	No direct or indirect disturbance to habitat (coastal vine thicket). Active management of coastal vine thicket to enhance conservation values. Wildlife corridors connecting the two patches of coastal vine thicket retained. No significant or unacceptable impacts.
Grey-headed flying fox *Pteropus poliocephalus*	Observed foraging, however HHI is beyond the northern extent of current known range, but within what is believed to be the original range. HHI may be important in maintaining or extending northward extent of range Lower importance	Loss of approximately 190 hectares of foraging trees. Mature habitat trees to be retained throughout the development footprint. As the area is lightly foraged only, this is not likely to reduce availability of foraging habitat. Grey-headed flying fox forage in urban areas. Vegetation offsets will be provided within range under Queensland legislative requirements. No significant or unacceptable impacts.
Yakka Skink *Egernia rugosai* vulnerable Brigalow scaly-foot *Paradelma orientalis* vulnerable	Not identified in surveys but HHI is within range and has suitable micro-habitat, notwithstanding previous land management practices which appear to have affected occurrence of ground dwelling fauna. Lower (moderate?) importance	If present within development footprint, clearing of vegetation will affect habitat. Habitat assessment and pre-clearing surveys proposed, with avoidance or translocation if colonies are identified. No significant or unacceptable impact.
Flatback turtle *Natator depressus* Vulnerable, migratory, marine Green turtle *Chelonia mydas* Vulnerable, migratory, marine Loggerhead turtle Caretta caretta Endangered, migratory, marine	Known to occur in waters around HHI. Flatback turtle have been observed to nest at low densities and intermittently on HHI on the beach to the east of the headland. Moderate importance	Nesting areas avoided and no direct impacts on marine habitat. Light spill to nesting areas avoided by retention of vegetation and building design measures. Marine and coastal water quality degradation not expected due to wastewater and stormwater system design and management. Minimal regional increase in recreational boating activity but intensification of use of waters around HHI due to provision of a boat ramp. Recreational boating impacts on water quality, habitat and marine megafauna are assessed as low but ongoing monitoring and surveillance required due to lack of information on impacts of recreational boating. The proponent will work with Queensland Government to impose a boat speed limit in and around marine megafauna habitat areas. No significant or unacceptable impact.

MNES Value	Importance	Summary of Impacts
Migratory Terrestrial Birds	Seven species known or potentially occurring, however HHI does not support important populations or provide key habitat. Lower importance	Some loss of habitat due to vegetation clearing. Five of the seven species utilise urban areas for foraging. Remainder of habitat across HHI will be included in managed conservation area. No significant or unacceptable impact.
Migratory Shorebirds	Intertidal foraging and roosting habitat of international and national importance is available at HHI and in the surrounding Colosseum/Mundoolin and Rodds Bay conglomerate of sites. Highest importance	No direct impacts on habitat, habitat is minimum of 700 m from boundary of development footprint. Currently, access by foot is restricted and this will remain the case. No indirect impacts associated with stormwater changes or marine water quality degradation. Boats cannot approach closely to roosting and foraging sites due to shallow water. An exclusion zone (1000 m horizontally and vertically) will be imposed on any flights into and out of the airstrip. No significant or unacceptable impact.
Indo-Pacific humpback dolphin *Sousa chinensis* Migratory, Cetacean.	Known to occur, however common throughout the region. Waters of HHI do not appear to offer any unique or important habitat. Lower importance	No direct impacts on habitat. Marine and coastal water quality degradation not expected due to wastewater and stormwater system design and management. Minimal regional increase in recreational boating activity but intensification of use of waters around HHI due to provision of a boat ramp. Recreational boating impacts on water quality, habitat and marine megafauna are assessed as low but ongoing monitoring and surveillance required due to lack of information on impacts of recreational boating. No significant or unacceptable impact.
Dugong *Dugong dugon* Migratory marine	Known to occur in waters around HHI. Not identified as one of the most important locations for dugong in Queensland, but nevertheless provides foraging habitat on intertidal and subtidal habitat. Moderate importance	No direct impacts on habitat. Marine and coastal water quality degradation not expected due to wastewater and stormwater system design and management. Minimal regional increase in recreational boating activity but intensification of use of waters around HHI due to provision of a boat ramp. Recreational boating impacts on water quality, habitat and marine megafauna are assessed as low but ongoing monitoring and surveillance required due to lack of information on impacts of recreational boating. The proponent will work with Queensland Government to impose a boat speed limit in and around marine megafauna habitat areas. No significant or unacceptable impact.

MNES Value	Importance	Summary of Impacts
GBRMP	GBRMP boundary runs along the northern shoreline of HHI. Adjacent zoning is general use zone.	No direct impacts on GBRMP. Minimal regional increase in recreational boating activity but intensification of use of waters around HHI due to provision of a boat ramp. Potential for exacerbation of threats associated with recreation in the GBRMP is assessed as low. Ongoing monitoring and surveillance required due to lack of information on impacts of recreational boating. Proponent would support preparation of an area management plan if necessary to address impacts of recreational use. PTP and associated consequential effects of increased access are consistent with objectives of the *Great Barrier Reef Marine Park Act 1975* and assessment indicates that PTP will enhance use, enjoyment and appreciation without detracting from the environment, biodiversity and heritage values. No significant or unacceptable impact.

(1) UNESCO June 2012a, see also Appendix C2

15.3 Mitigation Measures

A range of mitigation measures have been identified to avoid or manage potential impacts on MNES and on the environment generally from the construction and operation of the PTP.

Wherever possible, the project footprint and design has sought to avoid impacts. Key aspects in this regard include:

- A development footprint that avoids all areas of highest value and most areas of moderate value
- Provision of buffers within the development footprint to areas of retained vegetation
- Provision for wildlife movement within the proposed footprint, including wildlife corridors and highly permeable areas
- Retention of 50% of habitat trees in woodland areas
- Design of an enclosed water and wastewater management system that avoids discharges to the environment and provides for 100% recycling of treated wastewater
- Design of a stormwater system consistent with the principles of water sensitive urban design that manages the quality and quantity of stormwater to mimic pre-development conditions, with potential improvements in stormwater quality runoff compared to pre-development.

A wide range of other mitigation and management measures are proposed that will effectively and reliably mitigate all potential impacts. Existing best practice standards and guidelines will be applied wherever available, for example for erosion and sediment control and acid sulfate soil management.

In relation to impacts of recreational activities on the marine and coastal environment, a number of statutory controls are already in place and the proponent will promote education and awareness of these controls, and the importance of compliance. The proponent also seeks to impose a six knot speed limit on recreational boats in sensitive habitat areas and will work with the Queensland Government to implement this commitment.

Monitoring will be undertaken of the effectiveness of the stormwater management system in removing contaminants and maintaining surface flow patterns. A strict monitoring regime will also be implemented for the golf course and other areas where recycled water is to be used. For the golf course, levels of nutrients and pesticides will be monitored in soils, groundwater and surface water runoff. Corrective actions are available were monitoring indicates that the stormwater management system or use of recycled water is not meeting pre-determined trigger levels.

In relation to ongoing management and monitoring of terrestrial environmental values, the proponent will manage the balance of HHI, including that port of the Special Lease that is outside the development footprint as a conservation area and, on completion of the proposed development, surrender the remainder of the special lease, also for management as a conservation area. The Queensland Coordinator-General has imposed this as a condition of development (Queensland Government 2011) and has also recommended to the Minister administering the Queensland *Nature Conservation Act 1992* that the balance of HHI be given conservation area status under this Act. This will remove any pressure for development in the remainder of the development lease area and other land parcels on HHI. The proponent is required to, and is committed to, actively manage the conservation area to enhance conservation values and provide a sustainable level of human access for appreciation of the natural values of HHI and the GBRWHA/NHP. This active management will reduce threats such as weed invasion and predation.

The proponent will also prepare a Wildlife and Habitat Management Plan for management of biodiversity values within the development footprint. This wildlife and habitat management plan, together with the conservation area management plan will include a range of management actions and controls to protect and enhance biodiversity values and manage interfaces between the development footprint and areas set aside for conservation and monitoring programs to check effectiveness of management actions and controls.

Ultimately, the ongoing management of the conservation area will be handed over to the Gladstone Regional Council and funded through a bushland levy to be imposed on landholders at PTP.

With respect to management of the marine environment, the proponent will undertake a marine water quality monitoring program and marine ecosystem monitoring program and if results of this monitoring indicate that degradation of the marine and coastal environment is occurring, the proponent will investigate the causes of this and, if these causes are attributable to PTP, take corrective actions. The frequency of monitoring is proposed to be high enough that any degradation is detected early, before changes become irreversible. Baseline monitoring will be undertaken before any construction commences.

Framework EMPs have been developed and are included in Attachment G.

The assessment has not identified any residual significant or unacceptable impacts that require offsets under the EPBC Act Environmental Offsets Policy (SEWPC 2012).

15.4 Cumulative Impacts

While no significant or unacceptable impacts on MNES were identified from the construction and operation of the proposed PTP, the potential for residual insignificant impacts to combine with impacts of other development in the region was examined. This is important given that the Gladstone Region has a population of nearly 60,000 people and features one of Australia's largest ports and a 29,000 ha State Development Area.

Current ecosystem health in the Port Curtis/Rodds Bay area appears to have been affected by severe wet weather events in January 2011 and January-February 2013 which have affected seagrass beds at both impact and control sites. These effects may have masked other impacts from major capital dredging programs and construction projects with combined footprints of nearly 1,000 ha. However, monitoring undertaken for dredging activities indicates that, apart from during and in the weeks following the severe weather events, water quality and light penetration indicators have been met.

Ecosystem health monitoring undertaken prior to the severe weather events by PCIMP indicated that ecosystem health in Port Curtis and Rodds Bay was good, with very little deviation from background sites.

There are five medium to large development proposals currently undergoing assessment in the region, including a residential development, two industrial developments, a coal export terminal and a capital dredging program. Given the presence of the Port of Gladstone and the Gladstone State Development Area it can also be expected that Gladstone will remain a hub for ongoing port and industrial development.

Under the EPBC Act, development with potential to impact on MNES must be assessed and can only proceed if an approval is given. Development with impacts on the environment generally also requires assessment under Queensland legislation. These processes provide controls on future development such that both levels of government can curtail certain types of development if unacceptable cumulative impacts are predicted.

The population of Gladstone Regional Council is forecast to almost double in the next two decades. The residential component of the proposed PTP and employment opportunities created will make a minor contribution to population increase, but is estimated at 3% of the forecast growth and hence the PTP is not expected to cause population forecasts to be exceeded. Information on the potential future population at PTP has been available to population forecasters since the HHID EIS was released in 2007 and this allows population forecasts to consider the potential effects of PTP.

A growing population will increase pressure on the environment. At a local and regional level, these pressures include clearing land for residential development and generation of wastewater and stormwater. Development approval requirements, including approval requirements under the EPBC

Act and Queensland Government requirements include controls on clearing of land such that biodiversity is maintained. This includes requirements to offset remnant native vegetation and important habitats, if clearing cannot be avoided. Current approaches to stormwater and wastewater management focus on avoiding or minimising discharge of contaminants to surface waters and hence, new developments have reduced impacts in this regard.

A key area of concern in relation to impacts of population increase on the GBRWHA/NHP and GBRMP is the increase in recreational boating activity. An estimated 8-9% of the population owns a boat, although most boat owners use their boats infrequently. The population increase attributable to PTP is expected to contribute about 120 boats to an existing 46,000 registered boats in the Gladstone Region (Hervey Bay to Rockhampton) and 8,300 boats in the immediate Gladstone area. In terms of cumulative impacts associated with existing and forecast levels of boat ownership, this is insignificant. The main effect of PTP on recreational boating will be to provide improved access to the waters around HHI. This is not a cumulative effect however, but rather, a redistribution of activity and associated impacts have been addressed in Sections 8 to 12.

GBRMPA has the ability to control impacts of activities in the GBRMP/GBRCMP through zoning plans and permits. However, lack of information on impacts of recreational activities may make it difficult for GBRMPA to set sustainable limits on these activities, particularly in the short to medium term.

In order to provide a further dimension to the cumulative impact assessment, the EIS also examined the extent to which the proposed PTP might contribute to existing threats to the Great Barrier Reef ecosystem, as identified in the Great Barrier Reef Outlook Report 2009 and to terrestrial biodiversity as identified in Australia's Biodiversity Conservation Strategy 2010-2013 (NRMMC 2010). The assessment identified that PTP is not considered to contribute to any of the identified threats.

Given that PTP does not contribute to cumulative impacts of development at a regional scale, or to threats to the Great Barrier Reef ecosystem or terrestrial biodiversity, no new management or mitigation measures were identified from the cumulative impact assessment.

However, the proponent does recognise that population increases in the Gladstone Regional Council may lead to increased levels of recreational boating and fishing over and above that assessed in this environmental impact statement and that provision of a boat ramp at PTP will lead to local intensification of recreational boating activity. The proponent will seek to work with GBRMPA and relevant Queensland Government agencies with management responsibilities in relation to impacts of recreational boating.

15.5 Consequential and Facilitated Impacts

The consequential impacts of providing improved access to land and water components of the GBRWHA/NHP and the GBRMP have been addressed as part of the impact assessment.

There has previously been a mineral sands exploration permit over part of HHI, however the permit has expired and, if the proposed PTP goes ahead, it is considered unlikely that a new exploration permit or mining lease would be issued. If a proposal to mine mineral sands was put forward by a third party, such a proposal would require assessment under EPBC Act and also Queensland legislation.

Pressure for other types of development on HHI is unlikely to arise. Outside the special lease, tenure is state land and this is therefore not available for development. Further, the proponent has committed to surrendering the remainder of the special lease and creating a conservation area across the balance of HHI.

While PTP will make a small contribution to population growth in the region, any growth is expected to be within existing population forecasts and is not expected to trigger the need for significant additional community services and facilities.

Increase in demand for goods and services will arise due to the proposed PTP. As PTP is located within easy road distance of the Bruce Highway and the population centre of Gladstone, it is unlikely that any providers of goods and services to the proposed PTP would seek to develop substantial additional facilities or premises in currently undeveloped areas. Given the scale of PTP when compared to existing and proposed industrial developments in Gladstone, and the population of Gladstone generally, it is unlikely that significant additional development would occur in Gladstone in order to provide goods and services to PTP.

The proposed PTP will increase tourist numbers in the Central Queensland region which will in turn increase demand for commercial tourism services. Commercial tourism activities in the GBRMP require a permit under the *Great Barrier Reef Marine Park Act 1975* which allows GBRMPA to consider sustainable tourism levels when assessing permits. Commercial tourism activities in the Mackay-Capricorn management area of the GBRMP are lower than in other areas (GBRMPA 2009), and any increases arising from the proposed PTP are expected to be well within sustainable limits. Increased demand for commercial tourism activities associated with the GBRMP will provide economic opportunities in the Gladstone region.

Gladstone already has a marina and associated facilities to support boat based commercial tourism and hence, an increase in demand for these activities is not likely to lead to a demand for further coastal or marine infrastructure.

Increased tourism numbers will also mean increased visitation levels at other tourist attractions in the region. A review of available and planned tourism attractions in the Central Queensland Tourism Opportunity Plan indicates that land based activities currently available are not likely to impact on MNES. Should new tourism activities centred on MNES be developed, these would potentially require assessment under the EPBC Act. The Central Queensland Tourism Opportunity Plan identifies that existing tourist activities are possibly underutilised, and the proposed PTP will also provide tourist and recreational activities as part of the development, hence significant new demand for tourism activities is not expected to arise. Consequential impacts on MNES from an increase in tourism related activities are therefore not expected.

15.6 Compliance with Objectives of EPBC Act

Section 3 of the EPBC Act contains the objectives of the Act. The guidelines for the EIS require discussion of compliance with these objectives. This is provided in Table 15.3.

Table 15.3 – Evaluation of Compliance with Objectives of the EPBC Act

Objective	Response
(a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance	Potential impacts on the environment generally, and on MNES, are evaluated In sections 8 to 13 of the EIS, using a robust methodological framework. The conclusion of the assessment is that no significant or unacceptable impacts on MNES are expected. A range of mitigation measures have been built into the project design and configuration to avoid direct and indirect impacts on MNES and in addition, effective mitigation measures are available to manage significant and potentially significant impacts. In relation to impacts on the environment generally, the project is also subject to a wide range of environmental protection requirements contained as conditions in the Coordinator General's report for the HHID (Queensland Government 2011) and will also be required to obtain detailed approvals under a range of environmental protection and resource management legislation.
(b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources	The project does not draw on or utilise natural resources in an unsustainable manner. Water supply will be from desalination, and a comprehensive wastewater treatment and reuse system and stormwater management system has been developed so that there will be no adverse impacts on water resources. Vegetation clearing arising from the project will be offset in accordance with Queensland Government requirements. The proponent is required by the Coordinator-General's report to establish a conservation area on the balance of HHI outside the proposed footprint and to actively manage this area for conservation values. Households and commercial buildings will have solar power, which will be supplemented by electricity sourced from existing power supply generators and networks. Power generators are subject to carbon emissions trading requirements which are intended to limit carbon emissions to sustainable levels.
(c) to promote the conservation of biodiversity	The proponent is required by the Coordinator-General's report to establish a conservation area on the balance of HHI outside the proposed footprint and to actively manage this area for conservation values.
(ca) to provide for the protection and conservation of heritage	The principle heritage values present at HHI relate to its location within the GBRWHA and national heritage place. Assessment of potential impacts on the GBRWHA and national heritage place has not identified any significant or unacceptable impacts. The project will provide an opportunity to present the Mackay-Capricorn region of the GBRWHA and raise awareness of the WHA/NHP and associated outstanding universal values.

Objective	Response
(d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples;	The proponent of the project has already entered into discussions with local government regarding sustainable development controls and management of the proposed conservation area, indicating a cooperative approach to land management and management development. Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI. The proponent will also seek to work with Maritime Safety Queensland and the Queensland Department of National Parks, Recreation, Sports, and racing in relation management of boating activities in the waters around HHI, which include the GBRCMP.
(e) to assist in the co-operative implementation of Australia's international environmental responsibilities;	The project provides an opportunity to present the world heritage values of the GBRWHA. This will assist Australia in meeting its obligations in relation to presentation of world heritage values. As noted above, the project will not detract from any of the MNES values that Australia is obliged to protect under its treaty obligations.
(f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity;	Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI. HHI is located within the PCCC TUMRA and this may also present opportunities to partner on traditional knowledge and management approaches.
(g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.	Traditional owners have also indicated interest in participating in training programs in relation to tourism occupations that could include a ranger program associated with the environmental management of the undeveloped areas of HHI. HHI is located within the PCCC TUMRA and this may also present opportunities to partner on traditional knowledge and management approaches.

15.7 Compliance with Principles of Ecologically Sustainable Development

Section 3A of the EPBC Act sets out the principles of ecologically sustainable development. Section 136 2(a) of the EPBC Act requires the Minister to consider principles of ecologically sustainable development when making decisions regarding approvals of actions. These principles are drawn from the National Strategy for Ecologically Sustainable Development (Australian Government 1992).

The PTP is designed from the ground up on ESD principles. Triple bottom line factors of economic, social and environmental issues have been considered and incorporated into the master planned project from the design stage. The guidelines for this EIS require discussion of compliance with the principles of ecologically sustainable development. This discussion is presented in Table 15.4.

Table 15.4 – Evaluation of Compliance with Principles of Ecologically Sustainable Development

Objective	Response
(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equity considerations	The material presented in this EIS supports decision making processes that integrate economic, environmental and social dimensions of sustainability. The proponent has also already undertaken formal and informal community consultation including formal public review of an EIS prepared under the Queensland SDPWOA. Comments made on the EIS were responded to by the proponent in a Supplementary EIS (SKM 2010) and taken into consideration by the Queensland Coordinator-General in preparation of a Coordinator-General's report recommending that the project proceed (Queensland Coordinator-General 2011). The impact assessment has not identified any significant or unacceptable impacts on MNES or on the environment generally. In particular, the proposed development footprint and design avoids impacts on sensitive features of HHI and surrounding waters. The proposal will provide economic and social benefits including: • Regional expenditure. An estimated $950 million will be spent on infrastructure, buildings and other facilities during the development phase, a period of about 16 years. Expenditure by international, interstate and domestic visitors is estimated at $65 million by year 9 of the proposed development and $95 million in year 17, once the project is fully developed. • Employment opportunities, particularly in the construction, hospitality and tourism sectors. This will help to diversify the labour force in central Queensland. An average of 190 direct construction jobs is expected to be generated over the 16 year development period and at full capacity, the development is expected to provide 700 direct jobs in tourism, hospitality and related areas. • Expenditure and employment opportunities will lead to diversification of the local and regional economy which is currently heavily reliant on agriculture, resource extraction and manufacturing • New holiday and recreational opportunities will be created for residents in the central Queensland area. This will contribute to improved quality of life. • The project will include a wide range of accommodation and housing options to provide varying levels of affordability, from camping ground to a hotel-style resort. This will allow the recreational and leisure benefits of the proposal to be available to a wide social demographic. • Increased access to the GBRWHA and GBRMP/GBRCMP for enjoyment of the features and values of these by both residents in the region and visitors to the region. There are limited opportunities to access and enjoy the Mackay-Capricorn region of the GBRWHA/GBRMP. The proposal is consistent with and contributes to State and regional policies and plans, including in relation to regional tourism development (see also Section 3). The Central Queensland Tourism Opportunity Plan (2009-2019) identifies a lack of tourism and recreational opportunity in the region.

Objective	Response
(b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;	The impact assessment of the project has not identified any serious or irreversible threats to the environment. Vegetation clearing required for the proposed development is effectively irreversible however the loss of this vegetation has not been identified as causing any significant impacts on MNES or overall biodiversity values. Further, clearing of vegetation must be offset in accordance with Queensland Government offset policies such that there is no net loss in biodiversity.
(c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;	The project is not expected to have any adverse impacts on the health, diversity and productivity of the environment such that adverse impacts on current or future generations might occur. There are no particular elements of the community that will adversely affected by the project. The proposed development will provide a valuable holiday destination and recreational opportunity for current and future generations, meeting a shortfall in such facilities in the region. Accommodation options and facilities have been selected to provide for and appeal to a wide social demographic.
(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	This EIS has not identified any adverse impacts on biological diversity or ecological integrity. The proposed development footprint and design avoids impacts on sensitive features of HHI and surrounding waters and includes features to avoid degradation of water resources. Vegetation clearing is required however the loss of this vegetation has not been identified as causing any significant impacts on MNES or overall biodiversity values. Further, clearing of vegetation must be offset in accordance with Queensland Government offset policies such that there is no net loss in biodiversity. The proponent also proposes, and is required as a condition of the Queensland Coordinator-General's report, to make the balance of HHI a conservation area. The Queensland Coordinator-General has recommended to the Queensland Minister for Nature Conservation that the balance of HHI be given conservation area status under the Queensland Nature Conservation Act 1993.
(e) improved valuation, pricing and incentive mechanisms should be promoted.	As the project does not involve ongoing exploitation of natural resources, this principle is not directly relevant to the proposal. The project includes a comprehensive water cycle management approach that promotes sustainable use of water through provision of potable and non-potable water to buildings and facilities. Pricing of water and the availability of a range of water supply options will encourage residents and businesses to utilise the appropriate water stream, however design requirements will also make it mandatory to utilise non-potable (recycled) water for suitable uses. Incentives to utilise electricity sustainably are provided through the Australian government's carbon tax.

15.8 Conservation Objectives

Identified conservation objectives in relation to protection of MNES values are as follows:

- Aesthetic values are retained such that views from within the GBRWHA/NHP are not degraded
- Coastal processes of beach and dune formation are not altered
- Estuarine processes associated with tidal waterways and erosion and accretion of sand banks and mud flats are not altered
- HHI remains clearly recognisable as a continental island
- Aboriginal cultural heritage is conserved and managed through the agreed cultural heritage management plan
- Coastal wetlands, supratidal, intertidal and subtidal habitats are not degraded
- Waters around HHI continue to provide habitat for marine turtles and dugong
- Water quality and hydrological conditions in coastal and enclosed coastal waters surrounding HHI is not degraded when compared to water quality objectives
- Representative examples of all terrestrial ecological communities and habitats are retained and protected
- Floristic diversity, including EPBC Act listed ecological communities, is retained and protected
- Migratory shorebird habitat is not disturbed or degraded
- All elements that contribute to the OUV of the GBRWHA are retained in recognisable and viable condition
- Threats to the GBR ecosystem and habitats and species that are components of the ecosystem are not exacerbated
- Tourists, other visitors and residents are made aware of the MNES values and other environmental values of HHI and surrounding waters and how to protect these values while staying at the development and undertaking activities in and around HHI.

The assessment undertaken for PTP demonstrates that all conservation objectives can be achieved.

SECTION 16
References / Abbreviations / Glossary

Contents

16. References / Abbreviations / Glossary

16.1 References

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16.2 Abbreviations

µg	microgram (one millionth of a gram)
µS/cm	Micro-siemens per centimetre (measure of conductivity)
AADT	Average Annual Daily Traffic
ABS	Australian Bureau of Statistics
ACH Act	Aboriginal Cultural Heritage Act 2003 (Qld)
ACMER	Australian Centre for Mining Environmental Research
ADWF	Average dry weather flow
ADWQG	Australian Drinking Water Quality Guidelines
AEMSC	Australian Explosives Manufacturer Safety Committee
AGCSA	Australian Gold Course Superintendents' Association
AGO	Australian Greenhouse Office
AHD	Australian Height Datum
ALMP	Artificial Lighting Management Plan
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average rRecurrence Iinterval
ARI	Annual Rreturn Iinterval
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
ASC	Australian Soil Classification
ASFB	Australian Society for Fish Biology
ASMP	Acid Sulfate Management Plan
ASS	Acid Sulphate Soils
ASSMP	Acid Sulfate Soil Management Plan
AWQG	Australian Water Quality Guidelines
BA	Birds Australia
BCC	Brisbane City Council
BCR	Benefit Cost Ratio
BEMP	Best environmental management practices
BOD	Biological Oxygen Demand
BoM	Bureau of Meteorology
BP	Before present
BPA	Environmental Protection Agency Biodiversity Planning Assessment
BPA	Biodiversity Planning Assessment
BTO	Build, transfer, operate
BZ	Buffer Zone
Ca:Mg	Calcium: Magnesium ratio
CAD	Computer Aided Drafting
CAMBA	China-Australia Migratory Bird Agreement
CASA	Civil Aviation Safety Authority
CBA	Cost Benefit Analysis
CEMP	Construction Environmental Management Plan
CES	Coastal Engineering Solutions

CG	Coordinator General
CHMP	Cultural Heritage Management Plan
CHRIS	Coastal Habitat Resources Information System database
CLR	Contaminated Land Register
cm	Centimetre
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalents
CPTED	Crime Prevention through Environmental Design
CQ	Central Queensland
CQU	Central Queensland University
CRC Reef	Cooperative Research Centre Reef
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cz	Holocene aged sand, gravel, soil; coastal sand and swamps.
DAFF	Department of Agriculture, Forestry and Fisheries
dB	Decibel
dB(A)	Decibels adjusted
DEEDI	[former] Department of Employment, Economic Development and Innovation
DEH	[former] Department of Environment and Heritage (now Department of Environment and Water Resources (DEW))
DEHP	Department of Environment and Heritage Protection
DEOs	Desired Environmental Outcomes
DERM	[former] Department of Environment and Resource Management
DEW	[former] Department of Environment and Water Resources (Commonwealth)
DEWHA	[former] Department of Environment, Water, Heritage and the Arts
DEWR	[former] Department of Environment and Water Resources
DI	[former] Department of Infrastructure (formally the Office of the Coordinator General)
DLGPSR	[former] Department of Local Government, Planning, Sport and Recreation
DMR	[former] Department of Main Roads
DNPRSR	Department of National Parks, Recreation, Sport and Racing (Qld)
DNRM	Department of Natural Resources and Mines
DNRW	[former] Department of Natural Resources and Water
DO	Dissolved Oxygen
DotE	Department of the Environment (Commonwealth)
DPA	Dugong Protection Area
DPI	[former] Department of Primary Industries (Qld)
DPI&F (now DEEDI)	[former] Department of Primary Industries and Fisheries (Qld)
DSDIP	[former] Department of State Development, Infrastructure and Planning
DSDTI	[former] Queensland Department of State Development, Trade and Innovation
DTMR	Department of Transport and Main Roads
DVO	Desired visual outcome
E, V, R, (NCA)	Endangered, vulnerable and rare under the Nature Conservation Act
EA	Environmental authority

EHMP	Ecosystem Health Monitoring Program
EIL	Environmental investigation level
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMR	Environmental Management Register
EP	Equivalent persons
EP Act	Environmental Protection Act 1994
EPA (now DERM)	[former] Environmental Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPM	Exploration Permit for minerals
EPP(Noise)	*Environmental Protection (Noise) Policy 2008*
EPP(Air)	*Environmental Protection (Air) Policy 2008*
EPP(Water)	*Environmental Protection (Water) Policy 2009*
ERA	Environmentally relevant activity under the *Environmental Protection Act 1994*
ESCP	Erosion & and sediment control plan
ESD	Ecologically sustainable development
EV	Environmental value
FHA	Fish Habitat Areas
GAPDL	Gladstone Area Promotion and Development Ltd
GAWB	Gladstone Area Water Board
GBR	Great Barrier Reef
GBRCMP	Great Barrier Reef Coastal Marine Park
GBRHNP	Great Barrier Reef National Heritage Place
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GFA	Gross floor area
GHG	Greenhouse gas
GP	Gross pollutants
GPC	Gladstone Ports Corporation
GQAL	Good Quality Agricultural Land
GRC	Gladstone Regional Council
GRP	Gross Regional Product
GSDA	Gladstone State Development Area
GSP	Gross State Product
Ha	Hectare
HAT	Highest Astronomical Tide
HHI	Hummock Hill Island
HHID	Hummock Hill Island Development
HIL	Health-based Investigation Level
hr	Hour
HV	High voltage
HVAC	Heating, ventilation, and air conditioning

HVSD	High Velocity Sonic Disintegrator
IAIA	International Association of Impact Assessment
IAS	Initial Advice Statement
IDAS	Integrated Development Assessment System
IFD	Intensity, Frequency and Duration
IGAE	Intergovernmental Agreement on the Environment
ILUA	Indigenous Land Use Agreement
IP Act	Integrated Planning Act 1997 (Qld) (superseded)
IPCC	Intergovernmental Panel on Climate Change
IPMP	Integrated pest management plan
ITMP	Integrated turf management plan
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
Kg	Kilograms
kL	Kilolitre
km	Kilometre
km^2	Square kilometre
kV	Kilovolt
kWh	Kilo-watt hour
L	Litre
L/p/d	Litres per person per day
LCU	Landscape character unit
LED	Light-Emitting Diode
LGA	Local Government Area
LPG	Liquid petroleum gas
LV	Low voltage
m	metre
M, Ma (EPBC)	Migratory and Marine listed species under the EPBC Act
mAHD	Metres above Australian Height Datum
MDL	Mineral Development Licence
MEDLI	Model for effluent disposal by land irrigation
MEMP	Marine ecological monitoring plan
Mg	Milligrams
Mg/l	Milligrams per litre
MHHS	Mid-Holocene High Stand
ML	Megalitre (one million litres)
mm	Millimetres
MNES	Matter of national environmental significance (as defined by the EPBC Act)
MSDS	Material Safety Data Sheet
Mt (Air Quality)	Metatonnes
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
MVC	Mechanical vapour compression
NATA	National Association of Testing Authorities

NBSAPs	National Biodiversity Strategies and Action Plans
NC Act	Nature Conservation Act 1992 (Qld)
NEPM	National Environmental Protection Measure
NGA	National Greenhouse Accounts
NHMRC	National Health and Medical Research Council
NHP	National Heritage Place
NLWRA	National Land and Water Resource Audit
NOX	Oxides of nitrogen
NPV	Net present value (economics)
NSW	New South Wales
NT Act	Native Title Act 1993 (Cth)
OC	Of Concern species under the *Vegetation Management Act 1999* (Qld)
OEMP	Operational Environmental Management Plan
OESR	Queensland Office of Economic And Statistical Research
OUV	Outstanding universal value
pa	Per annum
PASS	Potential Acid Sulfate Soil
PCCC	Port Curtis Coral Coast
PCIMP	Port Curtis Integrated Monitoring Program
PIFU	Population Information and Forecasting Unit
PM	Particulate matter
POD	Plan of Development
PPT	Pacificus Tourism Project
PRm	Permian to Triassic aged granodiorites, tonalite and diorite.
Pug	Upper Permian aged granodiorite and minor adamellite.
PVMP	Property Vegetation Management Plan
Q100	An event that occurs roughly once every 100 years
QASSIT	Queensland Acid Sulfate Soils Investigation Team
Qb	Quaternary aged coastal beach ridges.
QFRS	Queensland Fire and Rescue Service
QFS	Queensland Fisheries Services
QH	Queensland Herbarium
QH Act	Queensland Heritage Act 1992
Qhn	Holocene aged mangroves swamps, mudflats and saltpans.
Qld	Queensland
Qm	Quaternary aged mangrove swamps and saltpans.
QPWS	Queensland Parks and Wildlife Service
QT	[former] Queensland Transport
QUACES	Queensland University Advanced Centre for Earthquake Studies
QUDM	Queensland Urban Drainage Manual
QWQG	Queensland Water Quality Guidelines
RAP	Remediation Action Plan
RCMP	Regional Coastal Management Plan

RE	Regional Ecosystem (Queensland classification)
RGMF	Regional Growth Management Framework
RTC	Rural Transaction Centre
RVMC	Regional Vegetation Management Code
RWMP	Recycled water management plan
RWQPP	Reef Water Quality Protection Plan
SAGCA	Society of Australian Golf Course Architects
SCMP	State Coastal Management Plan
SD	Statistical Division
SDA	State Development Area
SDPWO Act	*State Development and Planning Works Organisation Act 1971* (Qld)
SIA	Social Impact Assessment
SKM	Sinclair Knight Merz
SL	Special Lease
SLA	Statistical Local Area
SMD	Slightly to moderately disturbed (in relation to aquatic ecosystems)
SMP & SWMP	Stormwater Management Plan
SP Act	Sustainable Planning Act 2009 (Qld)
SPP	State Planning Policy
spp	Species (plural)
SPTR	Standard Percolation Test Rate
sqm	Square meters
SS	Suspended Solids
Sv	Vulnerable
TA	Technical Advisors
TAFE	Technical and Further Education
TN	Total Nitrogen
TOFO	Traditional Owner Field Officers
ToR	Terms of Reference as described in Part 4 of the State Development and Public Works Organisation Act 1971 (Qld)
TP	Total Phosphorus
TSM	Total Suspended Matter
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UST	Underground Storage Tank
UV	Ultra violet
V (Ecology)	Vulnerable under the Nature Conservation Act 1992 (Qld)
VM Act	Vegetation Management Act 1999 (Qld)
VMP	Vector Management Plan
VPD	Vehicles Trips per Day
VPH	Vehicles Trips per Hour
VSZ	Viewshed significance zone

WBBRP	Wide Bay Burnett Regional Plan
WBBRPU (Social)	Wide Bay Burnett Regional Planning Unit
WMCP	Wetland mapping and classification program
WMP	Waste Mmanagement Pplan
WQ	Water quality
WQMP	Water quality management plan
WQO	Water quality objectives
WSUD	Water sensitive urban design
WWTP	Waste Water Treatment Plant

16.3 Glossary

Term	Definition
Abiotic	Pertaining to physical and inorganic components of the environment; non-living.
Acidic	Quality of being acid; having a pH of less than 7 (see pH)
Acoustic	Acoustics is the science of sound concerned with *the generation, transmission and reception of energy in the form of vibrational waves in matter*.
Aeolian	Pertaining to the wind, referring to sediments or particles transported and deposited by wind, including as a means of sand dune formation
Allochthonous material	Organic matter that is derived from outside of the aquatic ecosystem, such as leaves of terrestrial vegetation that fall into the stream.
Alluvial (alluvium)	Weathered material transported and deposited by the movement of water.
Alluvial forests	Forests growing in alluvial soils, mainly sand and silt, that a river has carried in suspension and then deposited.
Alluvial plain	A plain formed by the deposition of alluvial material over a long period of time.
AMAs	Administrative arrangements developed by the EPA, Local Government and other parties for land where detailed information is not available but the community is to be provided with information that aids in dealing with land contamination.
Animal	Any member, alive or dead, of the animal kingdom (other than a human being).
Annual Exceedance Probability (AEP)	The probability that a given flood or river discharge flow will be exceeded in any one year, usually expressed as a percentage.
Anthropogenic	Effects, processes, objects or materials which do not occur in natural environments but are as a result of, or derived from human activities
Aquatic macrophyte	Submerged, emergent or floating aquatic vegetation that is visible to the naked eye.
Aquiclude	A boundary layer that prevents soil water infiltration.
Aquifer	A water-bearing stratum of permeable rock, sand, or gravel
Aquifer	A rock type with relatively large permeability, able to transmit substantial quantities of water
Australian Height Datum (AHD)	The datum used for determining elevations in Australia which uses a national network of bench marks and tide gauges, and has set mean seal level as zero elevation
Autochthonous	Material such as a sediment or rock that can be found at its site of formation or deposition
Average Recurrence Interval (ARI)	The average interval (in years) between the occurrence of a flow, discharge or rainfall greater than or equal to a specified amount.
B horizon	The second or subsurface zone of soil made of clay and oxidised materials and organic matter obtained from the A horizon by leaching.
Background noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor.
Batholith	A batholith is a large emplacement of igneous intrusive (also called plutonic) rock that forms from cooled magma deep in the Earth's crust. Batholiths are almost always made mostly of felsic or intermediate rock-types, such as granite, diorite or lighter coloured forms of andesite.
Barrier beaches	Elongate sandy ridges slightly above high tide level, and running parallel to the shoreline – extended by long shore transport (Brennan, 2004).
Benthic	Pertaining to the bottom of a body of water.
Biodiversity	Biodiversity is short for “biological diversity”. It describes the variety of life forms and their habitats that make up a region. Biodiversity includes the diversity of plant and animal species, the diversity of ecosystems formed by communities of

Term	Definition
	these organisms, and the genetic diversity within and between species.
Biogenic sediment	Sediment produced by the actions of living organisms.
Biotic	Pertaining to living organisms, and usually applied to the biological aspects of an organism's environment.
Boyne Creek	The water body forming the channel to the south of Hummock Hill Island.
Bunding	An artificially created boundary, usually in the form of an embankment used to prevent sediment and substances from entering a water stream or storage facility.
CAMBA	CAMBA means the Agreement between the Government of Australia and the Government of the People's Republic of China for the protection of Migratory Birds and their Environment done at Canberra on 20 October 1986, as in force for Australia immediately before the commencement of this Act.
Carboniferous	The period of geological time extending from about 360 to 290 million years ago.
Catena	A non-taxonomic group of soils about the same age, derived from similar parent materials and occurring under similar climatic conditions but having unlike characteristics because of variations in relief and drainage
Cease to flow	The period where water ceases to flow.
Coastal Plain	Any plain with its margins on the shore of the sea. Generally a flat featureless area of low relief which is usually underlain by sediments.
Colluvium	A general term applied to loose and incoherent materials accumulated at the foot of a slope, generally by movement of the material by gravity.
Colosseum Inlet	The water body to the west and southwest of HHI
Common	In reference to plants or animals that are common or abundant and are likely to survive in the wild.
Commonwealth marine area	The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters.
Community	An assemblage of interdependent populations of different species (plants and animals) interacting with one another, and living in a particular area.
Compensatory habitat	A vegetation offset to maintain the extent of remnant vegetation that will be loss as a result of the Project.
Conglomerate	Coarse sedimentary rock containing cemented rounded gravel or pebbles.
Connectivity	Refers to the ease with which organisms move between particular landscape elements.
Controlled action	An action (including a project, development, undertaking, activity, or series of activities) that is likely to have a significant impact on a matter of National Environmental Significance, as defined by the Commonwealth Minister of the Department of Environment and Water. If an action is controlled it is subject to a rigours assessment and approval process under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999.*
Covenant	An agreement or contract between two parties (i.e. landholder and council).
Cracking clay	Clay soil from surface with large cracking patterns. Usually with gilgai surface features.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
Dead Storage	The volume in a water storage below the lowest operable level.
Dendritic	Having a form resembling a shrub or tree
Denuded (denudation)	The removal of matter. Commonly used to describe the removal of vegetation, but also refers to the process of mass, or rapid, sediment removal
Dermosols	Soils lacking strong texture contrast and having a structured B horizon.

Term	Definition
Dispersion	To distribute or suspend fine particles, such as clay, in or throughout a dispersion medium, such as water
Duplex	Light surface texture or clay loam abruptly overlaying clay.
Ecology	The study of the interrelationships of organisms with and within their environment
Ecosystem	A community and its (living and nonliving) environment considered collectively; the fundamental unit in ecology.
Edge effect	All changes at an ecosystem boundary and within adjacent ecosystems; the negative influence of a disturbed habitat edge on the interior conditions of a habitat, or on species that use the interior habitat.
Endangered	In relation to a species, indicating that: there have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife; or the habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction; or the population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction; or the survival of the wildlife in the wild is unlikely if a threatening process continues.
Endangered Regional Ecosystem	A regional ecosystem is listed as endangered under the Vegetation Management Act 1999 if remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares.
Endemic	Restricted to a certain region or part of region.
Environment	The total of all the external conditions that act upon an organism.
Environmental flow	The flow of water that is required to maintain aquatic and riparian ecosystems in streams and rivers.
Environmental Flow Objective (EFO)	Performance indicators set out in the *Water Resource (Mary Basin) Plan 2006* for the measurement of the environmental performance of the Mary Basin.
Environmental quality	Human (individual or social) concepts of desirable ecological situations.
Ephemeral	Transitory, short-lived.
Erosion	The process by which rocks are loosened, worn away and removed from parts of the Earth's surface. Seven processes of erosion discussed separately; in practice they overlap and it is often difficult to isolate the net effects of any one process. Rainsplash erosion: the detachment and removal of soil and debris by raindrop impact. Overland flow OR surface runoff: water flowing over the surface before being concentrated into definite streams. Sheet erosion, sheet wash, or slope wash: the combined effect of overland flow and rainsplash. Gully erosion: the rapid development of gullies, usually in first- or second-order tributaries of streams, BUT also in situations unrelated to an integrated drainage system (eg highly dispersive soils) Mass Movement: downhill movement of debris *en masse* rather than as individual particles. It can occur slowly (creep), or rapidly (rockfalls, slumps, landslides). Surface rock creep: the movement of stones down sloping surfaces. Fluvial erosion: the detachment and removal by streams of material in solution, suspension, or as bed load. Includes removal of debris supplied to the streams by slope wash, mass movement, and gullies.
Essential habitat	Vegetation in which a species of wildlife is known to occur that is listed as endangered, vulnerable, near threatened or rare under the *Nature Conservation*

Term	Definition
	Act 1992.
Estuarine	The mouth region of a river that is affected by tides
Euphotic zone	Surface layer of a body of water which receives enough sunlight for photosynthesis.
Eutrophication	Process during which water bodies become enriched with dissolved nutrients resulting in excessive growth of organisms, such as algae, and the subsequent depletion of oxygen.
Evaporation	The process that changes a liquid or a solid into a gas. In the tropical hydrological cycle, this involves the conversion to water vapour and the return to the atmosphere of the precipitation (rainfall) that has reached the earth's surface.
Evapotranspiration	The combined effect of evaporation and transpiration.
Exotic species	Introduced species, that is, species that are not considered native to Australia
Ex-situ	Ex-situ means off site, i.e. protecting a species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location.
Fauna	See definition for 'animals'
Feral	An introduced or domestic animal living in the wild.
Ferrosols	Soil lacking strong texture contrast and having high free iron in B horizon.
Flood Plain	That portion of a river valley that is covered during periods of high flood water.
Flora	The collective plants growing in a geographic area (see definition for 'plants').
Fluvial	The river system.
Fragmentation	A process of landscape alteration in which natural areas are subdivided into smaller patches.
Geomorpological Time Periods	Proterozoic (2500-545 million years ago) During the Proterozoic two mountainous blocks, the Mt Isa Inlier and the Georgetown massif (current area of the Einasleigh Uplands) were formed. Formation was a result of faulting, folding, thrusting of deposited marine and terrestrial sediments, extrusive volcanics and igneous intrusions. Widespread metamorphism was associated with igneous intrusions and the deforming tectonic activities (Brennan, 2004). Palaeozoic (545-251 million years ago) Extensive erosion and planation was the major process occurring during this period. Weathered sediments were stripped from the two Proterozoic blocks and deposited within the Tasman geosyncline between these two divisions. North-west of the Proterozoic Mt Isa Inlier, a shallow sea transgressed from the south depositing carbonate-dominated marine sediments. These comprise the Barkly Tableland of the upper Nicholson and Settlement Catchments today. In the Einasleigh Uplands some extrusive volcanics accompanied erosion processes and resulted in the formation of the Newcastle and Croydon Ranges in the Norman and Gilbert Catchments. In the west, erosion continued to form an extensive plain that grew eastwards, and by the early Mesozoic, the whole of the Gulf region was reduced to a flat plain (Brennan, 2004). Mesozoic (251-65 million years ago) The Proterozoic to Mesozoic cycle of erosion was terminated by earth movements that warped the flat plains. The result was the transgression (higher sea levels) of the sea into the Carpentaria and Eromanga Basins and the widespread deposition of Mesozoic sediments, namely sandstone, siltstone, mudstone, limestone, shale and conglomerate overlying the erosion surface of old, deformed Proterozoic rocks. By the end of the Mesozoic, the only extruding Palaeozoic rocks remained in the east (Einasleigh Uplands) (Brennan, 2004). Early-Mid Tertiary (65-34 million years ago) During this period the Mesozoic plain was uplifted ad warped resulting in widespread erosion of the Mesozoic sediments. By the Mid-Tertiary most of the area was again reduced to a low relief plain that underwent laterisation (Brennan,

Term	Definition
	2004). Late Tertiary – Quaternary (34 million years ago to present) Uplifting and warping increased slopes and initiated another period of erosion and planation. Streams adjusted to a new base level (increased sea levels) and the erosional surfaces extended inland forming the dissected river valleys seen today. At the upland margins of the Gulf Plains, the late Cretaceous rocks (end of the Mesozoic period) were removed, and within the steeper ranges rocks formed at end of the Palaeozoic period were eroded away. Accompanying widespread erosion was extensive deposition and the formation of new alluvial fans in the lower reaches of the Gulf Catchments (Brennan, 2004). Along the coastline, down-warping lowered the laterised older Tertiary plain to wave action level (hence increased sea levels). This formed low cliffs and a marine terrace. Due to a low offshore gradient and wave action, and high loads of terrestrial sedimentation, constructional landforms were formed (eg, barrier beaches and islands). A later drop in sea level and subsequent emergence of land led to the abandonment of barrier beaches that occur as parallel ridges around the Gulf of Carpentaria today, and the formation of a new lower, marine terrace (Brennan, 2004). Some volcanic eruptions in the eastern block (Einasleigh Uplands) also occurred during this period, resulting in infilling of older valleys, particularly in the upper Flinders and Gilbert Catchments (Brennan, 2004).
Geomorphology (geomorphological)	The form or shape of the landscape and the processes that modify and change it.
Gilgai	Melon hole, mound depression surface
Global Warming	The warming of the earth's atmosphere generally attributed to the burning of fossil fuels. Also referred to as "The Greenhouse Effect" - the capacity of the atmosphere to transmit short-wave energy (visible and ultra violet light) to the earth's surface, and to absorb and retain heat radiating from the surface.
Groundwater	Water found underground in porous rock or soil strata
Habitat	The biophysical medium or media occupied (continuously, periodically or occasionally) by an organism or group of organisms.
Herpetofauna	Includes reptiles and amphibians.
Highest Astronomical Tide (HAT)	The highest tide level which can be predicted to occur under any combination of astronomical conditions.
Holocene	Refers to a geological period of time between the present and 10,000 years before present.
Hydraulic	Mechanical properties of liquids.
Hyporheic	Hyporheic zone is where there is mixing of shallow groundwater and surface water in a region beneath and lateral to a stream bed
Igneous rocks	Rocks formed by the solidification of molten material from far below the Earth's surface
Impermeable	Material through which substances, such as liquids or gases, cannot pass.
Intertidal	The area between high and low tide.
Intrusive noise	Refers to noise that intrudes above the background level by more than 5 dB(A).
JAMBA	JAMBA means the Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment done at Tokyo on 6 February 1974, as in force for Australia immediately before the commencement of this Act.
Kandosols	Soils lacking strong texture contrast and having a massive B horizon.
Kurosols	Soils with strong texture contrast and having pH <5.5 in B horizon.
$L_{A(xx)}$	The $L_{A(XX)}$ refers to statistical indicators that represent the percentage of time that a noise level is exceeded. These levels are commonly the L_{A1}, L_{A10}, and the

Term	Definition
	L_{A90}, and are graphed to show how these levels change over the course of a 24 hour period.
L_{A90}	Is an important statistical indicator that represents the A-weighted sound pressure level that is exceeded for 90% of the time over which the noise is measured. This is often termed the background noise.
L_{Aeq}	Although the L_{Aeq} is not a statistical indicator, it is probably one of the most important of the noise descriptors. It represents the equivalent continuous A-weighted noise level for the measurement period. This is the level of noise energy averaged over the measurement period.
L_{Amax} Maximum noise level	The highest noise level during a specified time period or during a specified number of events expressed as the absolute maximum value of the root-mean-square (r.m.s.) sound pressure level using time weighting 'F'.
L_{Amin} Minimum noise level	The lowest noise level during a specified time period or during a specified number of events expressed as the absolute minimum value of the root-mean-square (r.m.s.) sound pressure level using time weighting 'F'.
'Least Concern' Regional Ecosystem	A regional ecosystem is listed as least concern under the Vegetation Management Act 1999 if remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares.
Lentic habitat	Standing or still water habitats such as lakes and ponds.
Listed species	A plant or animal included in a schedule of vulnerable, rare or endangered biota, such as the schedules in the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) or the *Nature Conservation (Wildlife) Regulation 2004* (Qld).
Littoral vegetation	Vegetation that occurs within the littoral zone.
Littoral zone	Region of shallow water near the shore of a body of water where light reaches the bottom.
Lotic habitat	Flowing water habitats such as rivers and streams.
Macroinvertebrate	Organisms without a backbone which are large enough to be seen with the naked eye.
Microhabitat	Within this habitat area there is a low availability of ground microhabitat including leaf litter, logs and branches
Migratory species	A migratory species listed and protected under the provisions of the EPBC Act.
Native species	A species that is indigenous to Australia or an external Territory, or periodically or occasionally visits.
Natural Environment	The complex of atmospheric, geological, and biological characteristics found in an area in the absence of artefacts or influences of a well-developed technological human culture.
Notifiable Activity	Those activities that cause or are likely to cause contamination as listed under Schedule 2 of the EP Act.
'Of Concern' Regional Ecosystem	A regional ecosystem is listed as of concern under Vegetation Management Act 1999 if remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 30 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares.
Old growth forests	Forests that are both little disturbed and ecologically mature.
Opportunistic	When the conditions are ideal.
Pelagic zone	The water column associated with the surface or middle depths of a water body, away from the bottom.
Permeability	The capacity of a material (rock) to transmit fluids (groundwater)
Permeable Rock	Rock through which water can pass, either via (a) a network of pores between the grains, or (b) interconnected joints, bedding planes and fissures (more correctly termed

Term	Definition
	'pervious rock')
Permian	The period of geological time extending from about 285 to 250 million years ago.
pH	"power hydrogen". Negative logarithm of hydrogen-ion concentration; a numerical expression of acidity or alkalinity.
Plant	A member, alive or dead, of the plant kingdom or of the fungus kingdom, and includes a part of a plant and plant reproductive material.
Pleistocene	The first part of the Quaternary period of geological time lasting from about 2 million years to 10,000 years ago.
Population	Occurrence of a species or ecological community in a particular area.
Porosity	Is a measure of void spaces in various rock types.
Precambian	The period of geological time extending from about 285 to 250 mya.
Precipitation	A collective term for the moisture, either liquid or solid, that falls on the earth from the atmosphere. In North Queensland this is usually in the form of rain.
Probable Maximum Flood (PMF)	The flood resulting from the worst flood-producing catchment conditions that can be realistically expected in the prevailing meteorological conditions.
Propagation	The reproduction of plants.
Rare	An animal is rare / near threatened if: the population size or distribution of the wildlife is small and may become smaller; or the population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife; or the survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming vulnerable.
Recharge	The process involving the infiltration of water from the surface to groundwater.
Recovery plans	A recovery plan is a document stating the research and management actions necessary to stop the decline, support the recovery and enhance the chance of long-term survival in the wild, of a stated species or community of protected wildlife.
Regional Ecosystems	Regional ecosystems were defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil.
Regrowth	A young, usually even-aged forest stand that has regenerated after disturbance.
Rehabilitation	Making the land useful again after a disturbance. It involves the recovery of ecosystem functions and processes in a degraded habitat.
Regulated Waste	Waste defined under the Qld Environmental Protection (Waste) Policy as waste that contains a significant quantity and concentration of a hazardous contaminant; or waste in which the hazardous contaminant exhibits hazardous characteristics because of its toxicity, carcinogenicity, mutagenicity, teratogenicity, flammability, corrosivity, reactivity, ignitability or infectiousness, through its physical, chemical or biological characteristics; or waste that may cause environmental harm if improperly transported, treated, stored, disposed or otherwise managed.
Rehabilitation	Making the land useful again after a disturbance. It involves the recovery of ecosystem functions and processes in a degraded habitat.
Remnant vegetation	Small remaining areas of naturally occurring vegetation in a landscape that has been altered by human activity such as agriculture. These remnants were once part of a continuously vegetated landscape.
Riparian	Pertaining to, or situated on the bank of, a body of water, especially a watercourse such as a river.
Riverine	Pertaining to rivers

Term	Definition
Rodds Bay	The water body to the North of Hummock Hill Island.
Salinity	The concentration of any salt.
Sediment	Any usually finely divided organic and / or mineral matter deposited by air or water in non-turbulent areas.
Seven Mile Creek	The water body to the East of Hummock Hill Island.
Slickensides	Parallel striations on rock surfaces produced by relative motion across opposite sides of fault planes. They may appear similar to the striations produced by glaciers but can be seen to pass into the body of the rock.
Soil Aggregation	The lumping together of soil particles into a coherent mass.
Soil Profile	The physical and chemical features of the soil imagined or seen in vertical section from the surface to the point at which the characteristics of the parent rock are not modified by surface weathering or soil processes.
Species	A group of biological entities that (a) interbreed to produce fertile offspring; or (b) possess common characteristics derived from a common gene pool.
Species richness	A botanical term indicating a measure of the number of species of plants or animals occurring in a given area.
Spotter/catcher	An ecologist who is accredited by the QPWS to capture and relocate fauna (mainly mammals) from trees prior to vegetation clearance.
Stress	The result or consequent state of a physical or chemical, or social, stimulus on an organism or system
Sub-species	A geographically separate population of a species, being a population that is characterised by morphological or biological differences from other populations of that species.
Systematic	In a methodical and organised way.
Taxa	Taxonomic group of any rank (for example as species, genus, family, class, order).
Tenosols	Soils with weak pedological organisation.
Terrain	A tract of land and its physical features with emphasis on bedrock geology.
Terrestrial	Pertaining to land, the continents, and/or dry ground. Contrasts to aquatic.
Tertiary	The period of geological time extending from about 65 to 2 mya.
Threatened	A collective term for native plants and animals which are presumed extinct, endangered and vulnerable.
Threatened species and ecological communities	Threatened species or ecological communities listed and protected under the provisions of the EPBC Act.
Topography	Description or representation of natural or artificial features of the landscape; the description of any surface, but usually the earth's.
Translocation	The transfer of plants and animals from one part of their range to another.
Transpiration	The loss of water from plants, normally as vapour.
Ubiquitous	Having or seeming to have the ability to be everywhere at once.
Understorey	A general term for the plants of a community occurring at levels lower than the top stratum.
Vertosols	Soils with high clay content (>35%), cracks and slickensides.
Vulnerable	A species is vulnerable if: ▪ its population is decreasing because of threatening processes, or ▪ its population has been seriously depleted and its protection is not secured, or ▪ its population, while abundant, is at risk because of threatening processes, or ▪ its population is low or localised or depends on limited habitat that is at risk because of threatening processes.

Term	Definition
Waste	A substance that is left over, or an unwanted by-product, from an industrial, commercial, domestic or other activity; or surplus to the industrial, commercial, domestic or other activity generating wastes.
Weathering	Changes in the coherence, texture and composition of rocks and minerals by either physical (mechanical) or chemical processes as a result of exposure at the Earth's surface.
Weed	A plant that is considered undesirable because it threatens the persistence of native plants.
Wetlands	Low-lying areas regularly inundated or permanently covered by shallow water. Usually important areas for birds and other wildlife.
Wildlife	An animal, plant or specimen derived from an animal or plant.
Wildlife corridor	A strip of habitat that facilitates fauna movement between otherwise isolated patches of habitat.
World Heritage property	Under the EPBC Act, a World Heritage property is either: ▪ an Australian property on the World Heritage List kept under the World Heritage Convention; or ▪ a property declared to be a World Heritage property by the Commonwealth Environment Minister.
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