Port of Gladstone
Gatcombe and Golding Cutting Channel Duplication Project

Environmental Impact Statement

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Appendix P
Cumulative Impact Assessment

Gatcombe and Golding Cutting Channel Duplication EIS

Cumulative Impact Assessment

Prepared for
Aurecon

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Abbreviations

Abbreviation	Description
APLNG	Australia Pacific Liquefied Natural Gas
BPAR	Benthic Photosynthetically Active Radiation
CIA	Cumulative Impact Assessment
CSD	Cutter Suction Dredger
DIWA	Directory of Important Wetlands in Australia
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
ESD	Ecologically Sustainable Development
GBR	Great Barrier Reef
GBRWHA	Great Barrier Reef World Heritage Area
GLNG	Gladstone Liquefied Natural Gas
GPC	Gladstone Ports Corporation
LNG	Liquefied Natural Gas
Mm^3	Millions of cubic metres
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
OUV	Outstanding Universal Value
PAR	photosynthetically active radiation
PMM	Priority Management Measure
PPDA	Priority Port Development Area
QCLNG	Queensland Curtis Liquefied Natural Gas
TSHD	Trailing Suction Hopper Dredger
WB	Western Basin
WBE	Western Basin Expansion
WICT	Wiggins Island Coal Terminal

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Executive summary

A Cumulative Impact Assessment (CIA) was conducted for the proposed Gatcombe and Golding Cutting Channel Duplication Project at the Port of Gladstone (the Project).

The CIA aimed to:

- Assess the cumulative impacts of the Project on sensitive environmental values, considering the influence of current and reasonably foreseeable projects in the region
- Determine the degree to which cumulative impacts on sensitive environmental values will approach thresholds for environmental protection
- Assess the potential for Project impacts to act cumulatively with other environmental disturbances, such as flood events and climate change
- Conduct a CIA in accordance with contemporary impact assessment approaches and in a manner consistent with the Project Terms of Reference and Environmental Impact Statement Guidelines
- Assess the economic impacts of the Project on other industries and commercial operations in the Gladstone region.

The cumulative impacts of the Project and 'other projects' on environmental values that are site-attached, or habitat related (e.g. seagrass, mangroves), and mobile, or species related, over an extended geographic range (e.g. dugongs and shorebirds) were assessed.

The reasonably foreseeable 'other projects' potentially contributing environmental risk additional to that from the Project were identified by reviewing proposed projects known publicly or advised by the Coordinator-General. The relevance of such projects for incorporation into the assessment was further assessed, using accepted practices for CIA. Speculative projects were excluded from further analysis, as were projects where insufficient information was available to make informed judgements on impacts, or where impacts were unlikely to be material.

The 'other projects' determined for inclusion in the CIA which are reasonably foreseeable to be under construction and/or have operational impacts that are not presently influencing the existing environment were:

- Arrow Bowen Pipeline – Bowen Basin to Gladstone pipeline
- Clinton Vessel Interaction project
- Pacificus Tourism Project
- Toolooa Priority Development Area (PDA)
- Future maintenance dredging of the Port of Gladstone

Cumulative impacts were considered through the consideration of environmental risk of multiple projects over varying spatial and temporal scales. Using a scoring methodology, the environmental risks from the Project alone and the additive effects of the 'other projects' were analysed. The 'other projects' did not act cumulatively to significantly increase the environmental risk for any potential mode of impact for any of the environmental values, when assessed against the criteria established. Impacts on seagrass and soft bottom benthic habitats through a deterioration in water quality, and general disturbance to the habitat of dolphins, dugong and turtles, were the closest risks to increasing cumulative risks above those determined from the Project alone.

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When the cumulative risk scores from 'other projects' were considered, the distribution of risk across environmental values remained broadly similar to risks for the Project alone. The highest cumulative risk scores from 'other projects' were largely associated with environmental values subject to moderate levels of risk from the Project alone. Shorebirds, which incurred the highest Project risk score, were assessed to be subject to relatively small amounts of additional cumulative risk from 'other projects'. Marine turtles and shorebirds were the environmental values with the highest risk score when risks from all projects were considered. Dugongs, dolphins and seagrass had cumulative risk scores that were similar to, but below, those of shorebirds and marine turtles.

Most of the additional risk from ‘other projects’ arose from the Clinton Vessel Interaction project and future maintenance dredging for the Port of Gladstone. These are the only 'other projects' with activities located within the marine environment, and have the greatest potential for spatial overlap in the areas to be impacted by the Project. However, the Clinton Vessel Interaction project is likely to be completed several years before the commencement of the Project. Future maintenance dredging is likely to occur over a similar period as the Project, although the maintenance dredging is episodic, occurring for approximately four to six weeks each year.

Results of the CIA indicate that significant cumulative impacts from the Project combined with reasonably foreseeable 'other projects' are unlikely. However, the assessment identified that some environmental values are sensitive to the cumulative impacts of the Project combined with exogenous factors such as episodic climatic events, particularly floods. These cumulative risks primarily relate to seagrass, benthic habitats, marine turtles and dugongs. Some mitigation measures are proposed, to manage the potential for cumulative impacts, should such events occur at the same time as the Project.

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1 Introduction

1.1 Background

Eco Logical Australia (ELA) was engaged by Aurecon to prepare a Cumulative Impact Assessment (CIA) for the proposed Gatcombe and Golding Cutting Channel Duplication Project at the Port of Gladstone (the Project). The CIA forms part of the impact assessment process for the Project, and has been completed to address the Environmental Impact Statement (EIS) Terms of Reference (ToR) and the Commonwealth Government EIS Guidelines applicable to the Project.

This report has been prepared as a stand-alone document to be included as an appendix to the Project EIS. Accordingly, a brief description of the existing environmental values and proposed Project works have been presented in this report. For a full Project description, reference should be made to Chapter 2 of the Project EIS.

1.2 What is Cumulative Impact Assessment

CIA is part of the process of environmental impact assessment and is focussed on considering the actual and potential effects on the environment of multiple activities or impacts. It considers the impact of activities on a range of environmental values, including receptors, receivers, assets or valued resources. Environmental impacts may combine geographically (due to their close proximity) or over time (as projects are completed consecutively), to cause a different outcome than would otherwise have been the case had a project been developed in isolation.

CIA is integral to the impact assessment process, particularly in locations were development has previously occurred or is proposed. It is therefore important that the assessment process for cumulative impacts is appropriately scaled, both spatially and temporally, and designed to consider the relevant risks of combined activities and natural events that may influence environmental values.

There are a variety of definitions or approaches to CIA, which are described in published guidelines, scientific literature and in approval conditions. In Australia, cumulative impacts are generally assessed in a manner consistent with one of the circumstances summarised in **Table 1**.

Table 1: Summary of CIA approaches commonly used in Australia

Approach	Description
Single project	The cumulative impacts of a single project on the existing environmental baseline, accounting for previous activities. For example, assessment of the effects of clearing vegetation, taking into account all previous clearing that has occurred in the region.
Multiple projects, single environmental value	The cumulative impacts of multiple projects are assessed for a given environmental value or aspect of the environment. For example, development of a water quality strategy for a catchment, considering all sources of pollution.
Multiple projects, all environmental values	The cumulative impacts of multiple projects are assessed for all environmental values. For example, this may occur as part of a strategic assessment for a region, or assessment of a project where several other projects are also being developed nearby.

The approach of considering multiple projects and all environmental values is the broadest definition of CIA, and generally aligns with the requirements of environmental impact assessment. Harriman and Noble (2008) noted that such CIAs are generally completed through either project-related

environmental impact assessments (by proponents), or through strategic or regional assessments by government agencies across a broader scale (e.g. Strategic Assessments under Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999;* EPBC Act).

It should be noted that there is no specific methodology for CIA that has gained wide acceptance nationally, or internationally. Indeed, a standardised methodology would need to have sufficient flexibility to be adapted to the location, scale and circumstances of a particular project. In this context, a tailored methodology which addresses some generic criteria applicable to CIA is likely to be most successful.

It is often desirable to consider information on the combined effects of multiple projects or activities when making an assessment of the environmental effects of a project. For example, the incremental effects of several small projects may be greater than those of a single large project. For many environmental values, it is relevant to consider the concept of an impact threshold, beyond which significant and unacceptable changes to that environmental value may be expected. In order to evaluate the risk of exceeding such thresholds as a result of a new project, an assessment of the cumulative effects of other activities is also required.

There is growing recognition of the importance of CIA in managing the Great Barrier Reef World Heritage Area (GBRWHA), which is subject to a variety of pressures across a vast geographic scale (GBRMPA 2014a) and is of relevance to the Project due to its location. Activities such as agriculture, fishing, port development and urban development are all likely to act cumulatively on the values of the GBRWHA. The influence of other factors such as climate change and extreme weather events is known to be important in shaping the condition and trend of environmental values. This situation presents a challenge for CIA on the Great Barrier Reef (GBR) – to consider all relevant and realistic things pertinent to the Project, without the unrealistic expectation of considering everything.

An independent review of the Port of Gladstone (SEWPAC 2013) highlighted the need for the assessment and consideration of cumulative impacts as one of three key findings in the future management of industrial expansions within the GBRWHA. An emphasis was placed on the importance of considering the impacts of other projects in addition to the natural impacts of severe episodic weather events on environmental receptors. Such recommendations have been incorporated into the approach adopted for this CIA.

1.3 EIS Terms of Reference

Information to be included within the Project EIS is specified in the ToR prepared by the Queensland Government (Coordinator-General 2012) and the EIS Guidelines prepared by the Australian Government (Australian Government 2013). A summary of the key requirements for the CIA is provided in **Table 2**.

Table 2: Summary of requirements of the ToR and EIS Guidelines for the CIA

Coordinator-General (State legislation)	Commonwealth (EPBC Act and *Great Barrier Reef Marine Park Act 1975*)
Summarise the project's cumulative impacts and describe these impacts in combination with those of existing or proposed projects to be in the region, to the greatest extent practicable. Assess cumulative impacts with respect to both geographic location and environmental values. In particular, address cumulative impacts in sensitive environmental areas and in regard to potential economic impacts to existing industry and commercial operations Explain the methodology used (both qualitative and quantitative) to determine the cumulative impacts of the project, detailing the range of variables considered and propose strategies for mitigating identified cumulative impacts.	The EIS must identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including current and future expansions or developments by the proponent and other proponents in the region and vicinity). The EIS must also address the potential cumulative impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment must also be considered in the assessment of ecosystem resilience. Where relevant to the potential impact, a risk assessment must be conducted and documented. The risk assessment must include known future expansions or developments by the proponent and other proponents and known impacts on ecosystem resilience and Matters of National Environmental Significance (MNES).

Collectively, the ToR and EIS Guidelines have a focus on assessing the Project in combination with both existing and proposed projects. Gladstone Ports Corporation Limited (GPC) as the Project proponent is required to develop a CIA methodology that is suited to the local setting, with particular consideration of the geographic scale, sensitive environmental values, listed and migratory species, World Heritage values and existing threats to the GBRWHA. The CIA has built upon the findings of the broader Strategic Assessments completed for the GBR Region (GBRMPA 2014b) and Coastal Zone (Queensland Government 2014), and the findings of the GBR Outlook Report (GBRMPA 2014a).

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2 Project Setting

2.1 Description of Existing Environment

The Port of Gladstone (the Port) is located along the Capricorn Coast of Central Queensland, approximately 525 km north of Brisbane (**Figure 1**). The outer port limits extend east of Port Curtis, past the adjoining Curtis and Facing Islands. The southern Port limits extend to the northern tip of Hummock Hill Island, near Tannum Sands, and the northern Port limit is located within the upper sections of an estuarine passage known as The Narrows.

Key infrastructure within the Port includes Port Central Wharves, R. G. Tanna Coal Terminal, Wiggins Island Coal Terminal (WICT), Fisherman's Landing Wharves, the Curtis Island liquefied natural gas (LNG) Precinct, wharves associated with Queensland Alumina Limited and Boyne Smelters, and reclamation areas that support existing or approved industrial developments (**Figure 2**; GPC 2012; SEWPAC 2013). The main shipping entrance to the Port enters at the southern extent, through the Boyne River estuary, and onto Fisherman's Landing.

There are several areas of high conservation value either within or adjacent to the Port which have been monitored as part of the EIS (**Figures 3** and **4**). The entire Port is located within the GBRWHA, with the outer limits within the GBR Marine Park. The southern limits of the Port coincide with the Rodds Bay Dugong Protection Area. Three Fish Habitat Areas have been declared at Rodds Bay, Colosseum Inlet and the Calliope River. There are also nationally-important wetlands listed in the Directory of Important Wetlands in Australia within the Port. One such wetland, The Narrows passage, is recognised as one of only five tidal passages in Australia (Australian Heritage 2015).

The existing environment of the Port and surrounds includes a variety of marine, coastal and terrestrial habitats with marine and island habitats generally located within the GBRWHA. The main coastal area of the Port is described as a shallow, semi-enclosed estuarine system, with the Calliope River and Boyne River entering Port Curtis at Gladstone (Aurecon 2012). The coastal habitats within the Port are known to include:

- Intertidal habitats comprised of sand and mud flats, mangroves, salt marsh, rocky reefs and seagrass
- Sub-tidal habitats comprised of seagrasses, soft and hard coral communities, macroalgae communities and open soft substrate.

Extensive seagrass communities within the Gladstone region are of regional significance, and provide food for resident and migratory animals. Threatened species that are associated with coastal habitats of the Gladstone region are the Green turtle (*Chelonia mydas*), Dugong (*Dugong dugon*), migratory and resident shorebirds, the Australian humpback dolphin (*Sousa sahulensis*) and the Water mouse (*Xeromys myoides*). Significant rookeries for nesting Flatback turtles (*Natator depressus*) are also located on the eastern side of Curtis and Facing Islands. Nesting also occurs at Boyne Island and adjacent mainland beaches of Tannum Sands. Terrestrial habitats of the Port and surrounds include Boyne, Curtis and Facing Islands, and coastal wetlands along the marine and terrestrial interface.

The Port's existing environment, threatened species and associated biodiversity contribute to the Outstanding Universal Value (OUV) of the GBRWHA. The Independent Review of the Port of Gladstone specifically identified 19 OUV attributes that are expressed in the Port and surrounds (SEWPAC 2013;

Appendix A). The Master Plan for the Port of Gladstone also identifies the local expression of OUV of the GBRWHA (DTMR2018; **Appendix A**).

In addition to the existing natural environmental features, the Port has been monitored in response to significant flooding events. A 2011 flood event occurred after significant rainfall in the catchment and involved a large volume of water spilling over the Awoonga Dam and into the Boyne River estuary. Environmental impacts associated with this event were (DEHP 2013):

- Loss of seagrass habitats and a consequential reduction in foraging habitats for turtles and marine mammals
- Increased turtle and dugong strandings
- Increased incidence of fish diseases (e.g. cloudy eyes, skin discolouration and lesions)
- Fish kills.

Most of the environmental values affected by the flood event recovered, with seagrass returning to most areas from where it was lost the following year (Bryant *et al.* 2014). Health assessments of green turtles from Port Curtis also identified recovery in key blood biochemistry and haematology indicators in the years following the flood (Flint 2015). Generally, the observed environmental impacts were attributed to the influence of the flood event, although there has been no conclusive view on the cause of fish diseases (DEHP 2013).

Since 2011, there have been several rainfall events that have caused flooding in the Port Curtis catchment, and resulted in water spilling over Awoonga Dam. The environmental effects of these floods have not been as severe or widespread as those observed in 2011. The effect of the 2011 flood event, and subsequent weather events, on the environmental values of the Port demonstrates the variable influence that large-scale natural events can have on the region's environmental values. The potential for such events to act cumulatively with impacts from the Project warrants further consideration within the CIA.

While completed maintenance dredging campaigns are influencing the existing environment, and therefore inherent in the impact assessment, future maintenance dredging campaigns and their interactions with other projects, are not. The potential impacts of such future maintenance dredging campaigns should therefore be considered in the CIA. However, it should be noted that environmental impacts from future maintenance dredging of the new shipping channels to be created through this Project are included in the Project EIS (and are therefore inherent in the impact assessment). However, such maintenance dredging activities will comprise only 7% of the total future maintenance dredging activities for the Port. Thus, future maintenance dredging campaigns (the remaining 93%) have been included as a project to be considered for cumulative impacts.

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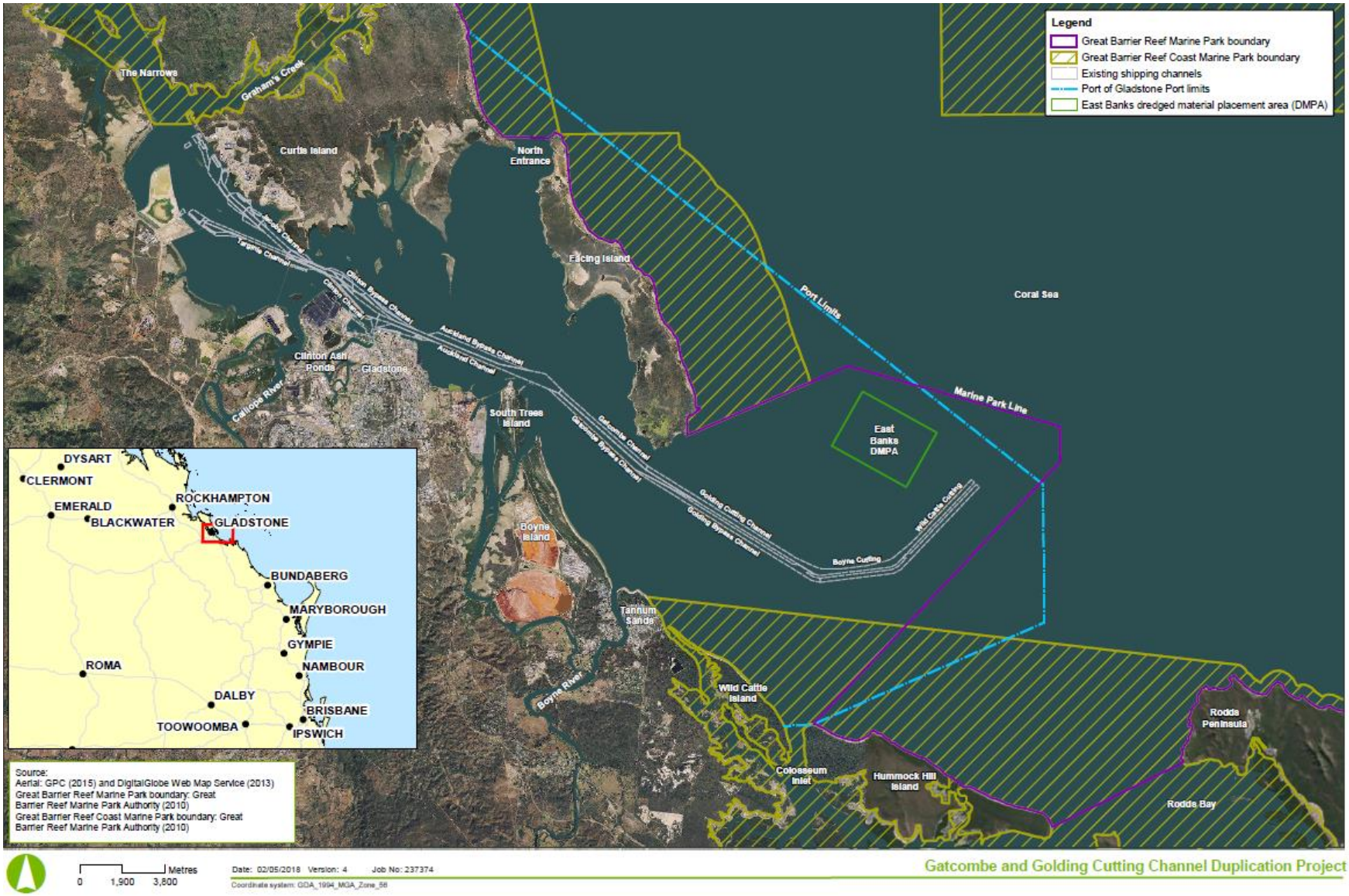

Figure 1: Port of Gladstone regional location (Chapter 1, Figure 1.1, Project EIS)

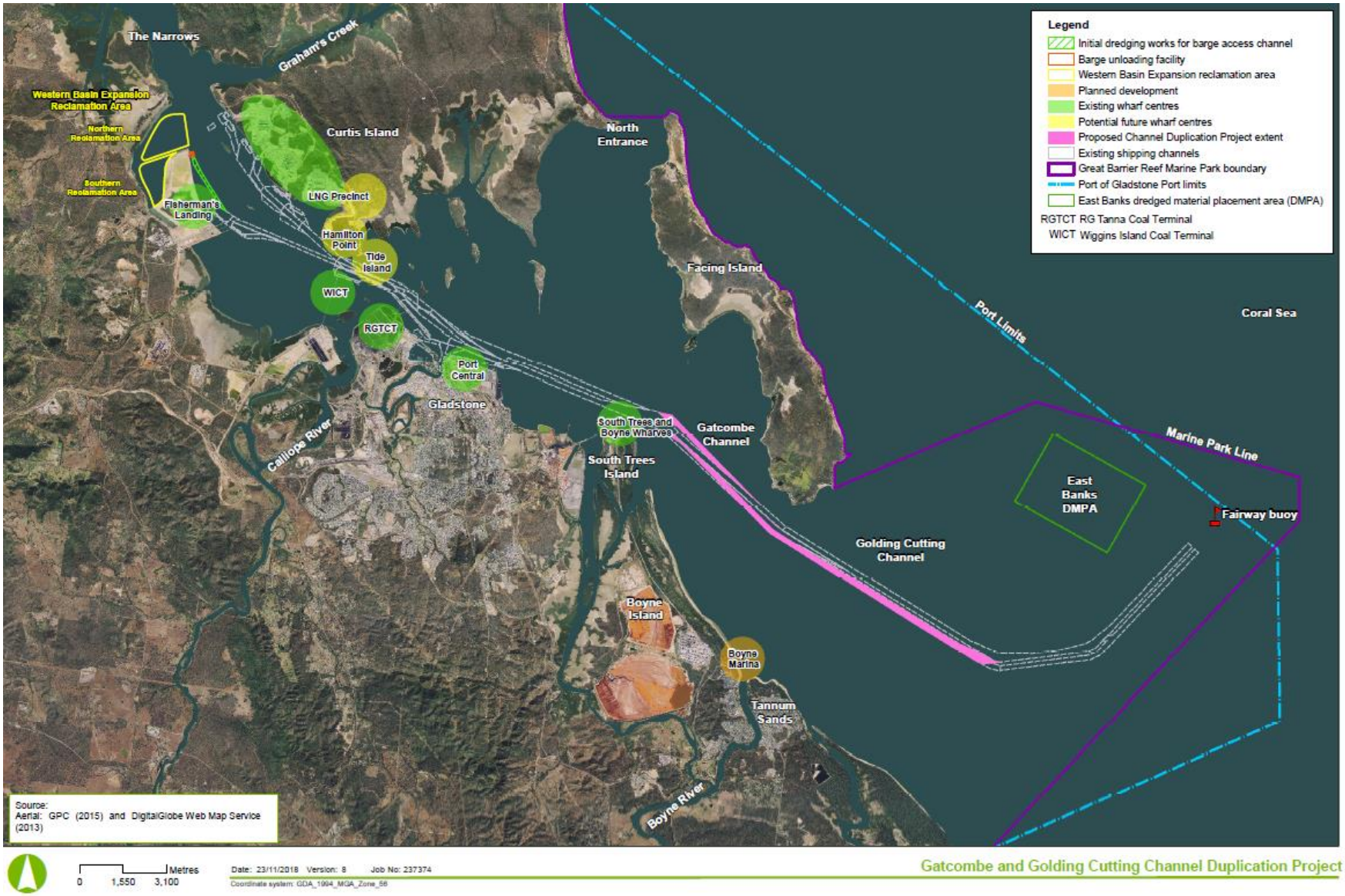

Figure 2: Port of Gladstone key infrastructure (Chapter 2, Figure 2.1, Project EIS)

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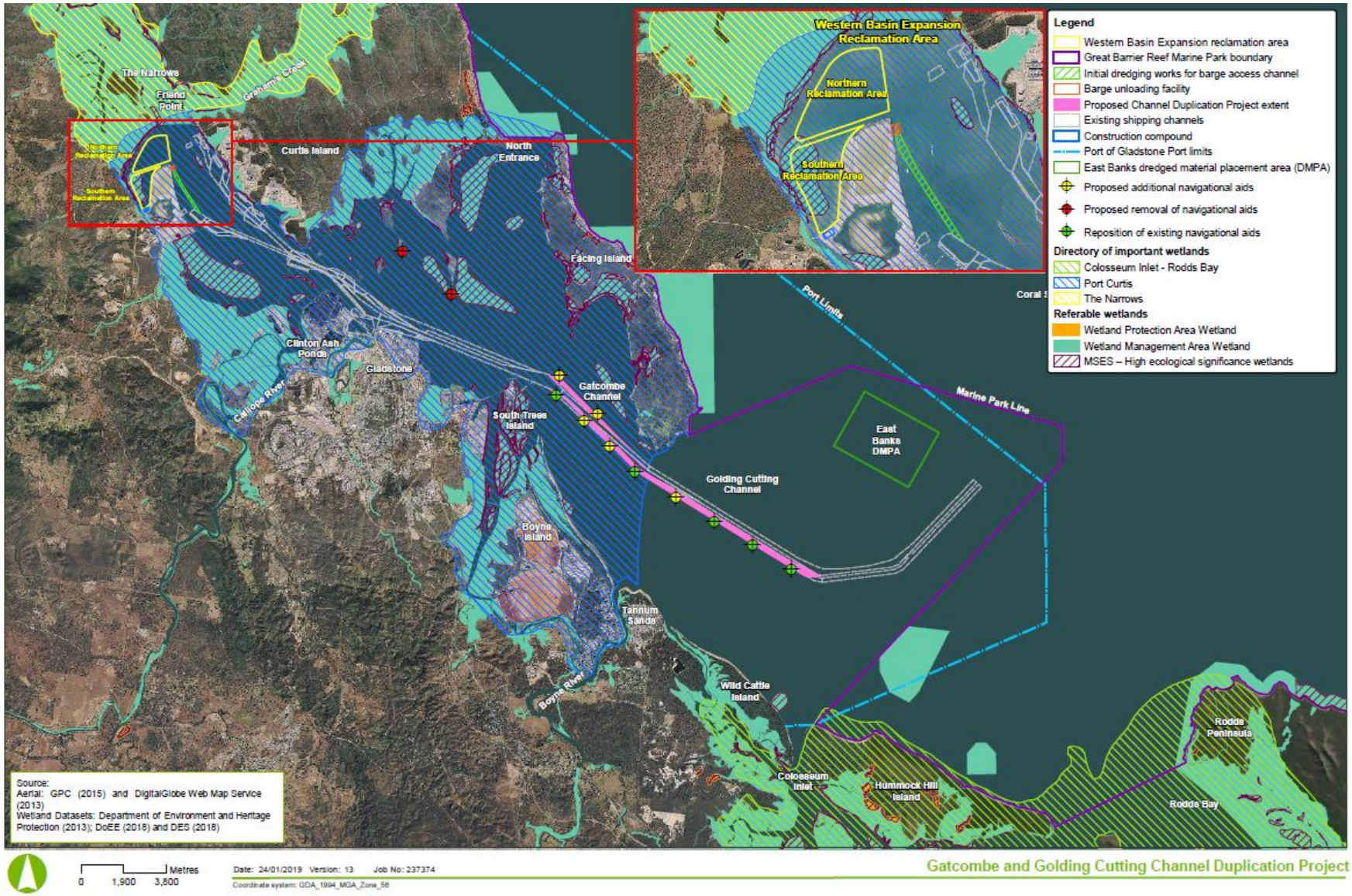

Figure 3: Port of Gladstone areas of high conservation value (Chapter 9, Figure 9.4, Project EIS; wetlands)

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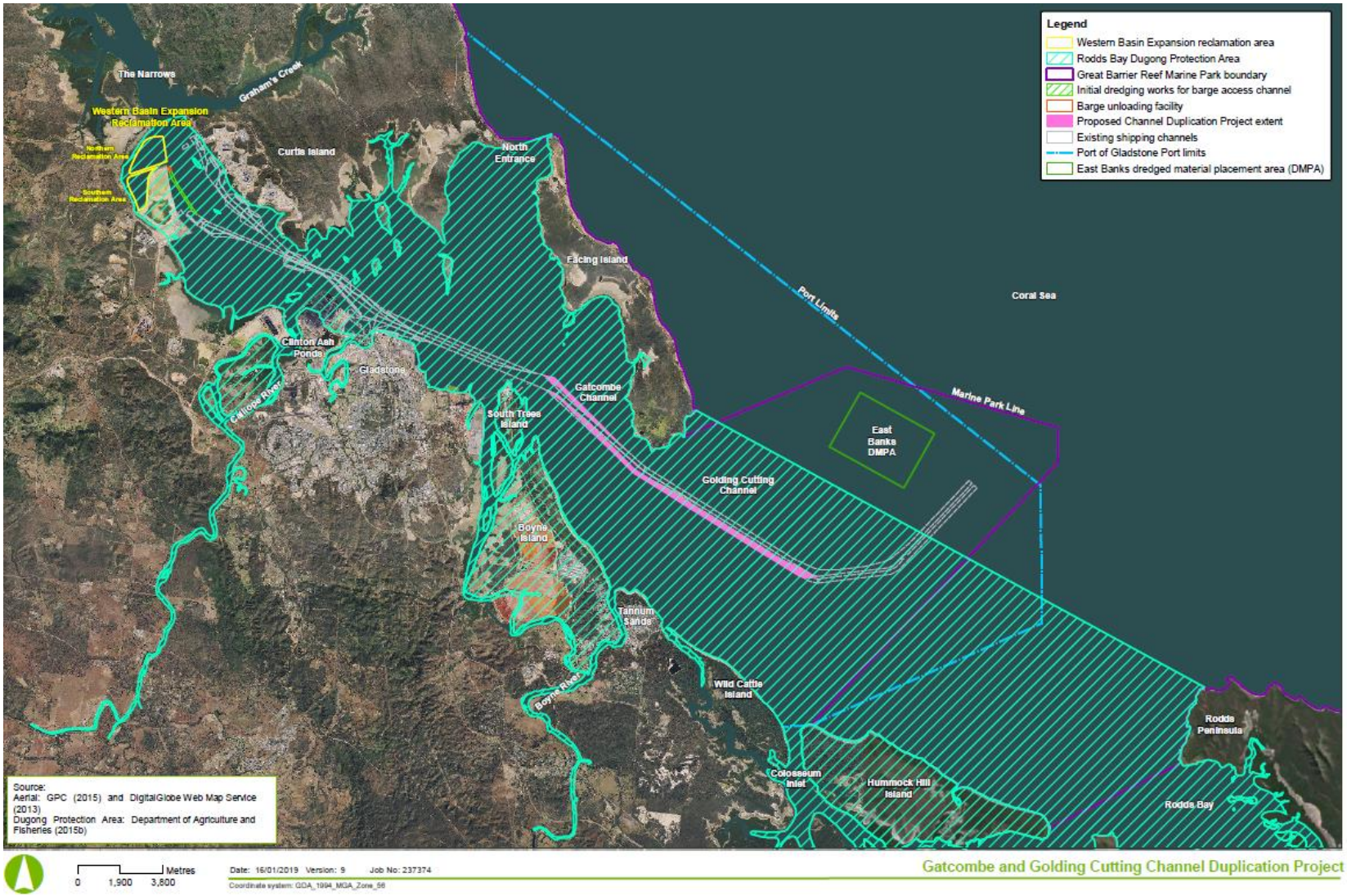

Figure 4: Port of Gladstone areas of high conservation value (Rodds Bay Dugong Protection Area; Chapter 9, Figure 9.16, Project EIS)

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2.2 Project Description

The Project is required to improve the Port of Gladstone's operational and economical efficiencies, and to mitigate an existing and increasing shipping safety risk as the Port throughput increases, and the associated shipping numbers and the portion of Cape-sized vessels increases.

GPC proposes to duplicate the existing Gatcombe and Golding Cutting shipping channels. The proposed deeper channels will provide for the safe two-way passage for ships from the outer harbour, around East Banks, to the western side of Facing Island.

Key aspects of the Project include (**Figure 5**):

- Initial dredging of approximately 0.25 Mm^3 of seabed material (including dredging tolerance) to establish an access channel to -7 m LAT to allow barges to transport dredged material from the Gatcombe and Golding Cutting shipping channels to a barge unloading facility (BUF) adjacent to the existing Western Basin (WB) reclamation area.
- Dredging approximately 12.6 Mm^3 of seabed material (including dredging tolerance) from the existing Gatcombe and Golding Cutting shipping channels to provide a duplicate channel with the dimensions:
    - length of approximately 15 km
    - ultimate depth of RL – 16.1 m LAT
    - width (toe to toe) of 200 m
- Initial dredging for the barge access channel to occur over 6.5 weeks, commencing 2023 or later
- Two dredging campaign options:
    - Option 1 – two staged campaign with an initial 33 weeks of dredging comprising 7.25 Mm^3 (2023 or later) and then 25 weeks of dredging comprising 5.35 Mm^3 (2026 or later).
    - Option 2 – one stage campaign with 58 weeks of dredging of 12.60 Mm^3 (2023 or later).
- An additional 7% increase in the annual Port maintenance dredging campaign following the completion of the Project dredging
- Establishment and construction of the Western Basin Extension (WBE) reclamation area bund wall and BUF prior to dredging, commencing 2020 or later over a three year period. This will include the sourcing and haulage of 1.1 Mm^3 of rock material (core and amour) from the Targinnie and Yarwun areas over a three year period.
- Dredging material placement within the WB and WBE reclamation areas commencing 2023 or later
- Removal of two existing navigational aids, the relocation of five existing navigational aids, and the installation of five new navigational aids (2026 or later)
- Outer BUF and bund wall warning lights will be installed every 100 m along the outer BUF and WBE seaward reclamation area bund wall in accordance with MSQ requirements.

The WB and WBE reclamation areas are the preferred dredged material placement areas, following the assessment of several options. The proposed dredging of the barge access channel to the north of the Fisherman's Landing swing basin will most likely be undertaken using a cutter suction dredger (CSD) and trailing suction hopper dredger (TSHD). The dredged material from the barge access channel will be placed directly into the existing WB reclamation area by the TSHD and CSD.

The preferred dredging methodology involves utilising a TSHD which loads the dredged material from the Gatcombe and Golding Cutting shipping channels into barges (four barges will be working in cycles for

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the entire dredging operations) which will transport the material to the BUF to be unloaded using large excavators into trucks for placement within the existing WB and WBE reclamation areas.

The final dredging methodology adopted for the Project is subject to variables such as contractor availability. A detailed explanation of the dredging methodology is provided in Section 2.4 of the Project EIS.

Conceptual design for the WBE reclamation area includes a northern (164.98 ha) and southern (111.12 ha) dredged material placement area with a bund wall constructed with core material, rock armouring and geotextile. The internal ponds will be designed to store the soil-water mix for sufficient time to allow the suspended sediments in the discharge water to reduce to less than or equal to 100 mg/L. The dewatering discharge will be released into Port Curtis. Disposal of dredged material at the WB and WBE reclamation areas will facilitate intertidal land reclamation for future use as stormwater ponds and potential Port development (three to four wharves attached to the northern area).

Removal of the navigational aids will involve a barge and pile extractor. Relocated and new navigational aids will be transported by barge to the proposed location, attached to a crane and installed using a pile hammer. One barge and one work boat will undertake the proposed navigation aid works over a two to three month period.

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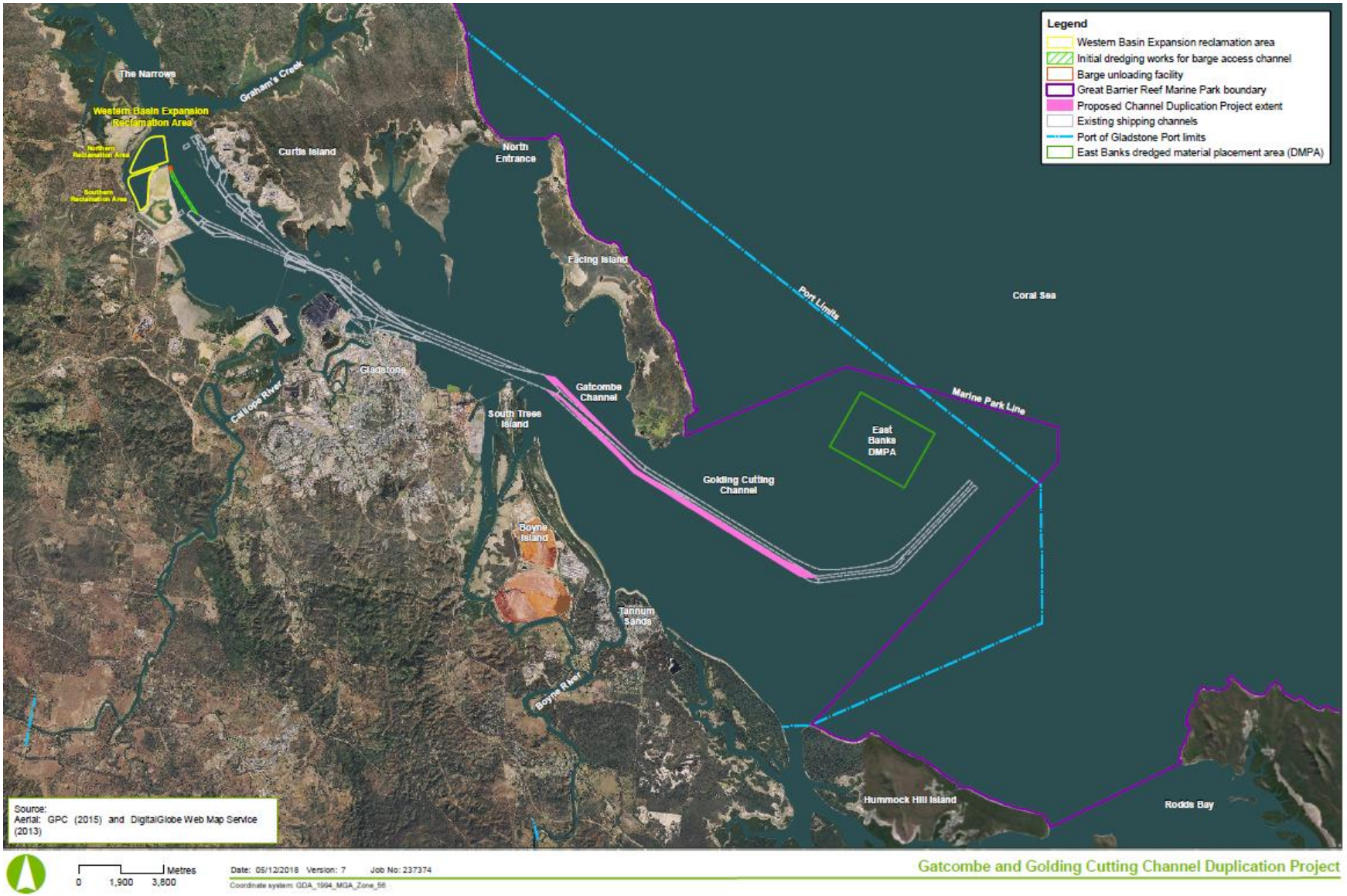

Figure 5: Location of works for the Gatcombe and Golding Cutting Channel Duplication Project (Chapter 1, Figure 1.2, Project EIS)

2.3 Future development at the Port of Gladstone

The Port has been operational since 1915 and is presently managed by GPC (GHD 2009; Aurecon 2012). Exported coal has been the Port's largest commodity and Gladstone is Australia's third largest coal-exporting port (SEWPAC 2013). To accommodate the growth in coal exports, the Port has expanded in recent years to include the WICT Project.

In addition to coal export facilities, there has also been the development of a liquefied natural gas (LNG) precinct between Laird and Hamilton Points on the south-western corner of Curtis Island. There are currently three LNG plants in operation, with a fourth LNG plant approved, but not scheduled for construction.

Key outputs from the combined coal and LNG developments, should all approved stages be constructed, are expected to be:

- WICT will increase the future coal export capability at the Port (ultimate capacity of 84 Mtpa)
- The combined ultimate volume of the three LNG plants in operation, plus the fourth approved for construction is 35 – 45 Mtpa.

Details of all proposed developments and the current status of projects are outlined in **Section 3.2**.

To adequately manage, develop and operate port facilities, GPC has prepared a Strategic Plan (GPC 2012). The Strategic Plan has highlighted potential future developments, which may include additional berths and associated berthing structures. Since development of the Strategic Plan, the Port of Gladstone has been named as one of four priority ports under the *Sustainable Ports Development Act 2015* (Ports Act).

In late 2018, the Master Plan for the priority Port of Gladstone was released by the Queensland Government. The Gladstone Port master planning process is currently ongoing, with the requirement now being to prepare and implement a port overlay (the regulatory instrument that implements the master plan over the master planned area; DTMR 2018). A key element of the Master Plan is an Environment Management Framework which identifies and maps environmental values; identifies impacts from development on the environmental values; and states objectives and priority management measures (PMMs) for managing the impacts.

The Master Plan evidence base considers three growth scenarios for economic development. Scenario 1 represents a base case in which growth is within the capacity of existing facilities and implementation of the Project is not warranted. Growth scenarios 2 and 3 are relevant to the CIA, requiring the channel duplication to be implemented through the Project in response to economic growth globally, across Queensland and in the Gladstone region. Future projects considered in the CIA are generally consistent with the anticipated future projects assumed in growth scenarios 2 and 3, taking into account current knowledge of market conditions and project status.

Implementation of the Master Plan over the Port is through the port overlay comprising PMM, development assessment (including categories of assessment and assessment benchmarks to be considered during development assessment), and requirements for planning authorities to consider when making or amending planning instruments (DTMR 2018).

PMMs identified in the Master Plan and relevant to the CIA include preparation of:

- An environmental values monitoring and reporting program within and surrounding the master planned area that will be impacted by development within the master planned area

- An environmental assessment guideline for development likely to have a significant adverse impact on the environmental values that contribute to the OUV of the GBRWHA to ensure those processes are appropriately and consistently applied across the master planned area
- A land management plan guideline to ensure that the OUV of the GBRWHA and other environmental values are consistently identified and managed; and associated land management plans are prepared and implemented for the Facing Island, Inshore Islands, Mount Larcom, Aldoga Reserve and Curtis Island land management areas.

These measures are discussed further in **Section 4.5** in the context of potential mitigation of identified cumulative impacts.

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3 Methods

3.1 Objectives and scope

The objectives of the CIA are as follows:

- Assess the cumulative impacts of the Project on sensitive environmental values, considering the influence of current and reasonably foreseeable projects in the region
- Determine the degree to which cumulative impacts on sensitive environmental values will approach thresholds for environmental protection
- Assess the potential for Project impacts to act cumulatively with other environmental disturbances, such as flood events and climate change
- Conduct a CIA in accordance with contemporary impact assessment approaches and in a manner consistent with the Project ToR and EIS Guidelines
- Assess the economic impacts of the Project on other industries and commercial operations in the Gladstone region.

The relevant geographic area for the CIA is that in which environmental values under consideration occur that may be influenced by the Project (**Figure 6**). The spatial scale should be sufficiently broad to include locations where other stresses may also affect those values, in combination with the Project.

It is important that the spatial scale can account for the differing distributions and ecology of the relevant environmental values. For example, some threatened marine species are migratory and are subject to significant pressures outside of the Gladstone region, which might affect their vulnerability to impacts from the Project within the Gladstone region. Other sensitive receptors are more site-attached (habitat-related), such as mangroves, seagrass meadows or inshore reefs, and the scale of the assessment for these values will be relatively confined (limited to tens of kilometres).

In order to simplify the assessment in relation to spatial scales, one of two limits to the spatial extent of the assessment has been applied to each environmental value, depending upon its ecology and the spatial scale over which impacts may be relevant. The two spatial scales are presented in **Table 3** (refer **Figure 6**).

Table 3: Description of the two spatial scales of the CIA

Spatial scale	Description
Port Curtis	Assessment of the immediate environment surrounding the Project. This will be the spatial extent considered for site-attached (habitat-related) environmental values.
Port Curtis, The Narrows, Port Alma, plus consideration of key threats within the population's migratory range.	The range of the assessment is expanded to consider: • The network of estuarine habitats to the north of Port Curtis, which provides habitat for some sensitive receptors which utilise areas affected by the Project, and • Any significant threatening process affecting an environmental value, which may also influence the cumulative impacts of the Project on that value.

The sensitive environmental values and related aspects of the environment considered to be most relevant to the CIA are presented in **Table 4**. The values are those most likely to be affected by dredging and reclamation activities, with a focus on species of conservation significance. Some species are

migratory and are therefore likely to be particularly vulnerable to the cumulative impacts of multiple projects or disturbances along their migratory route (e.g. shorebirds). These influencing factors were given an extra level of consideration during the assessment. For values that are site-attached or habitat-related (e.g. mangroves), the emphasis was on assessing the significance of regional fragmentation, integrity of World Heritage values and the synergistic effects of multiple stressors.

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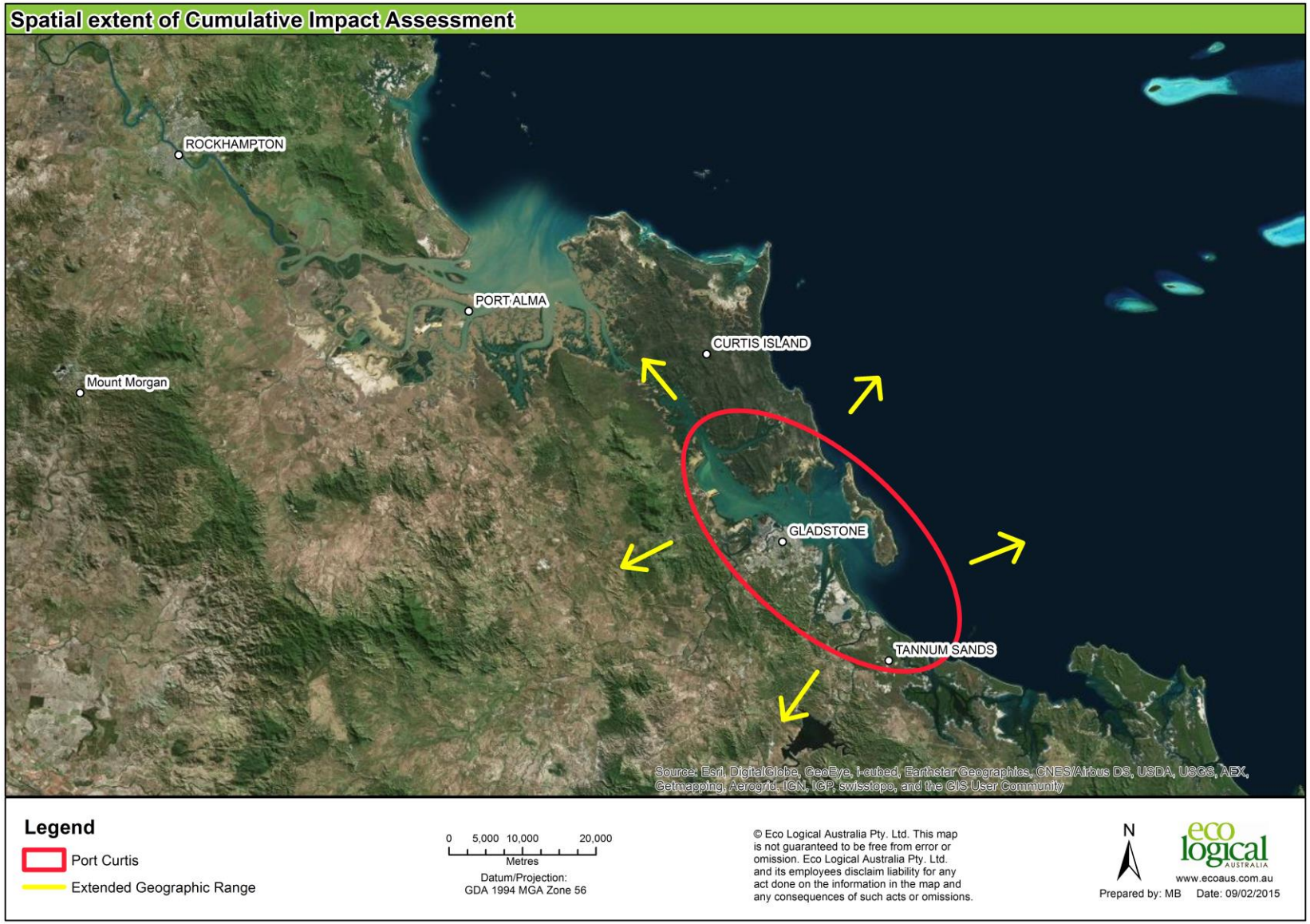

Figure 6: Map showing the spatial extent of the CIA across two areas (see Table 3)

Table 4: List of environmental values that will be a focus on the CIA within two geographic areas

Port Curtis	
Seagrass	Influenced by water quality, light levels, direct disturbance of the sea floor and events within Port Curtis and its catchment
Mangroves	Affected by local activities such as clearing, sediment processes and contamination.
Saltmarsh (including but not limited to the Threatened Ecological Community)	Affected by local activities such as clearing, sediment processes and contamination.
Inshore reefs	Influenced by water quality, sedimentation, direct disturbance of the sea floor and events within Port Curtis and its catchments
Soft bottom benthic habitats and associated macroinvertebrates	Influenced by water quality, direct disturbance of the sea floor and events within Port Curtis and its catchment
Fish (with particular reference to taxa of commercial or recreational value)	Impacts are manifested at a local (Port Curtis) scale in response to environmental conditions such as habitat quality, water quality and sediment quality. Ecology varies among species.
Water quality	Important aspect of the environment which affects the resilience of other values. Highly responsive to disturbances from multiple projects or natural events such as floods.
Sediment quality	Important aspect of the environment which affects the resilience of other values. Highly responsive to disturbances from multiple projects or natural events such as floods.
Port Curtis, The Narrows and Port Alma, and extended geographic range	
Dugongs	Individuals within the population are most abundant in Port Curtis (Sobtzick *et al*. 2013), and have also been sighted in The Narrows (GHD 2009). Port Alma may also provide suitable habitat for the species.
Australian humpback dolphin and Australian snubfin dolphin	Australian humpback dolphins are likely to move throughout Port Curtis, The Narrows and Port Alma region. The Australian snubfin dolphin predominantly utilises the Port Alma region (Cagnazzi 2018).
Humpback whale	While Port Curtis does not provide essential habitat for whale species, individuals may move throughout the Port Curtis, The Narrows and Port Alma region in association with migrations. The waters off Port Curtis are known to support calving activities for the Humpback whale (DoEE 2018).
Water mouse	While individuals are relatively site attached, habitat occurs throughout the intertidal areas of Port Curtis, The Narrows and Port Alma region, and fragmentation or disturbance of habitat should be considered at this scale.
Marine turtles (primarily Green turtles, Flatback turtles)	Flatbacks will use the Port Curtis region for nesting and during the inter-nesting period. Green turtles will forage and occasionally nest in the region. Foraging Green turtles within Port Curtis will be relatively site-attached, but will undergo breeding migrations outside of the region. Loggerheads also nest occasionally in the region.
Conservation significant and migratory fish species (shark and ray species)	Individuals within the population are likely to move throughout the Port Curtis, The Narrows and Port Alma region.
Shorebirds (resident and migratory)	Subject to significant pressures (hunting, habitat destruction, and disturbance from a range of sources including feral or domestic animals) along their international migratory pathway, which should be considered in the context of Project-related impacts.
OUV of the GBRWHA	Occurs at a larger scale than Port Curtis. Important that OUV is considered at a variety of scales and not just locally, particularly when assessing integrity. Values that contribute to the local expression of OUV are summarised in the Port Master Plan (DTMR 2018). They include marine water quality, marine turtles, seagrass, shorebirds and continental islands.

3.2 'Other Projects' included in the cumulative impact assessment

There are several projects within the Port of Gladstone, or in the immediate surrounding area, which have been approved in the past 10 years with conditions and recommendations (refer **Table 5**; DSDIP 2015, 2019). Several of these projects have multiple stages of development. While the initial stages of some projects are under construction or have been completed, there is significant uncertainty about whether future stages will be constructed within the timeframe of the Project (i.e. 2020 to 2030).

A common approach in CIA is to include present and reasonably foreseeable future projects. Present activities are considered in the Project EIS as a contributor to the environmental baseline relevant to each environmental value. Reasonably foreseeable future projects were identified in consideration of proposed projects publicly known or advised by the Coordinator-General and their relevance for incorporation into the CIA was further assessed using the process shown in **Figure 7** and **Figure 8** (MCA 2015).

The level of forecast certainty of future projects was determined (**Figure 7**) and speculative projects were excluded from further analysis. Reasonably foreseeable projects where the potential impacts were unlikely to be material or where there was insufficient information on project impacts were also excluded from the CIA **(Figure 8**).

Table 5 and **Figure 9** provide a comprehensive list of the 'other projects' proposed in the Gladstone region, which were given consideration due to their potential to result in cumulative environmental impacts. Following assessment in the CIA process, some of the projects were categorised as 'Excluded', as their potential impacts were not considered material to environmental values, they are not reasonably foreseeable, or they have been withdrawn.

Expansion of the Queensland Curtis LNG (QCLNG), Gladstone LNG (GLNG) and Australia Pacific LNG (APLNG) facilities (addition of third and fourth processing trains) and future stages of the WICT have received State and Commonwealth approval. However, there is uncertainty over the market conditions that would support commencement of future stages of these projects. Based on this uncertainty, and advice from the Office of the Coordinator-General, these expansions have been excluded from the CIA on the basis that they are not reasonably foreseeable in the current circumstances.

The 'other projects' determined for inclusion in the CIA which are reasonably foreseeable to be under construction and/or have operational impacts that are not yet influencing the existing environment are listed below, with their location shown in **Figure 10**:

- Arrow Bowen Pipeline – Bowen Basin to Gladstone pipeline
- Clinton Vessel Interaction project
- Pacificus Tourism Project
- Toolooa Priority Development Area (PDA)
- Future maintenance dredging within the Port of Gladstone (note that an additional 7% of maintenance dredging required for the Project's duplicated channels is assessed in the Project EIS).

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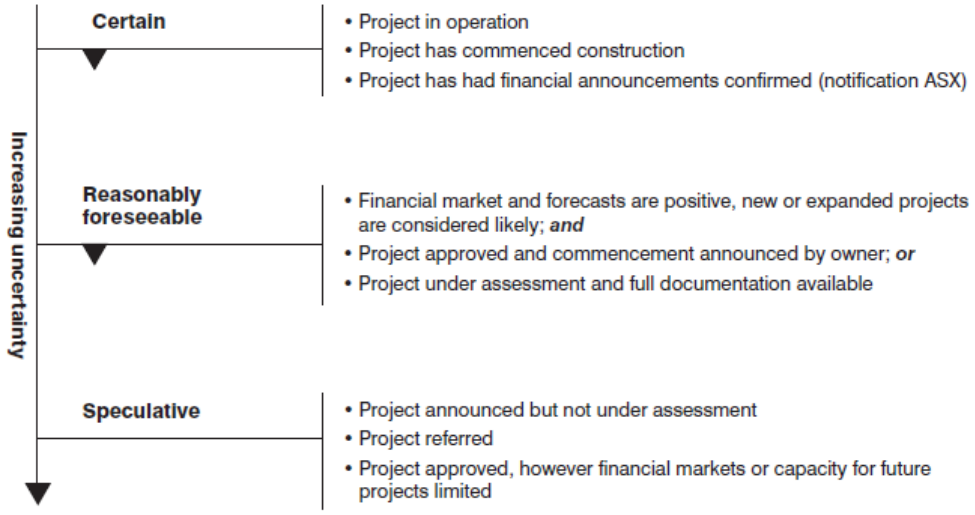

Figure 7: Certainty of 'other project' forecasting (MCA 2015)

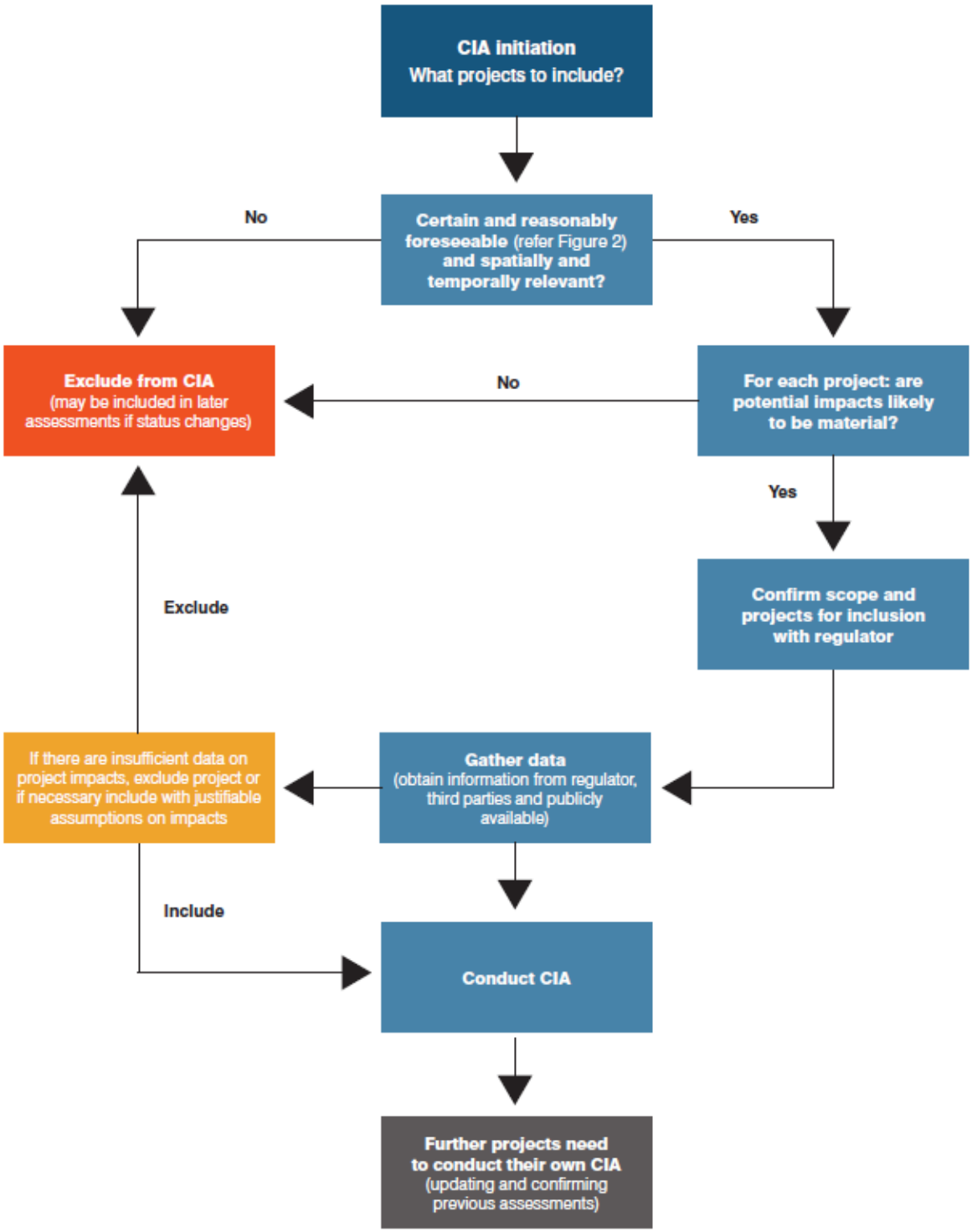

Figure 8: Process for determining inclusion of 'other projects' in cumulative impact assessment (MCA 2015)

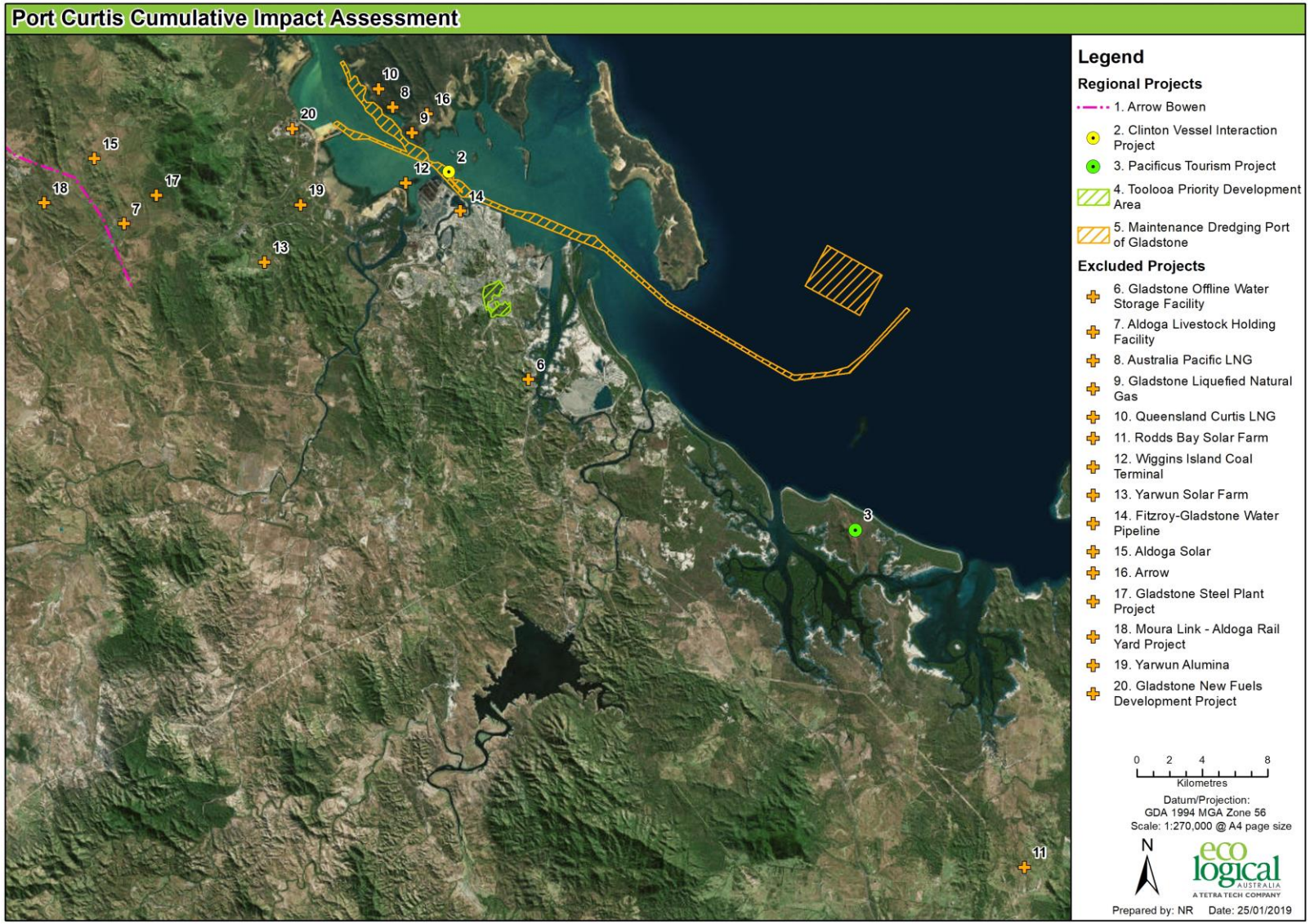

Figure 9: Projects included and excluded from the CIA

Figure 10: Other projects included in the cumulative impact assessment

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Table 5: Projects proposed for 2019 to 2030 within the Port of Gladstone and surrounding area (DSDIP 2015, 2019)

Project	Proponent/s	Location	Project features (related to harbour)	EPBC no.	Development stage	Likely timeframe for construction and/or operation	Outcome for CIA
Aldoga Livestock Handling Facility	Asia Pacific Agri-Corp (Projects) Pty Ltd	Aldoga, 12 km west of Gladstone	• Feedlot, holding pens and meat processing facility (330,000 head pa) • Anaerobic lagoons and biogas generators, • Manure stockpiles and sediment treatment area • Terrestrial land disturbance, disposal and treatment of wastes	2017/7905 Not controlled action	Planning consent sought.	Coordinator-General approval issued in September 2018. Operations planned to commence in 2021.	**Exclude project** – potential impacts not material to environmental values under consideration
Aldoga Renewable Energy Project	Acciona	Gladstone State Development area	• Located adjacent to Powerlink's Larcom Creek substation • Large-scale renewable energy project - up to 350 megawatts • Terrestrial land disturbance	Not referred	Preferred developer announced April 2018. Feasibility study and approvals to commence	Construction to commence 2019	**Exclude project** – insufficient data, potential impacts unlikely to be material to environmental values under consideration
Arrow Bowen Pipeline – Bowen Basin to Gladstone pipeline	Arrow Energy	Pipeline from Bowen Basin to gas hub 22km north west of Gladstone.	• 580 km pipeline delivering coal seam gas to proposed Arrow Energy Gladstone Gas Hub (Aldoga). Pipeline construction in proximity to the gas hub is of relevance to the CIA • Terrestrial land disturbance	2012/6459	Approved. Petroleum Pipeline Licence and Environmental Authority granted.	Assume project start occurs prior to 2020	**Include project**
Arrow LNG Plant	Arrow	Curtis Island	• LNG processing plant and export facility • Approximately 9 km feed gas pipeline • Marine logistics facilities on Curtis Island and the mainland • Dredging of the seabed in Port Curtis and the riverbed at the mouth of the Calliope River to provide access to the marine logistics facilities.	2009/5007 2009/5008	Approved. Construction not started.	Project cancelled in 2015 and Arrow gas reserves contracted to QCLNG. Project has been officially retracted	**Exclude project** - withdrawn

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Project	Proponent/s	Location	Project features (related to harbour)	EPBC no.	Development stage	Likely timeframe for construction and/or operation	Outcome for CIA
APLNG Project	APLNG	Curtis Island and Surat Basin	• 450 km underground main transmission gas pipeline • Processing plant and export facility (four trains with a total capacity of up to 18 million tonnes per annum of LNG).	2009/4976	Approved. Two trains constructed and operational from 2015	Timing of construction of the third and fourth trains is uncertain.	**Exclude Expansion** - Current operating facility included in environmental baseline. Expansion excluded as speculative future market with need uncertain
Clinton Vessel Interaction project	GPC	Port of Gladstone	• Dredging of 800,000 m^3 to widen the existing Clinton Channel by 100 m and a small wedge between the Clinton Bypass Channel and the Clinton Channel. • Dredging footprint of 21 ha of which 6.9 ha is not within current approved channel footprint. • Dredge spoil to be disposed of into the WB reclamation area.	2017/7976 Controlled action	Preliminary documentation has been lodged with Department of Environment and Energy.	Likely 2019 and prior to commencement of channel duplication	**Include project** – preliminary documentation sufficient
Fitzroy-Gladstone Water Pipeline	Gladstone Area Water Board (GAWB)	Pipeline from Fitzroy River to Aldoga	• 115 km pipeline with intake from the Fitzroy River, delivering water to water storage near Gladstone (Aldoga). Portion of the pipeline near Gladstone is of relevance to the CIA • Terrestrial land disturbance	2007/3501	Approved.	Coordinator-General approval currency period expired February 2018. GAWB advise that the need for the project is being reassessed No current timeframe available as project is on hold.	**Exclude project** – speculative, future market with need uncertain

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Project	Proponent/s	Location	Project features (related to harbour)	EPBC no.	Development stage	Likely timeframe for construction and/or operation	Outcome for CIA
GLNG	Santos GLNG	Gladstone and Surat Basin	• 453 km pipeline: from gas fields to Gladstone • Liquefaction and export facility: Curtis Island, Gladstone.	2008/4057 2008/4058 2008/4096	Approved. Two trains constructed and operational from 2015/6	Timing of construction of the third train is uncertain.	**Exclude Expansion** - Current operating facility included in environmental baseline. Expansion excluded as speculative future market with need uncertain.
Gladstone Offline Water Storage Facility	GAWB	O'Connell	• Small dam (12 m depth when full) next to existing concrete reservoir. • Footprint 26 ha		Approved	Project completed in 2018.	**Exclude project** - completed
Gladstone Steel Plant Project Boulder Steel Limited	Boulder Steel Limited	Aldoga Precinct, with marine facilities at Fisherman's Landing	• No details available		Withdrawn	No current timeframe available Project has been officially retracted.	**Exclude project** - withdrawn
Moura Link-Aldoga Rail Yard Project	Aurizon	Aldoga, Mount Larcom, Wiggins Island	• Construction of new rail link connecting to proposed Wiggins Island Coal Terminal, maintenance yard and provisioning facilities (east of Mount Larcom), additional electrified rail tracks (Aldoga)	2007/3773 Controlled action	No EPBC approval granted Co-ordinator General approval 2009.	No current timeframe available as project is on hold Construction period of 10 years over 4 stages	**Exclude project** – speculative, approvals not in place.
Pacificus Tourism Project	Eaton Place Pty Ltd	Rodds Bay (30km south east of Gladstone)	• Low rise tourism and supporting residential community • Tourism and recreational facilities including hotel, caravan park, apartments, golf course, boat ramp and boat hire	2012/6643	Revised project approved by the Queensland Government in 2018.	Assume 15 year construction period from 2020	**Include project**

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Project	Proponent/s	Location	Project features (related to harbour)	EPBC no.	Development stage	Likely timeframe for construction and/or operation	Outcome for CIA
Port of Gladstone Western Basin Dredging and Disposal Project	Gladstone Ports Corporation Ltd	Port of Gladstone	• Deepening and widening of existing channels and swing basins • Creation of new channels, swing basins and berth pockets • Use of dredged material to reclaim land, including 153 ha north of Fisherman's Landing.	2009/4904 2009/4826	Stages 1A and 1B approved and Stage 1A completed in September 2013. Stages 2 to 4 to be phased in accordance with a Long Term Sediment Disposal Plan.	The timing of Stages 1B, 2, 3 and 4 is uncertain. The need for future stages is driven by other projects. WBE reclamation area has potential to include dredged material from Stages 1B, 2, 3 and 4.	**Exclude additional stages** - current operations included in environmental baseline. Exclude Stages 1B, 2,3 and 4 of the project as speculative market with need uncertain
QCLNG	Queensland Gas Company Ltd	Curtis Island (near Gladstone) and Surat Basin	• Network of 730km of pipelines: from gas fields to Gladstone • LNG processing plant and export facility: Curtis Island, near Gladstone	2008/4399 2008/4401 2008/4402 2008/4405	Three process trains, marine facilities, pipeline and shipping approved. Two trains operational from 2014/15.	No current timeframe for third train expansion.	**Exclude Expansion** - current operating facility included in environmental baseline. Expansion excluded as speculative future market with need uncertain.
Gladstone New Fuels Development Project	Queensland Energy Resources Ltd	Landing Road, Yarwun	• Commercial scale oil shale processing plant to produce diesel and other fuel products • Extension of oil shale mining activities	2014/7241 (Stage 2) Controlled Action	Stage 1 Pilot Plant (Technology Demonstration Plan) completed and currently under care and maintenance regime	Stage 2 (Small-Scale Commercial Facility 8,000 barrels a day) under research and development. EIS yet to be submitted for assessment. Project is on hold pending increase	**Exclude project** – speculative, dependent on finance and market

Project	Proponent/s	Location	Project features (related to harbour)	EPBC no.	Development stage	Likely timeframe for construction and/or operation	Outcome for CIA
						in the global oil price and funding for Stage 2.	
Rodd's Bay Solar Farm Yarwun Solar Farm	Renew Estate Pty Ltd	Bororen (60km south of Gladstone) and Yarwun Industrial Area	• 300 megawatt solar farm and associated facilities on 2,758 ha site		DA lodged in February 2018.	Assume 12 month construction period from 2018	**Exclude project** – potential impacts not material to environmental values under consideration
Toolooa Priority Development Area (PDA)	Various	Toolooa, 6km south of the Gladstone CBD	• Planned residential development mixed with retained bushland and open space		Approved Priority Development Area for future urban development	Timing subject to demand in Gladstone Assume it is developed as residential growth occurs over time	**Include project**
WICT	GPC/Wiggins Island Coal Export Terminal Pty Ltd	Port of Gladstone	• Three ship loading conveyor streams serving three ship loaders across four coal-export berths • Coal stockyard and materials handling systems • Provision for two additional other product berths • Marine facilities, including jetty and wharf • Dredging of channel and swing basin	2005/2374	Approved (84Mtpa capacity). Stage 1 (27Mtpa) completed in 2015.	Timing of Stages 2 and 3 is uncertain.	**Exclude Expansion** - current operating facility included in environmental baseline. Expansion excluded as speculative future market with need uncertain
Yarwun Alumina Refinery – Residue Management Area Expansion	RTA Yarwun Pty	Aldoga, 15 km from Gladstone	• Earthworks over a 10 year period to raise RMA 1, construction RMA 2, and subsequently, operation of new red mud dam • Footprint: approximately 330 ha	2017/8107 Controlled action	Assessment on Preliminary Documentation yet to be lodged.	Assume earthworks over a 10 year period commencing 2018 Operative until 2062	**Exclude project** – speculative, no approval, full assessment documentation not available, referral

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Project	Proponent/s	Location	Project features (related to harbour)	EPBC no.	Development stage	Likely timeframe for construction and/or operation	Outcome for CIA
							documentation indicates potential impacts not material to the environmental values to be considered
Maintenance dredging Port of Gladstone	Gladstone Ports Corporation	Shipping channels, swing basins and berth pockets within the Port of Gladstone	• Annual maintenance dredging programme of approximately 200,000 m^3 • Dredging and material placement at sea occurs for 12 weeks each year	Not Applicable	Approved.	Annually.	**Include project –** includes maintenance dredging of all channels not part of the Project (93% of future maintenance dredging activities).

3.3 Impacts from increases in shipping

The Project will not directly increase shipping activity within Port Curtis or within offshore waters of the GBR Marine Park. Capital dredging of the existing Gatcombe and Golding Cutting bypass channels is required to improve the efficiency of port operations, and to mitigate an existing and increasing shipping safety risk associated with increases in the throughput, number of ships and increasing portion of Cape-sized vessels at the Port. The Project will, therefore, result in improved management of existing and increasing shipping activities, rather than contribute to an actual increase in shipping volumes.

Increases in shipping volumes and changes in the portion of Cape-sized vessels utilising the Port are being driven by the development of other future projects within the Port (e.g. increased export of LNG and coal) and by trade economies of scale (i.e. use of Cape-sized vessels). The environmental impacts of these projects, including those associated with increased shipping activities, have already been assessed through their project-specific EIS processes at a State and Commonwealth level.

It should be noted that shipping activities at the Port are influencing the existing environmental values (environmental baseline) of the Gladstone region. The influence of shipping activities on the existing environment is, therefore, inherent within the impact assessment, which predicts the additional effects of the Project on the environmental baseline. Several monitoring programmes have been in place for the purpose of accurately describing the environmental baseline.

Future increases in shipping volumes have some relevance to the CIA. However, only a portion of such increases will occur before the planned completion of Project-related dredging and material placement activities. The period between 2019 and the completion of dredging is when there is potential for the impacts of increased shipping activities within the Port which are not currently influencing the environmental baseline, to act cumulatively with impacts of the Project. In this context, the CIA has considered the potential for the impacts of increased shipping activities during the period from 2019 to 2030 to act cumulatively with Project impacts (see Section 1.4.1 of the Project EIS).

3.4 Assessment of Cumulative Environmental Risk

It is important that ‘cumulative impact’ is defined, prior to commencing the CIA. While ‘cumulative impact’ is not defined in the EPBC Act, Section 527E of the Act defines the meaning of ‘impact’, which includes events or circumstances that are:

- A direct consequence of the action
- An indirect consequence of the action
- Facilitated to a major extent by the action

In accordance with this definition, the impacts being considered in this assessment will be those that are direct, indirect or facilitated by the proposed Project. In this context, the definition of impact within the EPBC Act is considered to provide sufficient coverage of the generally accepted definition of CIA.

The CIA has been informed by data from a variety of sources, including completed project EISs’, published monitoring reports, scientific literature and government reports. Various technical studies have also been commissioned by GPC as part of the Project EIS to describe the existing environmental baseline for the Port. Collectively, this information has been the basis for the technical impact assessments completed for the Project EIS.

An additional factor integral to the CIA is the consideration of thresholds, beyond which unacceptable environmental impacts may be expected to occur. For some values, thresholds or guidelines are well established by scientific research, and have been directly linked to the protection of environmental values.

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For example, quantitative thresholds or trigger values for turbidity have been established for waters within Port Curtis below which effective photosynthesis by seagrass can be expected to occur. Some thresholds are based more on common sense or a general understanding of the natural environment, while others will need to be established based on expert advice of specialists. Prior to the assessment of cumulative impacts, quantitative or qualitative thresholds have been described for each environmental value, using the approach most suited to that particular environmental value and the information and understanding available. These are discussed in the relevant chapters of the Project EIS.

The initial step of the CIA was to collate all potential environmental impacts predicted to result from the Project alone. This was informed by the results of the technical impact assessments, including the associated environmental risk assessments. For each environmental value, the likelihood and consequence of potential modes of impact were evaluated, using the Project EIS ecological risk assessment framework. The likelihood and consequence definitions and risk matrix applied in assessing cumulative risk are shown in **Table 6** to **Table 9**. The risk assessment assisted in evaluating the risk of a mode of impact exceeding a threshold for each environmental value.

Table 6: Definition of likelihood

Rating	Likelihood / Probability
Almost certain	Very likely and expected to occur during construction/life of the Project or during a 12 month timeframe; likely to occur multiple times during relevant period. Probability of 90% or greater chance of occurring.
Likely	Likely to occur during the construction/life of the Project or during a 12 month timeframe; probability of up to 90% chance of occurring.
Possible	Less likely than not, but still considerable; probability of about 50% chance of occurring over the life of the Project.
Unlikely	Unlikely but not trivial. May occur during construction/life of the Project but probability well < 50%.
Rare	Highly unlikely to occur but theoretically possible during the life of the Project

Table 7: Definition of consequence

Rating	Description
Negligible	Minimal change to the existing situation, including impacts which are beneath levels of detection, impacts that are within the normal bounds of natural variation or impacts that are within the margin of forecasting error. Recovery periods associated with these impacts are within 3 to 6 months.
Low	These impacts are recognisable, but acceptable within the decision making process. They are still important in the determination of environmental management requirements. These impacts tend to be shorter, or temporary (recovery periods of greater than 6 months and up to 12 months are likely) and at the local scale.
Moderate	These impacts are relevant to decision making, particularly for the determination of environmental management requirements. Ecological values/receptors are moderately sensitive and have moderate resilience/adaptive capacity and/or the impacts are local or regional significance. These impacts tend to range from short to long term (recovery periods of 1 to 4 years are likely), and occur over medium scale areas or focussed within a localised area.
High	These impacts are of importance to the decision making process. Ecological values/receptors are moderately to highly sensitive, have low to moderate resilience/adaptive capacity and/or the impacts are of State and National significance.

Rating	Description
	They tend to be permanent or otherwise medium term to long term (recovery periods of 5 to 9 years are likely), and can occur over medium or large scale areas.
Very high	These impacts are considered to be critical to the decision making process. Ecological values/receptors are extremely sensitive, have low resilience/adaptive capacity and the impacts are of national significance. They tend to be permanent, or irreversible (if recovery is possible, it is likely in excess of 10 years), or otherwise long term, and can occur over large scale areas).

Table 8: Risk matrix

Consequence		Negligible (N)	Low (L)	Moderate (M)	High (H)	Very high (VH)
Likelihood	Almost Certain (AC)	**Low**	**Medium**	**High**	**Very high**	**Very high**
	Likely (L)	**Negligible**	**Medium**	**Medium**	**High**	**Very high**
	Possible (P)	**Negligible**	**Low**	**Medium**	**High**	**High**
	Unlikely (U)	**Negligible**	**Low**	**Low**	**Medium**	**High**
	Rare (R)	**Negligible**	**Negligible**	**Low**	**Medium**	**Medium**

Table 9: Risk rating and associated risk management response

Risk rating	Risk management response
Very high (VH)	An issue requiring a change in project scope and/or timing; almost certain to result in a 'significant' impact on MNES and/or Matters of State Environmental Significance (MSES).
High (H)	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a 'significant' impact on MNES and/or MSES.
Medium (M)	An issue requiring project specific controls and operating procedures.
Low (L)	Manageable by standard mitigation and similar operating procedures.
Negligible (N)	No additional management required.

To establish a consistent framework for the comparative risk analysis, risks extracted from the Project EIS were identified against a suite of potential modes of impact (**Table 10**). Mostly this meant 'elevating' the risk description to a more general nature to ensure consistency across environmental values. For a given environmental value, multiple rated risks relevant to a potential mode impact were sometimes identified in the EIS for the Project.

For example, the Project EIS separately rates the risks of direct impact to seagrass from establishing the WBE reclamation area and BUF, dredging activities, and installation and removal of the navigation aids. In these circumstances the highest rated residual risk from the Project EIS relevant to a potential mode of impact as indicated in the Project EIS, was carried forward into the CIA. If the Project EIS did not address a particular mode of impact for a given environmental value, the risk was assumed to be negligible for the purposes of the CIA.

Table 10: Potential modes of impact used in CIA risk analysis

Potential mode of Impact included in CIA	Types of potential impacts included in the Project EIS risk analysis
Direct removal of habitat	• Loss of seagrass habitat from smothering or being cut off from the marine environment • Loss of foraging habitat for shorebirds associated with the loss of soft sediments in intertidal environments
Secondary and indirect impacts	• Loss of seedbanks for seagrass • Loss of foraging resources for Water mouse or shorebirds that are supported by benthic communities indirectly impacted by the Project (e.g. from sediment plumes), or from fragmentation and degradation of terrestrial habitat
Injury and mortality	• Injury and death caused by contact with increased levels of waste and marine debris • Injury and death caused by entrapment and direct contact with construction machinery and/or vehicle strike
Turbidity and sedimentation	• Increased light attenuation reducing photosynthesis and growth rates of seagrass. • Siltation of the foreshore and intertidal environments during the placement of core and armour material leading to loss or weakening of intertidal marine plants and initiating local erosion. • Burial of sessile benthic species and stress in filter feeding species. Change in community structure • Impairment of species' ability to detect predators/prey in favoured habitats (e.g. seagrass).
Mobilisation of contaminants	• Degradation of soft sediment habitats and toxicity to benthic macroinvertebrates. Transfer of contamination to other aquatic ecosystem components • Illness, injury and death to marine species • Adverse health effects through algal blooms as a result of eutrophication in waters through increased nutrient supply
Hydrodynamic and hydrological changes	• Altered erosion and deposition rates impacting growth rates, causing mortality to seagrass. • Changes to stormwater flooding associated with the placement of core and armour material altering water quality and causing damage to adjacent mangrove communities.
Introduction of artificial reef habitat	• Changes to fauna assemblages from introduction of additional rock habitat – 3-dimensional artificial habitat in intertidal and subtidal areas, in replacement of natural habitat
Underwater or above ground noise	• Mortality of marine fauna from injury associated with being located too close to piling activities • Alteration of behaviour, impairment to communication, trauma to hearing and to non-hearing tissue.

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Potential mode of Impact included in CIA	Types of potential impacts included in the Project EIS risk analysis
	• Disruption to foraging and roosting behaviour of shorebirds leading to displacement
Additional light	• Phototaxis responses in marine fish and invertebrates: alteration of susceptibility to predation or access to food resources • Alteration of foraging behaviour in turtles, disorientation of hatchlings, impact on nesting of female turtles
Spread pests or weeds	• Displacement of benthic macroinvertebrates through competition with invasive species for resources. • Displacement of shorebirds and Water mouse by predation, reduction in food resources and reduction in habitat quality from introduction of invasive species.
Environmental incident	• Loss of containment of oil, hazardous waste or other contaminants - smothering mangrove roots, intertidal seagrass and saltmarsh.
Bund wall seepage	• Reduction and/or loss of marine fauna habitat values from changes to water quality

The initial assessment of environmental risk involved the evaluation of potential modes of impact associated with the Project (in isolation), and the potential impacts on environmental values. Following the initial assessment, the risk assessment was repeated taking into consideration the 'other projects' that are likely to occur within the timeframe of the Project activities (refer **Table 5**). Residual risk ratings for the 'other projects' were obtained and/or interpreted from the respective Project's environmental assessment and Environmental Management Plan (EMP) documentation and environmental value, and assigned against the standard suite of potential modes of impact for the CIA using a scoring methodology (**Table 11**).

Table 11: Scoring of 'other projects' risks

Residual risk rating	Score
Negligible	0
Low	1
Medium	2
High	3
Very High	4

The risk rating scores from the five 'other projects' were summed for each potential mode of impact to provide an overall score for each environmental value. The maximum possible score was 20 (a maximum score of 4 across each of the five 'other projects'). Using these overall scores, criteria (**Table 12**) were then used to determine whether and how the risk rating for the Project would change in light of the potential for cumulative risks from 'other projects'. The revised cumulative risk ratings were then incorporated into the CIA risk register.

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Table 12: Effect of total score for a potential mode of impact for 'other projects' in changing Project risk rating

Overall risk score for all 'other projects' in respect of a potential mode of impact for a given environmental value	Effect in changing Project risk rating
0-6	No change
7-13	Risk rating increases by one level*
14-20	Risk rating increases by two levels**

* for example, from low to medium
** for example, from low to high

Finally, once the environmental risk of all projects was evaluated, the additional risk of exogenous factors, such as climate change and severe weather events were considered. This assessment was qualitative in nature, and was based on known sensitivities of the environmental value to exogenous factors.

This staged environmental risk assessment process provided an initial indication of the modes of impact that are most relevant for the Project and the environmental values that are the highest risk of being affected by Project-related activities. The environmental values for which cumulative impacts are most likely were also identified (those for which the environmental risk increases with the scale of the assessment). The purpose of each analysis was to provide insight into relative cumulative risks rather than to derive an absolute measure of cumulative impact. The analyses also reflect the unlikely scenario that all risks from the 'other projects' would occur at the same time.

To provide insight into how the risks from 'other projects' may act cumulatively over time, their scheduling was mapped over the Project's anticipated implementation period. The broad analysis undertaken does not distinguish where in the Port or wider Gladstone region, cumulative risks are likely to be significant. Additional analysis examined how these cumulative risks may be spatially distributed (**Section 3.5**).

3.5 Spatial analysis of risks

Environmental values throughout the Gladstone region vary in their proximity to the proposed dredging footprint and reclamation area. Thus, there is a spatial element to the assessment of cumulative impacts, which is important to consider. For each 'other project', areas of direct disturbance and potential indirect disturbance or facilitated disturbance were considered for overlap with the Project. This qualitative analysis of the spatial distribution of risk assisted in identifying whether there are 'hot spots' which will be exposed to potential impacts from multiple sources. The values most relevant to each other project were also considered (**Table 13**).

This approach provided a basis for identifying which areas may be most vulnerable to cumulative impacts on environmental values. The potential for cumulative impacts is discussed in a qualitative manner for each area of interaction.

Once the potential for cumulative environmental impacts arising from the Project were considered, options to mitigate impacts were assessed. This followed the Mitigation Hierarchy of Avoidance, Minimisation, Reduction, Rehabilitation and Offset (BBOP 2012). Mitigation options were assessed for their potential to reduce overall Project impacts in addition to their potential to reduce the risk of impacts acting cumulatively.

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3.6 Limitations and Assumptions

The method described in this report has been developed to satisfy the requirements of the ToR and EIS Guidelines in relation to cumulative impacts, using contemporary approaches to CIA. Projects proposed for the Gladstone region that are not yet approved by the Commonwealth and Queensland governments or have not yet been announced as funded by their owners were not considered in the CIA, as there is a reasonable expectation that such projects may not be constructed. Such projects, should they proceed in the future, would be considered as part of future environmental assessments or through regional planning assessments of the Gladstone region.

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Table 13: Summary of values and spatial overlap of other projects with the Gatcombe and Golding Cutting Channel Duplication Project

Environmental values	Gatcombe and Golding Cutting Channel Duplication Project	Pacificus Tourism Project	Clinton Vessel Interaction project	Toolooa Priority Development Area (PDA)	Port of Gladstone future maintenance dredging	Arrow Bowen Pipeline
Seagrass	✓	✓	✓		✓	
Mangroves	✓	✓	✓	Indirect	✓	
Saltmarsh	✓	✓	✓	Indirect	✓	
Inshore reefs	✓		✓		✓	
Soft bottom benthic habitats and macroinvertebrates	✓	✓	✓		✓	
Fish (with particular reference to taxa of commercial or recreational value)	✓	✓	✓		✓	
Water quality	✓	✓	✓	Indirect	✓	Localised at project site
Sediment quality	✓	✓	✓		✓	
Dugongs	✓	✓	✓		✓	
Inshore dolphins	✓	✓	✓		✓	
Humpback whale	✓		✓			
Water mouse	✓	✓	✓		✓	
Marine turtles	✓	✓	✓		✓	
Conservation significant and migratory fish species (shark and ray species)	✓	✓	✓		✓	
Shorebirds	✓	✓	✓	Indirect		
Outstanding Universal Value (OUV) of the GBRWHA	✓	✓	✓	Indirect	✓	

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Environmental values	Gatcombe and Golding Cutting Channel Duplication Project	Pacificus Tourism Project	Clinton Vessel Interaction project	Toolooa Priority Development Area (PDA)	Port of Gladstone future maintenance dredging	Arrow Bowen Pipeline
Comment		Common values impacted with some spatial separation	Temporal separation of impacts with enough time for recovery (4 years between impacts)	Indirect impacts from runoff	High degree of spatial and temporal overlap	No overlapping biodiversity values. Runoff only relevant impact, and too far away to interact with the Project

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4 Results

4.1 Assessment of cumulative environmental risk

Results of the assessment of cumulative environmental risk are presented in **Appendix B, C and D**, with a summary provided in the following sections. **Appendix B** provides the risk assessment ratings for the project alone and when 'other projects' are considered. **Appendix C** provides a summary of each 'other project' and the additional cumulative risk that is contributed by each 'other project'. **Appendix D** provides a summary of the cumulative environmental risk scores for all 'other projects' for each environmental value.

4.1.1 Risk from 'other projects'

Risk scores for all environmental values are shown in **Table 14**, for each 'other project'. The scores provide a basis for identifying the relative scale and extent of cumulative risks across the five other projects. The Clinton Vessel Interaction project, and future maintenance dredging within the Port of Gladstone contribute most of the cumulative environmental risk to the environmental values under consideration. While most works are located on land, disturbance from the Pacificus Tourism Facility has the potential to indirectly impact on some values, such as turtles and shorebirds.

Table 14: Risk scores to all values from 'other projects'

'Other Project'	Additional cumulative risk score across all values
Arrow Bowen Pipeline Project	5
Clinton Vessel Interaction project	**35**
Pacificus Tourism Facility	24
Toolooa Priority Development Area	10
Future maintenance dredging within the Port of Gladstone	**58**

4.1.2 Modes of impact

Risk scores for 'other projects' were not sufficient to cause a Project risk to increase for any mode of impact to an environmental value, when assessed against the criteria established in **Table 12**. Risk scores that came closest to increasing cumulative risks, compared with the Project alone, were:

- Mobilisation of contaminants on soft bottom benthic and seagrass habitats
- Turbidity and sedimentation on seagrass habitats
- Underwater noise impacting on marine turtles, dugong and/or dolphins

Risk scores for 'other projects' that added some additional risk for a mode of impact to an environmental value (but remained well below the criteria to alter the Project risk rating) include:

- Injury and mortality to marine turtles, dugong and/or dolphins
- Mobilisation of contaminants to marine turtles, dugong, dolphins, inshore reef, saltmarsh and/or mangrove habitat
- Direct removal of soft bottom benthic habitat
- Secondary or indirect impacts to shorebirds
- Turbidity and sedimentation on soft bottom benthic, inshore reef, saltmarsh and/or mangrove habitat

- Underwater noise impacting on humpback whales and conservation significant fish
- Spread of pests to soft bottom benthic habitat or change in habitat type to rock
- Additional light on habitat for marine turtles.

There was nil to negligible difference between the Project's environmental risk alone and cumulative environmental risk for the following key values and modes of impact:

- Direct removal of habitat for marine turtle, shorebirds, Water mouse, dugong, dolphins, Humpback whale, conservation significant fish, seagrass and fisheries
- Secondary or indirect impacts to Water mouse and seagrass
- Injury and mortality on shorebirds, Water mouse, Humpback whale, conservation significant fish, fisheries
- Turbidity and sedimentation on the habitat for marine turtles, shorebirds, Water mouse, dugong, dolphins, Humpback whale and conservation significant fish
- Mobilisation of contaminants on the habitat for shorebirds, Water mouse, Humpback whale, conservation significant fish and/or fisheries
- Hydrodynamic and hydrological changes on habitat for shorebirds, Water mouse, seagrass, saltmarsh and mangroves
- Change of habitat type to rock for mangroves, saltmarsh, Water mouse and shorebirds
- Additional noise on habitat for fish and fisheries, Water mouse and shorebirds
- Additional light on habitat for Water mouse
- Spread of pests or weeds on habitat for mangroves, saltmarsh, Water mouse and shorebirds
- Bund wall incident releasing turbid water on the habitat of Water mouse.

In summary, the 'other projects' do not act cumulatively to increase the risk for any mode of impact for any of the environmental values, when assessed against the criteria. Water quality modes of impact to seagrass and soft bottom benthic habitats, and general disturbance of habitat for dugongs, dolphins and turtles were those impacts closest to increasing risks above those of the Project alone.

4.1.3 Environmental values

The Project EIS identified variable levels of risk for environmental values. The Project alone presents the highest risks to values that are site-attached (habitat-related) and dependent on water quality (e.g. seagrass), and mobile species that are vulnerable to disturbance (e.g. shorebirds, marine turtles, dugongs and dolphins). Values for which environmental risk is low are those that will be subject to minimal disturbance or are widespread throughout the region and/or are known to be resilient to change (e.g. mangroves, saltmarsh, and benthic habitats).

The cumulative risk scores for 'other projects' in respect of the key values are summarised in **Table 15** and where relevant, the potential influence of exogenous factors is noted. Raw scores are provided in **Appendix D**. Scores were highest for seagrass, inshore reefs, soft bottom benthic habitats, dugong, dolphin and marine turtles, primarily resulting from sensitivity to reduced water quality and sedimentation. This indicates that these environmental values have the highest potential to be influenced by the cumulative impacts of other projects.

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Table 15: Cumulative risk scores from 'other projects' for environmental values

Environmental value	Additional cumulative risk score from 'other projects'	Key contributing impacts affecting cumulative environmental risk
Seagrass	12	Decreased water quality and increased sedimentation. Exogenous factors such as floods
Mangroves	6	Decreased water quality, increased sedimentation and hydrological changes. Exogenous factors such as floods and climate change.
Saltmarsh	6	Decreased water quality, increased sedimentation and hydrological changes
Inshore reefs	12	Decreased water quality, increased sedimentation and introduction of pests. Exogenous factors such as floods and climate change.
Soft bottom benthic habitats	15	Direct removal of habitat, decreased water quality, increased sedimentation and introduction of pests
Fisheries (recreational and commercial)	3	Direct removal of fisheries habitat and decrease in habitat suitability as a result of decreased water quality
Dugongs	16	Decreased water quality (dependence on seagrass), injury and mortality, and underwater noise. Exogenous factors such as floods
Dolphins	16	Loss of inshore foraging habitat, decreased water quality, injury and mortality, and underwater noise
Humpback whales	6	Underwater noise
Water Mouse	7	Direct loss and fragmentation of habitat
Marine turtles	18	Decreased water quality (dependence on seagrass), injury and mortality, underwater noise, lighting, interaction with vessels and increased disturbance to nesting and hatching success. Exogenous factors such as floods and climate change.
Conservation significant fish	8	Loss of inshore habitat and underwater noise.
Shorebirds	7	Sensitivity to increased disturbance (noise and light), injury and mortality and reduction in food resources. Sensitivity to exogenous factors such as climate change and disruption to ecological requirements in migratory 'fly ways'.

When the cumulative risk scores from 'other projects' are considered in addition to those from the Project alone, the distribution of risk across the environmental values remains broadly similar to that from the Project alone (**Table 16**). The highest cumulative risks scores from 'other projects' (**Table 15**) largely fall on environmental values subject to moderate risk from the Project alone. Shorebirds, which incur the highest Project risk score, and marine turtles, are subject to varying degrees of additional cumulative risk from 'other projects', and are the environmental values with the highest cumulative risk scores.

The overall effect is that while the risks to shorebirds are significantly higher compared with other values for the Project alone, when the additive risks of 'other projects' are considered, the risks to seagrass, dugongs, dolphins, and marine turtles are similar (although still lower than the risk to shorebirds). Most of this additional risk comes from the Clinton Vessel Interaction project and future maintenance dredging for the Port (**Table 14**), the 'other projects' with activities located within the marine environment. There is also potential for indirect impacts from the Pacificus Tourism Facility (e.g. lighting and recreational use of beaches) to affect turtles and shorebirds in a manner that is cumulative with impacts from the Project.

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Table 16: Effect of cumulative environmental risk scores from 'other projects' on Project risks for key environmental values (raw scores are in Appendix D)

Cumulative Risk[#]	Seagrass	Mangroves	Saltmarsh	Inshore reefs	Benthic habitats	Fish (recreation and commercial)	Dugongs	Dolphins	Humpback whales	Water mouse	Marine turtles	Conservation significant fish	Shorebirds
Project alone	16	4	6	1	7	7	12	12	9	18	14	8	25
Project plus other projects	28	20	12	13	22	10	28	28	15	25	32	16	32

Project alone: <11 Low (green), 11-20 Medium (orange) and 21+ High (red)
Project plus other projects: <20 Low (green), 20-29 Medium (orange), 30+ High (red)
Note: The risk rating criteria in this table are derived to assist in categorising and distinguishing the difference between raw scores, and are not linked to the risk categories in Appendix B.

4.1.4 Cumulative risk over time

The Project has the potential to occur over a period of approximately 10 years, however not continuous during this period. The 'other projects' acting cumulatively over this period will occur at different timeframes within this period. The indicative timing of 'other projects' is shown in **Figure 11** with regard to the anticipated Project period.

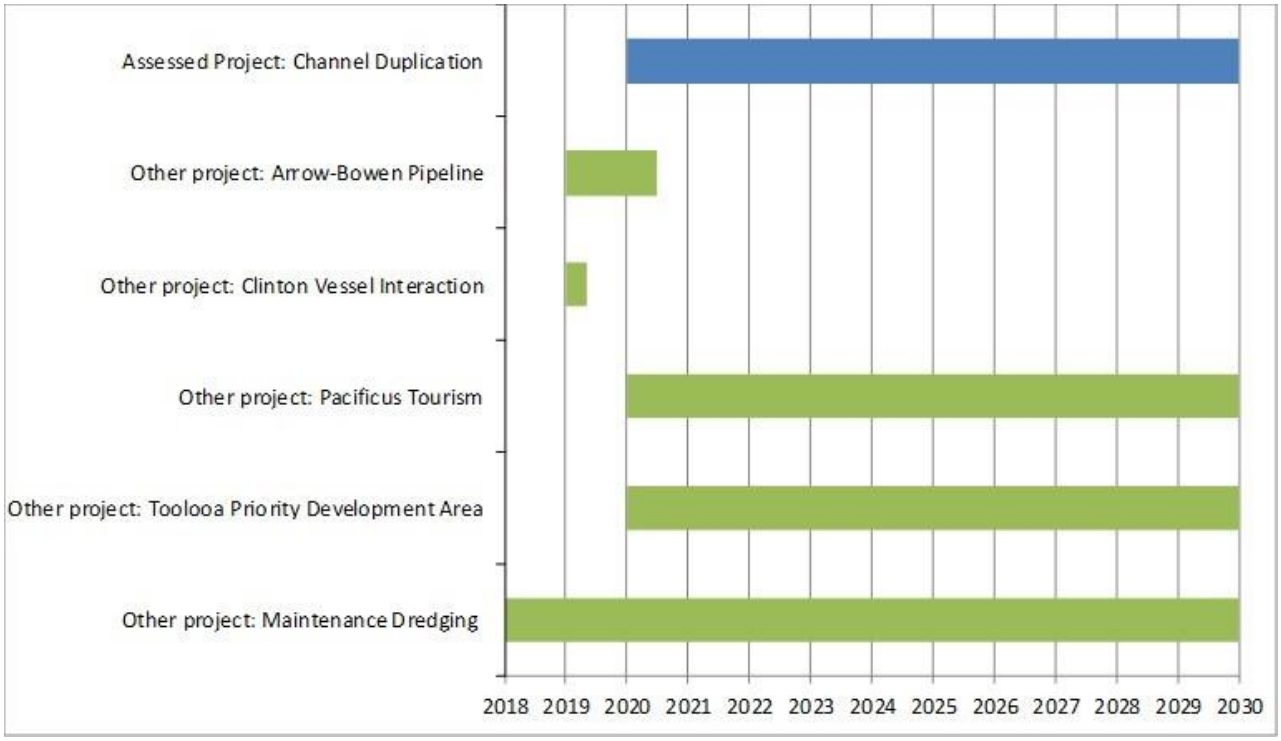

Figure 11: Timing of the 'Assessed' and 'other projects'

The Clinton Vessel Interaction project and future maintenance dredging for the Port of Gladstone contribute the most cumulative risk, due to their presence within the marine environment. However, the former is likely to be completed in 2019, before commencement of the Project. Future maintenance dredging, while scheduled over the ten-year period of Project implementation, will occur intermittently. GPC usually completes a maintenance dredging campaign annually between November and February over a four to six week period, with a dredger potentially returning mid-year to complete a minor campaign, subject to requirements and scheduling (GPC 2012).

4.2 Spatial distribution of impacts from multiple projects

Aspects of the Project are located across an area of approximately 80 km^2, from the southern entrance to The Narrows (in the north) to the southern entrance channel to the Port (in the south). Activities in the western third of the Port include dredging, barge access channel, BUF and the placement and beneficial reuse of dredged material in the WB and WBE reclamation areas. In the central part of Port Curtis, works are limited to the removal of navigation aids. In the eastern third of the Port, the installation of navigational aids and dredging of the Gatcombe and Golding Cutting bypass channels will occur.

The distribution of the five other projects under consideration is summarised in **Table 17**.

Table 17: Location of other projects in relation to the Channel Duplication Project

Project	Distance from Project	Areas with potential to be affected
Arrow Bowen Pipeline	~10 km from reclamation area	Negligible effects on coastal areas. Potential indirect impacts from water and sediment runoff.
Clinton Vessel Interaction	~4 km from initial dredging for access channel	Temporary increase in suspended sediment and disturbance in central part of Port Curtis.
Pacificus Tourism	~6 km from the channel duplication dredging, located to the SE on Hummock Hill Island	Eastern sections of Port Curtis and areas further south. Increased disturbance from recreational visitation, minor changes to water quality and habitat fragmentation.
Toolooa PDA	~8 km west of the channel duplication dredging, located away from the coast in a suburb of Gladstone	Central and eastern sections of Port Curtis. Incremental decline in water quality from urbanisation of the catchment.
Future maintenance dredging of the Port	Dredging and material placement activities to occur in similar areas of Port Curtis as Project activities	All parts of Port Curtis. Periodic decline in water quality and seagrass health from the suspension of sediments. Some disturbance to marine fauna.

The Clinton Vessel Interaction project and the future maintenance dredging of the Port are the two projects with the greatest potential for spatial overlap in the areas to be impacted by the Project. Both are dredging projects with similar potential modes of impact to the Project. The Clinton Vessel Interaction project is likely to be completed several years before the commencement of dredging for the Project. However, the future maintenance dredging is likely to be completed at a similar time as the Project, as this activity occurs each year.

The remaining three projects are located on land and have the potential for indirect or facilitated cumulative impacts. This may occur through fragmentation of wildlife habitat at a regional scale, increased disturbance to a population and/or its habitat (e.g. marine turtles or shorebirds), or through declines in water quality from runoff. Of these, the Pacificus Tourism project occurs in closest proximity to the Project activities, and has the greatest potential for disturbance of sensitive receptors during construction. The

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Arrow Bowen Pipeline is location more than 10 km from the coast, and is unlikely to contribute cumulative risks. Increased visitation arising from the Pacificus Tourism project after construction, and increased urbanisation from the Toolooa PDA following the completion of construction are also relevant.

4.3 Exogenous factors

4.3.1 Flood events

A major flood event occurred in the Calliope and Boyne Rivers of the Gladstone region in December 2010 and January 2011, with a range of impacts on the estuarine environment of Port Curtis (Wesche *et al.* 2013). The Awoonga Dam overflowed on 12 December 2010 for the first time in 14 years, with water continuing to flow over its spillway for a period of seven months. The event resulted in decreased water quality within Port Curtis, with high turbidity and suspended sediment concentrations.

In the months that followed, a temporary reduction of seagrass habitats and an increase in strandings of marine wildlife occurred, including turtles and dugong. An increase in the prevalence of animal diseases was also reported, particularly in fish, sharks and crustaceans. The Queensland Government closed Gladstone Harbour and the surrounding area to fishing for a period of 21 days in response to concerns about human health and to allow testing to be carried out on fish. A scientific advisory panel was established to advise the government on responses to the issue and to assist in determining the cause.

The flood event of 2011 illustrates the potential vulnerability of estuarine ecosystems such as Port Curtis during times of stress caused by climatic events. During such times, there is a heightened potential for cumulative impacts as the ecosystem is likely to be less resilient to the influence of anthropogenic activities such as dredging.

Since 2011, there have been several rainfall events that have caused flooding in the Port Curtis catchment, and resulted in water spilling over Awoonga Dam. However, environmental effects of these subsequent floods have not been as severe or widespread as those observed in 2011.

Additional impacts from the Project, if carried out during a time of exogenous stress such as a flood, are difficult to predict in advance. However, they are likely to include a reduced tolerance of sensitive habitats such as seagrass and coral communities to respond to Project-related changes in environmental conditions such as increased suspended sediment concentrations and deposition. This in turn may affect marine fauna that depend on such habitats, such as turtles, dugong and fish. Such factors will be considered in the development of management plans for the Project dredging, with the timing and nature of Project activities reviewed, should a major flood or significant exogenous event occur at the same time as the Project.

4.3.2 Climate change

One of the most significant risks to the GBRWHA is climate change. Increasing sea surface temperatures and acidification of the ocean are expected to have impacts on coral reef ecosystems. In recent years, severe bleaching events have been recorded in response to warming sea surface temperatures. Such events have the potential to kill corals and their associated reef communities or leave them vulnerable to stresses from other factors, such as anthropogenic activities. The inshore coral reefs of the GBR, have been noted to be in significant decline over the past few decades, due to activities primarily within the GBR catchment and declines in water quality along the GBR coast (GBRMPA 2014a, Waterhouse *et al.* 2017).

Climate change is recognised as a key system-wide threat to the GBR, and widespread coral bleaching is known to be a major consequence of increased sea surface temperatures. Additional levels of environmental risk have the potential to occur, when bleaching events coincide with dredging programs.

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Numerous dredging campaigns have been undertaken across the world during coral bleaching events, with varying consequences (e.g. Miami Harbour Phase III Federal Channel Expansion; Barrow Island, Pluto and Wheatstone projects in Western Australia and the Nelly Bay Harbour Development on the GBR). Recent experimental research has also indicated that bleached corals have more difficulty clearing themselves of sediments (Bessell-Browne *et al.* 2017), thereby providing a clear evidence pathway for cumulative impacts of combined bleaching and dredging events.

Based on the above, there is clearly increased risk for inshore coral communities within and around the area to be dredged if a coral bleaching event coincides with the Project. Additional impacts are most likely to be associated with a decreased tolerance from corals of smothering by sediments, and therefore risks are highest to corals inhabiting areas where deposition rates are the highest.

Coral bleaching events can be predicted with some certainty at a regional scale, by monitoring sea surface temperatures. Whether and how events may manifest at a local level is less clear. However, having mechanisms to identify coral bleaching events (predictive and *in situ*) along with adaptive management mechanisms to address potential risks, will be a component of dredging management plans to address the potential for cumulative effects.

4.4 Cumulative impact to key environmental values

This section provides further detail on the cumulative impact of multiple projects on key environmental values of Port Curtis. The assessment includes relevant attributes of OUV of the GBRWHA expressed locally in the Port Curtis region (**Appendix A**). The CIA identified that the contribution of 'other projects' to cumulative environmental risk was not sufficiently high to cause the risk rating of any environmental value to increase (**Appendix B**). However, for those values that are approaching a threshold of increased risk, the key factors contributing to this increase, and their links with other projects are discussed. Exogenous factors that may exacerbate cumulative risks are also considered. Values that were identified as medium or high in **Table 16** are discussed in further detail in the following sections, ordered from highest to lowest risk.

4.4.1 Shorebirds

Migratory shorebirds show fidelity to their roosting and foraging sites and prefer to roost close to foraging areas. This fidelity may adversely impact upon survival rates when the habitat is permanently lost or altered. Roosting sites have been identified near the WBE reclamation area, and establishment of Project infrastructure may alter roosting behaviour, due to the loss of foraging habitat. Resident shorebirds also utilise coastal habitats of the Port Curtis region. Approximately 1.18% of the total area of potential shorebird habitat within the Port Curtis region is expected to be lost due to the establishment of the WBE reclamation area. The environmental risk associated with this is assessed as very high in the Project EIS.

Direct injury or mortality caused by the establishment of the WBE reclamation area is unlikely to affect shorebirds to the extent that numbers or species populations decline or are significantly impacted. The generation of noise, vibration and dust during the Project has the potential to cause disturbance to foraging, roosting and migratory behaviour. The risk to Critically endangered or Endangered shorebird species under the EPBC Act is assessed as high to very high, and medium to high for Vulnerable and/or migratory species.

There will be minimal direct disturbance to shorebird habitat from the other projects. The Toolooa PDA is located approximately 2 km from wetland habitats at the entrance to the Boyne River, which are likely to be utilised by shorebirds as foraging and roosting areas. The Pacificus Tourism project will result in disturbance of a small coastal area for construction of a bridge. There will also be increased visitation to the region, which may in turn increase disturbance to shorebirds along coastal foreshores. However, the

additional affects from these projects are considered to be minor. All of the remaining 'other projects' are located a significant distance from shorebird habitat, avoiding impacts, and are in keeping with the current environmental setting of the Gladstone region

Shorebirds are relatively tolerant of exogenous factors that may impact on the local environment of Port Curtis, due to the types of habitats they utilise and ability to move to alternative areas. While they may be vulnerable to significant events such as cyclones, their ability to migrate vast distances in the event of temporary declines in habitat values makes them more resilient than other species, particularly those dependent on seagrass for food (e.g. turtles and dugong). However, movements based on temporary impacts from projects also have the potential to reduce the migration and breeding success of shorebirds, through the expenditure of additional energy reserves.

The significant residual adverse impact assessment concludes that the establishment of the WBE reclamation area has the potential to result in a significant residual adverse impact on migratory shorebird foraging habitat in the area.

While shorebirds will be subject to the highest environmental risks of any value in the Port Curtis region from the Project alone, there will be only a minor increase in this risk from other projects and exogenous factors. Therefore the potential for cumulative impacts is low.

The highest rated cumulative risk for a mode of impact to shorebirds (direct disturbance of habitat) was assessed to be very high, the same as for the Project alone.

4.4.2 Marine Turtles

Of the six species of marine turtle with the potential to occur within the Port Curtis region, the Green turtle (*Chelonia mydas*) and Flatback turtle (*Natator depressus*) are most common. Foraging Green turtles live within the sheltered environments of Port Curtis, feeding on a range of food sources, including seagrasses, algae and mangrove fruits (Limpus *et al*. 2013a). Flatback turtles nest on the beaches of Curtis Island and Facing Island (Limpus *et al*. 2013b). Flatback turtles often move into Port Curtis during the inter-nesting period, the approximate two week period between laying successive clutches of eggs. Once they complete nesting, Flatback turtles return to their foraging grounds, which may be up to 1,000 km away (Hamann *et al*. 2017).

Hawksbill turtles, Olive ridley turtles and Loggerhead turtles have a lower abundance in Port Curtis, but may be present in small numbers from time to time (Limpus *et al.* 2013c, d, e). The Leatherback turtle has a low likelihood of occurrence within the Port based on previous records (Limpus *et al*. 2013f), but may occur very occasionally.

The assessment of potential impacts of the Project on marine turtles is therefore focussed primarily on foraging Green turtles, and Flatback turtles during the nesting period (which occurs from October to January each year).

The impact assessment found that the Project will not have a significant residual adverse impact on marine turtle species. The area of seagrass and inshore habitat to be disturbed during the Project is relatively small, with indirect impacts likely to be short-term. Potential indirect Project impacts will not have a significant impact on the marine turtle life cycle.

Marine turtles have a higher vulnerability to cumulative impacts than some other environmental values, due to their exposure to a multitude of pressures and stressors across their life cycle within the GBR region and beyond. Most marine turtles utilising Port Curtis will be at risk of anthropogenic impacts across various aspects of their life cycle. This makes the assessment of cumulative impacts difficult.

Of the other projects under consideration for cumulative impacts, the Pacificus Tourism project, Clinton Vessel Interaction project, and future maintenance dredging of the Port are most relevant for impacts on marine turtles. These projects can be expected to result in:

- Disturbance from increased visitation and recreational boat use in the area
- An increase in artificial lighting and the night time sky glow of the Gladstone region
- Short-term declines in water quality and impacts to seagrass from dredging plumes
- Disturbance from the temporary use of dredging plant, increasing the risk of boat strike, and disturbance to habitat

Dredging techniques generally result in a low interaction rate between marine turtles and dredging plant. The noise and vibration and general disturbance to habitat is temporary. Each 'other project' will have its own environmental management and monitoring regime to mitigate the risk of impacts to key habitat values such as seagrass. Common approaches for dredging projects include the application of turbidity or light trigger values, which if exceeded, result in a change to the dredging activities. The timing of the 'other projects' will most likely reduce the potential for cumulative impacts. The Clinton Vessel Interaction project is due to be completed in 2019, prior to the commencement of the Project. This capital dredging project and the annual Port maintenance dredging is undertaken by GPC (the same proponent as the Project), providing opportunity to manage cumulative impacts.

Marine turtles are also vulnerable to the influence of exogenous factors that affect the health of their habitat. In particular, major flood events have the potential to result in a temporary reduction in seagrass and potentially result in an increase in strandings. Studies have shown that the recovery of health indicators in Green turtles following the flood conditions generally takes years (e.g. Flint 2015). There is a medium to high potential for cumulative impacts should there be similar natural events such as floods during the dredging campaign. If a flood event was to occur during the dredging campaign, the dredging activities will need to be managed to mitigate further impacts.

The highest rated cumulative environmental risk for a mode of impact to marine turtles (direct loss of habitat) is assessed to be very high, the same as for the Project alone.

4.4.3 Dugong

Dugongs are protected as a Migratory species under the EPBC Act and listed as Vulnerable under the *Nature Conservation Act 1992*. A small population of dugongs considered to be regionally-significant to southern Queensland is known to utilise the Port, and areas immediately adjacent, to forage on seagrass which forms a key part of their diet. Isolated patches of seagrass have been identified within the WBE reclamation area, accounting for approximately 3.8% of coastal seagrass mapped in Port Curtis. The removal of these seagrass meadows as part of the establishment of the WBE reclamation area will result in the permanent and irreversible loss of dugong habitat, and may disrupt foraging ability.

Noise and vibration caused by the removal and installation of navigational aids are also likely to disrupt foraging temporarily, with a risk rating assessed as medium. Dugongs use sensitive bristles on their upper lip to detect seagrass rather than relying on their poor eyesight (Marshall *et al*. 2003). Therefore, it is unlikely that an increase in sedimentation caused by dredging will directly affect foraging ability. However, seagrass meadows are particularly susceptible to changes in water quality, and may decline as a result of increased turbidity, leading to an indirect impact on dugongs.

A medium risk rating is associated with an increase in waste materials entering the marine environment (i.e. ingestion or entanglement in marine debris), while vessel strike, direct contact with construction plant or entrapment in reclamation areas has been assessed as low to medium.

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The significant residual adverse impact assessment concluded that the establishment of the WBE reclamation area has the potential to result in a significant residual adverse impact on dugong habitat in the area.

Of the 'other projects' under consideration for cumulative impacts, the Pacificus Tourism project, Clinton Vessel Interaction project, and future maintenance dredging of the Port are most relevant for impacts on dugong. These projects can be expected to result in:

- Disturbance from increased visitation and recreational boat use in the area
- Short-term declines in water quality and impacts to seagrass from dredging plumes
- Disturbance from the temporary use of dredging plant, increasing the risk of boat strike, and disturbance to habitat

Like marine turtles, dugongs are vulnerable to the influence of exogenous factors that affect the health of their habitat. Major flood events, such as that which occurred in 2011, can be expected to result in a reduction of seagrass and facilitate a potential temporary increase in dugong strandings. There is a medium potential for cumulative impacts, should the Project be completed at a similar time as natural episodic events such as a flood. If a flood event was to occur during the dredging campaign, the dredging activities will need to be managed to mitigate further impacts.

The highest rated cumulative environmental risk for a mode of impact to dugongs (direct loss of habitat) is assessed to be very high, the same as for the Project alone.

4.4.4 Dolphins

The Australian humpback dolphin is known to utilise waters surrounding the channel duplication area to forage for food (a range of fish species and crustaceans). The permanent loss of benthic substrate at the channel duplication area through dredging activities has a high risk rating and the potential to directly impact an important area of habitat for this species. Establishment of the WBE reclamation area, and associated loss of habitat is almost certain to impact the species, with a very high-risk rating. The Australian snubfin dolphin occurs at Port Alma, further away from Project activities (Cagnazzi 2018).

Dolphins may be affected by indirect impacts of the Project, through changes in water quality, underwater noise and vibration, and the introduction of invasive species and disease. An increase in waste materials entering the marine environment (i.e. ingestion or entanglement in marine debris), vessel strike and direct contact with construction plant or entrapment in reclamation areas are also potential impacts, assessed as low to medium risk in the Project EIS.

The significant residual adverse impact assessment concludes that the Project activities at the WBE reclamation area are unlikely to have a significant residual adverse impact on inshore dolphin species in the area.

Of the other projects under consideration for cumulative impacts, the Pacificus Tourism project, Clinton Vessel Interaction project, and future maintenance dredging of the Port are most relevant for impacts on inshore dolphins. These projects can be expected to result in:

- Disturbance from increased visitation and recreational boat use in the area
- Short-term declines in water quality and impacts to habitat from dredging plumes
- Disturbance from the temporary use of dredging plant, increasing the risk of boat strike, and disturbance to habitat

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Exogenous factors such as flooding and cyclones may affect inshore dolphins, although they are likely to have lower sensitivity to such events than marine turtles and dugong. Overall, the potential for cumulative impacts is assessed to be low to medium.

The highest rated cumulative environmental risk for a mode of impact to dolphins (direct loss of habitat) is assessed to be very high, the same as for the Project alone.

4.4.5 Seagrass

Seagrass is a key ecological value within Port Curtis, providing habitat, shelter and food resources for a variety of ecologically-significant marine species (i.e. dugong, dolphins and fish). During construction of the WBE reclamation area, suspended sediment will smother seagrass, resulting in the direct loss of coastal seagrass habitat, irreversibly impacting on seagrass meadows within the WBE reclamation area. Approximately 3.8% of coastal seagrass mapped in Port Curtis is almost certain to be impacted by Project activities.

Secondary impacts caused by the construction of the WBE reclamation area are of medium risk. Permanent loss of viable seagrass seeds in the WBE reclamation area may impact on the capacity for surrounding seagrass meadows in Port Curtis to recover from future losses. A short-term reduction in water quality during the establishment of the WBE reclamation area, affecting seagrass through the release of sediment laden runoff and/or contaminants will be generally restricted to a contained area.

Dredging activities leading to the permanent loss or alteration of benthic substrate within the areas to be dredged are of low risk to coastal seagrass meadows and medium risk to deep water seagrass meadows. A reduction in benthic light due to elevated turbidity caused by dredging will reduce the ability of seagrass to photosynthesise, resulting in a medium risk to both coastal and deep-water seagrass habitats.

The significant residual adverse impact assessment concludes that the establishment of the WBE reclamation area will result in a significant residual adverse impact on seagrass.

Of the other projects under consideration for cumulative impacts, the Clinton Vessel Interaction project and future maintenance dredging of the Port, are most relevant for impacts on seagrass, causing short-term declines in water quality and impacts from dredging plumes. There is potential for cumulative impacts, depending on the timing of dredging activities and the ability of seagrass to recover from impacts caused by the Project.

Seagrass is vulnerable to exogenous factors such as major floods or cyclones due to sediment laden runoff and/or contaminants from upstream, and turbidity causing the reduction in benthic light and smothering. The potential for cumulative impacts from ‘other projects’ and exogenous factors should be carefully considered in management plans developed for the Project. There is a medium to high potential for cumulative impacts, should the Project be completed at a similar time to such activities or natural events. If a flood event was to occur during the dredging campaign, the dredging activities will need to be managed to mitigate further impacts.

The highest rated cumulative environmental risk for a mode of impact to seagrass (direct loss) is assessed to be very high, the same as for the Project alone.

4.4.6 Water mouse

The Water mouse (*Xeromys myoides*) is a Vulnerable species under the EPBC Act and the *Nature Conservation Act 1992*. The Project EIS assessment concluded that the Project will not have a significant residual adverse impact on the Water mouse. There are no areas of potential water mouse habitat within the proposed WBE reclamation area.

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Potential Water mouse habitat is mapped within the area that may be influenced by indirect impacts of the Project (e.g. influenced by Project noise, lighting, or changes to hydrology). These habitat areas meet the definition of critical habitat for the species.

The removal and degradation of habitat as a result of development actions is the principal threat to the survival of the Water mouse. The species is vulnerable to cumulative impacts if a series of projects establish along a section of coastal foreshore habitat, fragmenting habitat. Permanent loss of habitat areas may impact on the species' ability to disperse and persist within the landscape. Indirect impacts from noise, lighting and changes in hydrology may also effect the species.

The Landscape Fragmentation and Connectivity Tool analysis undertaken during the Project EIS concluded that the loss of vegetation within the WBE reclamation area would not have a significant impact on connectivity areas for terrestrial species.

There are no significant impacts on Water mouse anticipated from the five 'other projects' being considered in the CIA. The Pacificus Tourism project is the only project that will result the clearing of Water mouse habitat, with <0.1 ha of disturbed mangrove areas to be affected. Some minor indirect impacts may occur from urbanisation of the Toolooa PDA, but these are considered to be negligible in scale.

The Water mouse is not particularly susceptible to impacts from exogenous factors such as floods and cyclones. Mangrove environments are generally quite resilient to impacts from such events, and will recover from damage caused by cyclones once hydrological conditions return to normal.

Overall, there is a low potential for cumulative impacts on the Water mouse, when considering the combined effects of the Project, 'other projects' and exogenous factors. The highest rated cumulative environmental risk for a mode of impact to Water mouse (impacts on habitat connectivity) is assessed to be high, the same as for the Project alone.

4.4.7 Benthic habitats

Construction of the WBE reclamation area bund walls and BUF will result in the permanent loss of wetland areas from within the Port Curtis Directory of Important Wetlands in Australia wetland and is likely to result in the loss of benthic habitats and associated benthic flora and fauna communities. Dredging of the barge access channel will also result in the direct loss of benthic habitats.

Dredging to duplicate the channels will be situated directly adjacent to the existing shipping channel, and these benthic habitats have experienced previous disturbance due to capital and maintenance dredging operations associated with the existing shipping channel.

Potential impacts due to the operation of the duplication shipping channel are expected to occur over a medium term and be contained to relatively small areas within the marine environment. The barge access channel and surrounding areas may experience increased siltation (due to increased depth and reduced water velocity) during dredging activities but no change in the siltation rate is expected in the vicinity of the Barney Point pocket beach.

The main impact related to coastal processes and hydrodynamic modelling is a potential for some erosion to occur in the channels surrounding the WBE reclamation area (southern and northern areas). This erosion would continue (provided the bed material is erodible), until the channel reaches a new equilibrium depth. These changes are not expected to result in major changes to benthic communities in the affected areas.

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Of the other projects under consideration for cumulative impacts, the Clinton Vessel Interaction project, and future maintenance dredging of the Port are the only projects that will have direct disturbance of benthic habitats. These projects can be expected to result in incremental additional impacts related to the loss of epibenthic biota and short-term declines in water quality from dredging plumes.

Several studies report that climate change, along with exploitation, habitat alteration, and pollution, is reducing the abundance of many marine species and increasing the likelihood of local (and in some cases global) extinction (Harley *et al*. 2006). However, the most sensitive benthic habitats are those containing corals or seagrass, which are assessed specifically. Overall, the potential for cumulative impacts from other projects and exogenous factors on benthic habitats is assessed to be medium. The potential for cumulative impacts will be carefully considered in management plans for dredging developed as part of the Project.

The highest rated cumulative environmental risk for a mode of impact to benthic habitats (direct disturbance) is assessed to be high, the same as for the Project alone.

4.4.8 Fish having Conservation significance

The Project will have direct and indirect impacts on intertidal and subtidal environments, which provide habitat value for fish and fisheries resources having conservation significance. Eight listed fish species, Estuary stingray (*Dasyatis fluviorum*), Whale shark (*Rhincodon typus*), Great white shark (*Carcharodon carcharias*), Shortfin mako shark (*Isurus oxyrnchus*), Longfin mako shark (*Isurus paucus*), Porbeagle (*Lamna nasus*), Reef manta ray (*Manta alfredi*) and Giant manta ray (*Manta birostris*) are considered to have a moderate likelihood of occurring within and/or adjacent to the proposed dredging works (Likelihood Assessment in Ecology Technical Report - Appendix I1 of the EIS). These species are classified as conservation significant and/or migratory species with a “High” sensitivity rating in the Project EIS.

There will be a direct loss of intertidal and subtidal habitat for conservation significant and/or migratory fish species associated with the establishment of the WBE reclamation area, the BUF and dredging activities.

Of the ‘other projects’ under consideration for cumulative impacts, the Pacificus Tourism project, Clinton Vessel Interaction project, and future maintenance dredging of the Port are most relevant for impacts on conservation-significant fish. These projects can be expected to result in incremental additional impacts related to:

- Disturbance from increased visitation and recreational boat use in the area
- Short-term declines in water quality and impacts to habitat from dredging plumes
- Disturbance from the temporary use of dredging plant, including noise and vibration

Fish having conservation significance may be vulnerable to the influence of exogenous factors that affect the health of their habitat. Major flood events, such as that which occurred in 2011 and 2012 to 2014 can be expected to result in water quality declines within Port Curtis and surrounding areas, and the temporary reduction of seagrass. However, the mobile nature and oceanic habits of many of the listed fish species make them more resilient to such impacts than other fish species. Therefore, the potential for cumulative impacts is low.

The highest rated cumulative environmental risks for a mode of impact to conservation-significant fish (direct loss of habitat, increased turbidity and disturbance of habitat from underwater noise) was assessed to be medium, the same as for the Project alone.

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4.4.9 Inshore reefs

Construction of the WBE reclamation area and BUF will result in the direct loss of intertidal and subtidal soft sediment habitat which does not support any known reef communities. Therefore the potential for direct impacts on inshore reefs is negligible. Also, no hard structure reef habitat is located in any of the areas to be dredged. Some inshore coral communities occur within the broader Gladstone region and may be subject to indirect impacts from increased sedimentation and suspended sediment concentrations.

Broad-scale benthic habitat classifications identified rocky/rubble reefs at two areas during the environmental baseline survey area (refer to Chapter 9 and Appendix I1 of the Project EIS). These communities occurred as five smaller areas and encompassed the areas to be dredged and surrounds. Another benthic community type comprised mostly of open substrate interspersed with polychaetes and encrusting bryozoans, encompassed the southern end of the areas to be dredged.

Although 'low to medium density', the regions made up of benthic macroinvertebrates and algae contribute value in the form of biodiversity to the Port Curtis ecosystem. These communities are a source of food for many consumers and benthic fauna also 'form a link between habitat substrata, detritus-based food chains and larger carnivores'. The communities also support fisheries productivity in the form of providing food, habitat and shelter for benthic animals and other larger carnivores as well as a source of food for some species of marine turtles that consume macroalgae.

The key potential stressors on reefs from the Project activities may include increased sedimentation and turbidity caused through the mobilisation of sediments associated with dredging activities and dredged material placement activities. A reduction of benthic photosynthetically active radiation (BPAR) in the water column caused by light attenuation through increased turbidity reduces the photosynthetic potential and energy production of most reef building hard corals which rely on the photosynthetic activity of the microalgae zooxanthellae for their growth and survival. A reduction in BPAR may also lead to an increase in mucus production, changes in coral colour or darkening, and in extreme cases mortality and complete changes in reef community structure.

Other potential stressors on reefs from the Project activities may include changes in water quality, particularly salinity, temperature and increased nutrients from discharges of water into the marine environment from dredged material decant water, dredger overflow or runoff.

Of the 'other projects' under consideration for cumulative impacts, the Pacificus Tourism project, Clinton Vessel Interaction project, and future maintenance dredging of the Port are most relevant for impacts on inshore reefs. These projects can be expected to result in incremental additional impacts related to short-term declines in water quality.

Coral reefs are highly vulnerable to impacts from climate change, particularly, rising temperature, acidification and extreme weather events. Studies show that reef recovery from such exogenous factors is slow, as fewer corals survive to recolonise in the affected areas. Inshore coral reefs of the GBR have experienced significant declines over recent decades, through a range of pressures. In this context, protecting the remaining inshore reefs of the Gladstone region is important for maintaining the diversity and OUV of the GBRWHA.

Overall, the potential for cumulative impacts from the Project, combining with the effects of 'other projects' and exogenous factors, is assessed to be medium.

The highest rated cumulative environmental risk for a mode of impact to inshore reefs (increased turbidity and sedimentation) is assessed as low, the same as for the Project alone.

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4.4.10 Other values

For other values for which biological modes of impact are not relevant or are minor, cumulative impacts are predicted to be low and comparable with those outlined in the Project EIS, as summarised in **Table 18**.

Table 18: Summary of the potential for cumulative impacts on a range of non-biological values

Discipline	Comments on potential for cumulative impact
Social values	Construction and maintenance of the Project requires a small number of workers and specialised skills and equipment that is unlikely to be affected by other projects. Other projects have no significant impact on the existing visual amenity or landscape character of the Gladstone region.
Economics	The Project is required to accommodate medium and longer-term future growth in industry and trade in the Gladstone region. The potential (positive) economic impact of the Project on the Queensland economy is substantial, where a $159 million investment will lead to generation of employment of 1810 full time jobs, income generation of $177 million and economic growth of more than $300 million. If the project does not proceed, then future trades and economic growth will be restricted. The project will have a positive effect on marine industry and shipping in the region, while having minimal to no effect on other industries such as tourism and fishing.
Air quality and greenhouse gas emissions	Air quality changes and exhaust emissions arising from the Project are predicted to comply with relevant air quality objectives provided recommended controls are implemented. Dust emissions from the Project are predicted to be highest during construction of the WBE reclamation area bund wall and BUF. None of the other projects assessed have the potential to impact on air quality in the vicinity of the WBE reclamation area bund wall.
Transport	Dredging activities, changes to navigational aids and the traffic generated from the Project activities including workforce will generate low levels of additional shipping and traffic movements in the region. The most significant transport impacts will occur temporarily during the construction of the bund wall for the WBE reclamation area and the BUF. None of the other projects under consideration are in the vicinity of this area and do not have the potential to act cumulatively with the Project.
Waste	The generation of waste from the Project activities is expected to be minimal due to the dredged material being beneficially reused within the WB and WBE reclamation areas, the construction materials for the bund wall being sourced locally, and the construction workforce being relatively low. The Project is therefore unlikely to act cumulatively with other projects to produce waste in volumes of concern.
Coastal resources (sediment, coastal processes and hydrodynamics)	Hydrodynamic and WAVE modelling indicates that the Project will have no impact on existing water levels within the Port. The wave climate on coastlines adjacent to the duplicated channels is also not expected to be impacted. The projected impacts of climate change and sea level rise on Port Curtis are not expected to be changed by the Project. Mitigation measures are in place to manage the potential impacts of coastal sediments on the environment, through the exposure of acid sulphate soils or release of contaminants. No cumulative impacts from other projects or exogenous factors are anticipated.
Water resources	There will be no direct impact on the freshwater surface water resources identified upstream of the WBE reclamation area. Dredging activities and changes to navigational aids will occur in tidal waters and have negligible impacts on water resources. Residual impact risk on groundwater resources is assessed as being low. No cumulative impacts from other projects are therefore anticipated.
Cultural heritage	Due to the location of the majority of Project activities being within tidal waters, the potential for impact on known sites of aboriginal cultural heritage significance is predicted to be low. A number of recorded shipwreck sites are located within 5km of project activities. However, with mitigation measures, indirect impacts are predicted to be negligible to minor. No cumulative impacts from other projects are therefore anticipated.
OUV of the GBRWHA	A detailed assessment of the cumulative impacts of the Project on key and locally expressed OUV of the GBRWHA has been completed in the above sections. This has focussed on biological attributes of OUV. The Project is assessed to have minimal to no impact on other attributes of OUV not assessed above, including connectivity, continental islands, beaches, dune systems, river deltas, island plant species diversity and traditional owner interaction with the local environment. No cumulative impacts from other projects or exogenous factors are therefore anticipated.

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4.5 Mitigation measures

A range of mitigation measures are outlined in the Project EIS to reduce the potential for impacts of the Project on the environment. The CIA has identified that the environmental risk posed by 'other projects' is minimal, and is not of a sufficient magnitude to increase the environmental risk rating for any potential mode of impact, from what was assessed when considering the Project alone. This result indicates that additional mitigation measures, beyond what have been established for the Project alone, are largely unnecessary.

However, the assessment also assessed that there is potential for cumulative impacts arising from the combination of Project impacts and exogenous factors, particularly for the environmental values of seagrass, inshore corals, marine turtles and dugong. In the event that a bleaching event or major flood event occurs at a similar time to the Project, additional mitigation measures may be necessary to reduce cumulative impacts arising from the Project to acceptable levels.

In this context, the following mitigation are recommended for consideration, to reduce the potential for cumulative impacts:

- As Proponent of the Project, the future maintenance dredging of the Port, and the Clinton Vessel Interaction project, GPC should consider the potential for cumulative impacts when completing these projects. Monitoring programs on sensitive receptors and water quality should consider the influence of multiple project activities when evaluating the exceedance of thresholds and developing management plans.
- In the event of a major flood event affecting the Gladstone region, dredging management plans should be reviewed and additional mitigation measures implemented to reduce the potential for cumulative impacts on seagrass, benthic communities, inshore reefs, marine turtles and dugong. Where possible, the timing of Project activities should be reviewed to reduce the potential for cumulative impacts.

Implementation of the above mitigation measures, if needed, should be supported by appropriate monitoring programs which provide feedback on the success of management actions and the response of sensitive receptors. This program could link with the PMM established under the Master Plan for the priority Port of Gladstone 2018 involving an environmental values monitoring and reporting program.

Finally, one limitation of the CIA is that it has been completed in 2019, up to 11 years before Project activities may be completed in 2030. It is possible that cumulative impacts from other sources, not identifiable at the present time, may become relevant prior to the Project commencing. It is therefore recommended that prior to commencement of the Project, the findings of this CIA are reviewed and that any relevant influences of cumulative risk that were not foreseeable at the time of the assessment be considered, and inform the development or update of environmental management plans for the Project.

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5 Conclusion

The cumulative impacts of the Project, combined with 'other projects' and exogenous factors have been assessed. The assessment approach is consistent with a key recommendations of an independent review of Gladstone Harbour (SEWPAC 2013), which noted the importance of completing CIA for future projects, where cumulative impacts are superimposed on the dynamics of natural impacts of severe episodic weather events that are expected to increase in frequency.

Overall, the potential for cumulative impacts arising from the Project was found to be low. However, risks associated with cumulative impacts on seagrass, inshore reefs, turtles and dugong, were found to be highest, with the influence of exogenous factors such as flood events the key additional stressors of consideration, rather than the activities of reasonably foreseeable 'other projects'.

Ecosystem resilience refers to the capacity of an ecosystem to recover from disturbance or withstand ongoing pressures. It is a measure of how well an ecosystem can tolerate disturbance without collapsing into a different state that is controlled by a different set of processes (GBRMPA 2009). A resilient ecosystem will be able to recover from the variety of threats that impact on tropical coastal ecosystems, such as cyclones, flood events and a range of human activities.

If there are aspects of the biology and ecology of an ecosystem that limit its ability to absorb impacts and recover quickly following impacts, then recovery may take a prolonged period (years to decades), or may fail. Similarly, if threats or impacts to an ecosystem are continuous or regular, then the resilience of an ecosystem may erode and affect the diversity and ecosystem health of environmental values.

Flood events that have affected Port Curtis and the recovery made over time demonstrate that, like other estuarine environments within Queensland, the local environment has resilience thresholds that are relevant to the process of impact assessment. The aim of effective CIA is to manage the impacts of multiple projects to avoid passing a threshold at which ecosystem processes change, or their recovery from disturbance is significantly hampered.

Tools available to reduce the risk of cumulative impacts include the staging of projects, where possible, to avoid impacts on sensitive receptors from multiple projects at the same time. An awareness of the influence of exogenous factors such as bleaching events or floods on the resilience thresholds of ecosystems is also important. Detailed management plans will be developed to manage the potential cumulative effects of the Project, 'other projects' and extreme weather events.

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Appendix A Attributes of OUV expressed in the Port Gladstone and surrounds

Table A1 OUV attributes expressed in the Port of Gladstone and surrounds (SEWPAC 2013)

Overview of attributes	Criterion vii – aesthetic values and superlative natural phenomena	Criterion viii – ongoing geological processes	Criterion ix – ecological and biological processes	Criterion x – biodiversity conservation
Connectivity: cross-shelf, longshore & vertical		•	•	•
Continental islands	•	•	•	•
Beaches	•			
Dune systems	•	•		
Fringing reefs	•	•	•	•
Inshore turbid reefs		•	•	•
River deltas	•	•	•	•
Marine faunal groups diversity	•		•	•
Coral species – diversity & extent	•	•	•	•
Total species diversity	•		•	•
Island plant species diversity	•		•	•
Seagrass	•	•	•	•
Mangroves	•	•	•	•
Marine turtles	•			•
Whales	•			•
Threatened & endangered species				•
Dolphins	•			•
Seabirds	•		•	•
Traditional Owner interaction with the natural environment			•	

Table A2 Matters of National Environmental Significance relevant to Port Curtis and the relevant OUV criteria and contribution classifications (DTMR 2018)

Category	Local attribute	Relevant OUV criteria and contribution classifications[1]				Summary of the key environmental values
		vii[2]	viii[3]	ix[4]	x[5]	
Coral reefs	Fringing reefs	**Min**	**Min**	**Min**	**Min**	Fringing coral reefs
	Inshore turbid reefs	**-**	**Min**	**Min**	**Min**	Inshore turbid coral reefs
	Coral species diversity and extent	**Min**	**Min**	**Min**	**Min**	Various coral species
Marine water quality	Marine water quality	**-**	**-**	**Mod**	**Mod**	Marine water quality
Fish	Fish species and diversity	**Min**	**-**	**Min**	**Min**	Colosseum Inlet Fish Habitat Area Calliope River Fish Habitat Area Coral reefs, seagrass meadows, mangrove communities, hard and soft benthic substrates, beach habitats, estuaries, creeks and rivers
Marine megafauna	Dugong	**-**	**-**	**-**	**Mod**	Dugong species Seagrass meadows
	Species of whales	**-**	**-**	**-**	**Min**	Minke whales Sperm whales Humpback whales
	Migrating whales	**Min**	**-**	**-**	**-**	Humpback whales and calving habitat
	Species of dolphins	**Min**	**-**	**-**	**Sig**	Australian humpback dolphins
Marine turtles	Breeding colonies of marine turtles	**Mod**	**-**	**-**	**Mod**	Flatback turtle rookery on Curtis Island Nesting beaches on Facing, Curtis and Wild Cattle Islands, Boyne Island Beach and Tannum Sands
	Green turtle breeding	**Min**	**-**	**-**	**Min**	
	Marine turtle rookeries	**Mod**	**-**	**-**	**Mod**	
	Nesting turtles	**Min**	**-**	**-**	**-**	
Seagrass and macroalgae	Seagrass	**Min**	**Min**	**Mod**	**Mod**	Seagrass meadows
	Beds of *Halimeda* algae	**-**	**-**	**Min**	**-**	Beds of *Halimeda* algae
Shorebirds and migratory seabirds	Seabirds	**Min**	**-**	**Min**	**Min**	Potential foraging habitat
	Shorebirds and migratory birds	**-**	**-**	**-**	**Sig**	Threatened migratory shorebird species Shorebird habitat and important roost sites (note these vary from year to year)
Flora, fauna and ecological communities	Threatened and endangered flora and fauna species (including threatened ecological communities)	**Min**	**-**	**-**	**Mod**	Coastal Saltmarsh Threatened Ecological Community
	Vegetated mountains	**Min**	**-**	**-**	**-**	Mount Larcom landform
	Mangroves	**Min**	**Min**	**Min**	**Min**	Various mangrove species
	Mangrove species diversity	**-**	**-**	**-**	**Min**	Various mangrove species

Category	Local attribute	Relevant OUV criteria and contribution classifications[1]				Summary of the key environmental values
		vii[2]	viii[3]	ix[4]	x[5]	
	Vast mangrove forests	**Mod**	**-**	**-**	**-**	Mangrove sequences at The Narrows
Continental islands	Continental islands and green vegetated islands	**Mod**	**Mod**	**-**	**-**	Curtis Island
	Plant species diversity and endemism (species being unique to a defined geographic location)	**-**	**-**	**-**	**Sig**	Curtis Island
	Vegetation of the continental islands	**-**	**-**	**Sig**	**Sig**	Curtis Island
Geomorphology	Beaches	**Min**	**-**	**-**	**-**	Curtis Island beaches Facing Island beaches Boyne Island Beach
	Dune systems	**Min**	**Min**	**-**	**-**	Parabolic dunes Curtis Island
	River deltas	**Min**	**Min**	**Min**	**Min**	Marine tidal sand deltas (Curtis Island, Boyne River, Colosseum Inlet)
	Connectivity: cross-shelf, longshore and vertical	**-**	**Min**	**Min**	**Min**	The Narrows tidal passage
Cultural heritage values	Traditional Owner interaction with the natural environment	**-**	**-**	**Mod**	**-**	Indigenous cultural heritage sites and values
Marine fauna	Diversity supporting marine fauna species (global conservation significance)	**Min**	**-**	**Min**	**Mod**	A diverse range of marine fauna species
Total species diversity	Total species diversity	**Mod**	**-**	**Mod**	**Mod**	A diverse range of marine, intertidal and terrestrial flora and fauna species

Table notes:

1 Min Minor
Mod Moderate
Sig Significant
2 vii Aesthetic values and superlative natural phenomena
3 viii Ongoing geological processes
4 ix Ecological and biological processes
5 x Biodiversity conservation

Appendix B Cumulative Impact Assessment Risk Register

Note: risks from all modes of impact that were not rated in the EIS have been assumed to be 'negligible' and along with risks rated as 'negligible', are not included in this register. None of the cumulative risks scores for Project risks assessed as 'negligible' were sufficient to change that rating, when evaluated against the criteria.

		Likelihood	Consequence	Risk
Port Curtis				
Potential Mode of Impact on Seagrass				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	AC	VH	VH
	Project, combined with the effects of other projects.	Cumulative risk score: 0		VH
Secondary impacts of habitat loss on recruitment to and resilience of surrounding population, including fragmentation or loss of connectivity values and indirect impacts on food resources	Project only	U	VH	H
	Project, combined with the effects of other projects	Cumulative risk score: 0		H
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform.	Project only	P	H	H
	Project, combined with the effects of other projects	Cumulative risk score: 5		H
Mobilisation of contaminants from dredging, intertidal construction activities, spoil disposal activities, removal of navigation aids and final landform.	Project only	U	VH	H
	Project, combined with the effects of other projects	Cumulative risk score: 4		H
Changes in hydrology, hydrodynamics and coastal processes arising from dredging, WBE reclamation area and BUF	Project only	P	VH	H
	Project, combined with the effects of other projects	Cumulative risk score: 1		H
Potential Mode of Impact on Mangroves				
	Project only	U	M	L

		Likelihood	Consequence	Risk
Port Curtis				
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project, combined with the effects of other projects.	Cumulative risk score: 2		L
Mobilisation of contaminants from dredging, intertidal construction activities, spoil disposal activities, removal of navigation aids and final landform	Project only	U	L	L
	Project, combined with the effects of other projects.	Cumulative risk score: 3		L
Changes in hydrology, hydrodynamics and coastal processes arising from dredging and WBE reclamation area	Project only	U	L	L
	Project, combined with the effects of other projects.	Cumulative risk score: 1		L
Introduction or spread of pest or weed species from construction activities/ vessels/final landform or changes in habitats	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 0		L
Potential Mode of Impact on Saltmarsh				
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 2		M
Mobilisation of contaminants from dredging, intertidal construction activities, spoil disposal activities, removal of navigation aids and final landform	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 3		L
Changes in hydrology, hydrodynamics and coastal processes arising from dredging and WBE reclamation area	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 1		L
Introduction or spread of pest or weed species from construction activities/ vessels/final landform or changes in habitats	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Potential Mode of Impact on Inshore Reefs				
	Project only	U	M	L

		Likelihood	Consequence	Risk
Port Curtis				
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project, combined with the effects of other projects.	Cumulative risk score: 3		L
Potential Mode of Impact on Soft Bottom Benthic Habitats				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	AC	M	H
	Project, combined with the effects of other projects.	Cumulative risk score: 3		H
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	L	L	M
	Project, combined with the effects of other projects.	Cumulative risk score: 3		M
Mobilisation of contaminants from dredging, intertidal construction activities, spoil disposal activities, removal of navigation aids and final landform	Project only	U	L	L
	Project, combined with the effects of other projects.	Cumulative risk score: 4		L
Introduction or spread of pest or weed species from construction activities/ vessels/final landform or changes in habitats	Project only	U	L	L
	Project, combined with the effects of other projects.	Cumulative risk score: 2		L
Potential Mode of Impact on Fish (commercial and recreational value)				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 0		L
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M

		Likelihood	Consequence	Risk
Port Curtis				
Increased underwater noise and general disturbance of marine environment from dredging, establishment of the WBE reclamation area, BUF, removal and installation of navigation aids, and dredged material placement activities	Project only	P	M	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Port Curtis, The Narrows and Port Alma, and extended geographic range				
Potential Mode of Impact on Dugongs				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	AC	H	VH
	Project, combined with the effects of other projects	Cumulative risk score: 0		VH
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project only	U	H	M
	Project, combined with the effects of other projects	Cumulative risk score: 3		M
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects	Cumulative risk score: 1		M
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects	Cumulative risk score: 3		M
Increased underwater noise and general disturbance of marine environment from dredging, establishment of the WBE reclamation area, BUF, removal and installation of navigation aids and dredged material placement activities	Project only	P	M	M
	Project, combined with the effects of other projects	Cumulative risk score: 4		M
Potential Mode of Impact on Indo-Pacific humpback dolphin				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	AC	H	VH
	Project, combined with the effects of other projects.	Cumulative risk score: 0		VH
	Project only	U	H	M

		Likelihood	Consequence	Risk
Port Curtis				
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project, combined with the effects of other projects	Cumulative risk score: 3		M
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects	Cumulative risk score:1		M
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects	Cumulative risk score: 3		M
Increased underwater noise and general disturbance of marine environment from dredging, establishment of the WBE reclamation area, BUF, removal and installation of navigation aids, and dredged material placement activities	Project only	P	M	M
	Project, combined with the effects of other projects	Cumulative risk score: 4		M
Potential Mode of Impact on Humpback whale				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	R	VH	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project only	R	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	R	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and final landform	Project only	R	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
	Project only	R	M	L

		Likelihood	Consequence	Risk
Port Curtis				
Increased underwater noise and general disturbance of marine environment from dredging, establishment of the WBE reclamation area, BUF, removal and installation of navigation aids, and dredged material placement activities	Project, combined with the effects of other projects.	Cumulative risk score: 2		L
Potential Mode of Impact on Water mouse				
Secondary impacts of habitat loss on recruitment to and resilience of surrounding population, including fragmentation or loss of connectivity values and indirect impacts on food resources.	Project only	L	H	H
	Project, combined with the effects of other projects.	Cumulative risk score: 1		H
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 0		L
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Changes in hydrology, hydrodynamics and coastal processes arising from dredging and WBE reclamation area	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Introduction or spread of pest or weed species from construction activities, vessels, and the final landform or changes in habitats	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Increased noise above the water disturbing fauna	Project only	P	M	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Increased lighting at night from dredging vessels and reclamation area works	Project only	P	M	M

		Likelihood	Consequence	Risk
Port Curtis				
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Bund wall failure or seepage, resulting in reduced water quality in adjacent areas	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Potential Mode of Impact on turtle species				
Direct loss or removal of habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	AC	H	VH
	Project, combined with the effects of other projects.	Cumulative risk score: 0		VH
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project only	R	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 3		M
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and the final landform	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and final landform	Project only	R	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 3		M
Increased underwater noise and general disturbance of marine environment from dredging, establishment of the WBE reclamation area, BUF, removal and installation of navigation aids, and material placement activities	Project only	P	M	M
	Project, combined with the effects of other projects.	Cumulative risk score: 4		M
Increased lighting at night from dredging vessels and reclamation area works	Project only	R	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 2		M
Potential Mode of Impact on Conservation Significant and migratory fish species (Estuary stingray, Whale shark, Great white shark, Shortfin mako shark, Longfin mako shark, Porbeagle, Reef manta ray, Giant manta ray)				

		Likelihood	Consequence	Risk
Port Curtis				
Direct loss or removal of intertidal and tidal habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids.	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 0		M
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredged material placement, dredging, and operation of the final landform	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 1		L
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	H	M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and the final landform	Project only	U	M	L
	Project, combined with the effects of other projects.	Cumulative risk score: 1		L
Increased underwater noise and general disturbance of marine environment from dredging, establishment of the WBE reclamation area, removal and installation of navigation aids, and dredged material placement activities	Project only	P	M	M
	Project, combined with the effects of other projects.	Cumulative risk score: 2		M
	Project, combined with the effects of other projects.	Cumulative risk score: 1		M
Potential Mode of Impact on Shorebirds				
Direct loss or removal of shorebird habitat by dredging activity, reclamation of tidal lands through establishment of the WBE reclamation area, BUF, dredged material placement, removal and installation of navigational aids	Project only	AC	VH	VH
	Project, combined with the effects of other projects.	Cumulative risk score: 1		VH
Direct injury and mortality during establishment of WBE reclamation area and BUF, dredge spoil placement, dredging, and operation of the final landform	Project only	U	VH	H
	Project, combined with the effects of other projects.	Cumulative risk score: 1		H
	Project only	U	VH	H

		Likelihood	Consequence	Risk
Port Curtis				
Secondary impacts of habitat loss on recruitment to and resilience of surrounding population, including fragmentation or loss of connectivity values and indirect impacts on food resources	Project, combined with the effects of other projects.	Cumulative risk score: 2		H
Increased turbidity and sedimentation caused by establishment of WBE reclamation area, BUF, dredging activities, removal of navigational aids and final landform	Project only	U	VH	H
	Project, combined with the effects of other projects.	Cumulative risk score: 0		H
Mobilisation of contaminants from dredging, intertidal construction activities, dredged material placement activities, removal of navigation aids and final landform	Project only	U	VH	H
	Project, combined with the effects of other projects.	Cumulative risk score: 0		H
Changes in hydrology, hydrodynamics and coastal processes arising from dredging and WBE reclamation area	Project only	U	VH	H
	Project, combined with the effects of other projects.	Cumulative risk score: 1		H
Introduction or spread of pest or weed species from construction activities, vessels and the final landform or changes in habitats	Project only	U	VH	H
	Project, combined with the effects of other projects.	Cumulative risk score: 0		H
Increased noise above the water disturbing fauna	Project only	P	VH	H
	Project, combined with the effects of other projects.	Cumulative risk score: 1		H

Appendix C Summary of Other Projects

Project name	Arrow Bowen Pipeline – Bowen Basin to Gladstone pipeline
Location and Reference	Project 1 (**Figure 10**)
Description	The project consists of approximately 580 km of pipelines which will convey coal seam gas (CSG) for subsequent export as liquefied natural gas (LNG) and associated above ground infrastructure. The pipeline will be a buried steel gas transmission pipeline (of up to 42 inches in nominal diameter) and consist of the Arrow Bowen mainline and three lateral pipelines. The proposed pipeline route will commence at Red Hill, approximately 90 km north of Moranbah in Central Queensland and will terminate at Curtis Island, Gladstone.
Phase of construction or operation	EIS Approved. Petroleum Pipeline Licence and Environmental Authority granted. Assuming project start occurs prior to 2020.
Key environmental values relevant to cumulative assessment from EIS	Landscape character, hydrology, water quality, air quality, vegetation, terrestrial and aquatic fauna and mangroves.
Predicted future impacts that may act cumulatively with Channel Duplication Project	Contamination of land and water from accidental spills during construction. Impacts on landscape character at watercourse crossings, environmentally sensitive areas, and where vegetation clearing is required. Erosion of creek banks during construction phases, and following the establishment of rehabilitation. Decreased water quality at watercourse crossings through the disturbance and mobilisation of sediments, increasing turbidity and potentially mobilising contaminants such as metals, pesticides and nutrients. Fragmentation of wildlife habitat and coastal wetlands surrounding Port Curtis. Introduction and spread of pests and weeds.
Summary of implications for the CIA	Project is located well inland. Low risk of impacts to water quality and associated environmental values (seagrass and megafauna) during construction phases and early phases of rehabilitation. Impacts on landscape character, although these are likely to be minor in the long term (after construction is complete).

Risk rating – Arrow Bowen Pipeline

Value	Direct loss habitat	Secondary and indirect impacts	Injury and mortality	Turbidity and sedimentation	Mobilisation of contaminants	Hydrodynamic & hydrological changes	Change habitat type -rock	Underwater or above ground noise	Additional light	Spread pests or weeds	Environmental incident	Bund wall failure/seepage
Water mouse	1	0	0	0	0	0	0	0	0	0	0	0
Seagrass	0	0	0	1	0	0	0	0	0	0	0	0
Mangroves	0	0	0	1	0	0	0	0	0	0	0	0
Saltmarsh	0	0	0	1	0	0	0	0	0	0	0	0
Benthic habitats	0	0	0	1	0	0	0	0	0	0	0	0

Negligible = 0, Low =1, Medium = 2, High =3, Very High = 4

Project name	Clinton Vessel Interaction project
Location and Reference	Project 2 (**Figure 10**)
Description	Dredging project of 800,000 m^3 to widen the existing Clinton Channel by 100 m and a small wedge between the Clinton Bypass Channel and the Clinton Channel. Dredging footprint of 21 ha of which 6.9 ha is not within the current approved channel footprint. Dredged material to be placed into the existing WB reclamation area.
Phase of construction or operation	Dredging is likely to occur in 2019, prior to the Channel Duplication Project. The project is yet to be constructed.
Key environmental values relevant to cumulative assessment from EIS	Marine habitats including seagrass, coastal processes and hydrology, water quality, turtles, dugong and inshore dolphins.
Predicted future impacts that may act cumulatively with Channel Duplication Project	Disturbance to sediments and reef communities within the proposed dredge footprint will lead to a loss of epibenthic biota. Increase in suspended solids and turbidity which may result in short term impacts to seagrass habitats. Potential direct effects to marine megafauna associated with underwater noise generation and vessel strike.
Summary of implications for the CIA	Relatively large dredging project in a similar location to the Channel Duplication Project. Sensitive receptors are similar to the Channel Duplication Project. Potential for impacts to be cumulative if the time between projects is less than one year.

Risk rating – Clinton Vessel Interaction project

Value	Direct loss habitat	Secondary and indirect impacts	Injury and mortality	Turbidity and sedimentation	Mobilisation of contaminants	Hydrodynamic & hydrological changes	Change habitat type -rock	Underwater or above ground noise	Additional light	Spread pests or weeds	Environmental incident	Bund wall failure/seepage
Seagrass	0	0	0	1	2	0	0	0	0	1	0	0
Mangroves	0	0	0	0	2	0	0	0	0	0	0	0
Saltmarsh	0	0	0	0	2	0	0	0	0	0	0	0
Inshore reefs	1	0	0	1	2	0	0	0	0	1	0	0
Benthic habitats	1	0	0	0	2	0	0	0	0	1	0	0
Fisheries	0	0	0	0	2	0	0	0	0	1	0	0
Dugong	0	0	1	0	2	0	0	1	0	1	0	0
Dolphin	0	0	1	0	2	0	0	1	0	1	0	0
Turtles	0	0	1	0	2	0	0	1	0	1	0	0

Negligible = 0, Low =1, Medium = 2, High =3, Very High = 4

Project name	Pacificus Tourism Project
Location and Reference	Project 4 (**Figure 10**)
Description	A 1,163 ha lot on Hummock Hill Island to be developed for business, industrial, commercial, residential, tourism and recreational purposes. Ten percent of the island is proposed to be developed. The undeveloped areas will be given conservation status by the Queensland Government and managed for conservation and recreational usage.
Phase of construction or operation	15 year construction period from 2020
Key environmental values relevant to cumulative assessment from EIS	Terrestrial vegetation, intertidal and marine habitat, geological and geomorphological features.
Predicted future impacts that may act cumulatively with Channel Duplication Project	Reduction and fragmentation of terrestrial wildlife habitat due to full or partial clearing of 465 ha of native vegetation within the development footprint. Direct disturbance and fragmentation of marine habitat from construction of a bridge and boat ramp. Anchor damage from increased numbers of recreational vessels. Direct and indirect disturbance of wildlife during construction and operations. Increased visitation to sections of the GBR Marine Park and World Heritage Area.
Summary of implications for the CIA	Located a significant distance from most of the Channel Duplication activities. Some potential for cumulative impacts on wildlife and their habitat from fragmentation (at a regional scale).

Risk rating – Pacificus Tourism Project

Value	Direct loss habitat	Secondary and indirect impacts	Injury and mortality	Turbidity and sedimentation	Mobilisation of contaminants	Hydrodynamic & hydrological changes	Change habitat type -rock	Underwater or above ground noise	Additional light	Spread pests or weeds	Environmental incident	Bund wall failure/seepage
Dugong	0	1	1	0	0	0	0	1	0	0	0	0
Dolphin	0	1	1	0	0	0	0	1	0	0	0	0
Water mouse	1	1	1	0	0	1	0	1	1	0	0	0
Turtles	0	2	1	0	0	0	0	1	1	0	0	0
Shorebirds	1	2	1	0	0	1	0	1	1	0	0	0

Negligible = 0, Low =1, Medium = 2, High =3, Very High = 4

Project name	Toolooa Priority Development Area (PDA)
Location and Reference	Project 5 (**Figure 10**)
Description	Planned residential development mixed with industrial land, retained bushland and open space.
Phase of construction or operation	Approved Priority Development Area for future urban development. Development may occur during the Channel Duplication Project, if there is suitable demand for new housing and industrial land.
Key environmental values relevant to cumulative assessment from EIS	Vegetation and wildlife habitat and landscape values associated with flood prone land.
Predicted future impacts that may act cumulatively with Channel Duplication Project	No information on predicted impacts or monitoring measures could be identified from the information sources. The site of the development away from the coast. Therefore, impacts are likely to be restricted to fragmentation of coastal or terrestrial habitat values and downstream impacts from stormwater runoff.
Summary of implications for the CIA	The development is not located immediately adjacent to the Channel Duplication Project. The development may cause additional fragmentation of vegetation and wildlife habitat at a regional scale. A deterioration in water quality may also be expected during construction and operations, due to stormwater discharges and runoff.

Risk Rating – Toolooa PDA

Value	Direct loss habitat	Secondary and indirect impacts	Injury and mortality	Turbidity and sedimentation	Mobilisation of contaminants	Hydrodynamic & hydrological changes	Change habitat type -rock	Underwater or above ground noise	Additional light	Spread pests or weeds	Environmental incident	Bund wall failure/seepage
Seagrass	0	0	0	1	1	0	0	0	0	0	0	0
Mangroves	0	0	0	1	1	1	0	0	0	0	0	0
Saltmarsh	0	0	0	1	1	1	0	0	0	0	0	0
Benthic	0	0	0	1	1	0	0	0	0	0	0	0

Negligible = 0, Low =1, Medium = 2, High =3, Very High = 4

Project name	Future maintenance dredging Port of Gladstone
Reference	Project 6 (**Figure 10**)
Description	Annual maintenance dredging of the Port of Gladstone shipping channels involving the dredging of 200,000 cubic metres per year and placement at sea at the East Banks Disposal Site.
Phase of construction or operation	Occurs annually.
Key environmental values relevant to cumulative assessment from EIS	Water quality, seagrass habitats, turtles, dugong and inshore dolphins.
Predicted future impacts that may act cumulatively with Channel Duplication Project	Increased suspended sediment concentrations and deposition. Potential impacts to seagrass. Disturbance of marine megafauna (turtles, dugong and dolphins).
Summary of implications for the CIA	Relatively small dredging project that occurs annually in the Port, with short term impacts on specific environmental values. There is some potential for cumulative impacts with the Channel Duplication Project, as many of the sensitive receptors for each project are similar.

Risk rating –Future maintenance dredging Port of Gladstone

Value	Direct loss habitat	Secondary and indirect impacts	Injury and mortality	Turbidity and sedimentation	Mobilisation of contaminants	Hydrodynamic & hydrological changes	Change habitat type -rock	Underwater or above ground noise	Additional light	Spread pests or weeds	Environmental incident	Bund wall failure/seepage
Seagrass	0	0	0	2	1	1	0	0	0	0	1	0
Inshore reefs	0	0	0	2	1	1	0	1	0	1	1	0
Benthic habitats	2	1	0	1	1	1	0	0	0	1	1	0
Dugong	0	0	1	1	1	1	0	2	1	0	1	0
Dolphin	0	0	1	1	1	1	0	2	1	0	1	0
Humpback whale	0	0	1	1	0	0	0	2	1	0	1	0
Turtles	0	0	1	1	1	1	0	2	1	0	1	0
Conservation significant fish	0	0	1	1	1	1	0	2	1	0	1	0

Negligible = 0, Low =1, Medium = 2, High =3, Very High = 4

Appendix D Risk scores for environmental values

Marine turtles

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	2	0	0	2	No change
Injury and mortality	0	1	1	0	1	3	No change
Turbidity and sedimentation	0	0	0	0	1	1	No change
Mobilisation of contaminants	0	2	0	0	1	3	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	1	1	0	2	4	No change
Additional light	0	0	1	0	1	2	No change
Spread pests or weeds	0	1	0	0	0	1	No change
Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Shorebirds

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	1	0	0	1	No change
Secondary and indirect impacts	0	0	2	0	0	2	No change
Injury and mortality	0	0	1	0	0	1	No change
Turbidity and sedimentation	0	0	0	0	0	0	No change
Mobilisation of contaminants	0	0	0	0	0	0	No change
Hydrodynamic & hydrological changes	0	0	1	0	0	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Underwater or above ground noise	0	0	1	0	0	1	No change
Additional light	0	0	1	0	0	1	No change
Spread pests or weeds	0	0	0	0	0	0	No change
Environmental incident	0	0	0	0	0	0	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Water mouse

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	1	0	1	0	0	2	No change
Secondary and indirect impacts	0	0	1	0	0	1	No change
Injury and mortality	0	0	1	0	0	1	No change
Turbidity and sedimentation	0	0	0	0	0	0	No change
Mobilisation of contaminants	0	0	0	0	0	0	No change
Hydrodynamic & hydrological changes	0	0	1	0	0	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	1	0	0	1	No change
Additional light	0	0	1	0	0	1	No change
Spread pests or weeds	0	0	0	0	0	0	No change
Environmental incident	0	0	0	0	0	0	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Dugong

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	1	0	0	1	No change
Injury and mortality	0	1	1	0	1	3	No change
Turbidity and sedimentation	0	0	0	0	1	1	No change
Mobilisation of contaminants	0	2	0	0	1	3	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	1	1	0	2	4	No change
Additional light	0	0	0	0	1	1	No change
Spread pests or weeds	0	1	0	0	0	1	No change
Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Dolphin

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	1	0	0	1	No change
Injury and mortality	0	1	1	0	1	3	No change
Turbidity and sedimentation	0	0	0	0	1	1	No change
Mobilisation of contaminants	0	2	0	0	1	3	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	1	1	0	2	4	No change
Additional light	0	0	0	0	1	1	No change
Spread pests or weeds	0	1	0	0	0	1	No change
Environmental incident	0	0	0	0	1	1	No change

Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Humpback whale

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	1	1	No change
Turbidity and sedimentation	0	0	0	0	1	1	No change
Mobilisation of contaminants	0	0	0	0	0	0	No change
Hydrodynamic & hydrological changes	0	0	0	0	0	0	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	2	2	No change
Additional light	0	0	0	0	1	1	No change
Spread pests or weeds	0	0	0	0	0	0	No change
Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Conservation significant fish

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	1	1	No change
Turbidity and sedimentation	0	0	0	0	1	1	No change
Mobilisation of contaminants	0	0	0	0	1	1	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	2	2	No change
Additional light	0	0	0	0	1	1	No change
Spread pests or weeds	0	0	0	0	0	0	No change

Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Seagrass

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	0	0	No change
Turbidity and sedimentation	1	1	0	1	2	5	No change
Mobilisation of contaminants	0	2	0	1	1	4	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	0	0	No change
Additional light	0	0	0	0	0	0	No change
Spread pests or weeds	0	1	0	0	0	1	No change
Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Soft Bottom Benthic habitats

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	1	0	0	2	3	No change
Secondary and indirect impacts	0	0	0	0	1	1	No change
Injury and mortality	0	0	0	0	0	0	No change
Turbidity and sedimentation	1	0	0	1	1	3	No change
Mobilisation of contaminants	0	2	0	1	1	4	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Underwater or above ground noise	0	0	0	0	0	0	No change
Additional light	0	0	0	0	0	0	No change
Spread pests or weeds	0	1	0	0	1	2	No change
Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Inshore reefs

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	1	0	0	0	1	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	0	0	No change
Turbidity and sedimentation	0	1	0	0	2	3	No change
Mobilisation of contaminants	0	2	0	0	1	3	No change
Hydrodynamic & hydrological changes	0	0	0	0	1	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	1	1	No change
Additional light	0	0	0	0	0	0	No change
Spread pests or weeds	0	1	0	0	1	2	No change
Environmental incident	0	0	0	0	1	1	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Saltmarsh

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	0	0	No change
Turbidity and sedimentation	1	0	0	1	0	2	No change
Mobilisation of contaminants	0	2	0	1	0	3	No change
Hydrodynamic & hydrological changes	0	0	0	1	0	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	0	0	No change
Additional light	0	0	0	0	0	0	No change
Spread pests or weeds	0	0	0	0	0	0	No change
Environmental incident	0	0	0	0	0	0	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Mangroves

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	0	0	No change
Turbidity and sedimentation	1	0	0	1	0	2	No change
Mobilisation of contaminants	0	2	0	1	0	3	No change
Hydrodynamic & hydrological changes	0	0	0	1	0	1	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	0	0	No change
Additional light	0	0	0	0	0	0	No change
Spread pests or weeds	0	0	0	0	0	0	No change
Environmental incident	0	0	0	0	0	0	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

Fisheries

Potential impact	Arrow Bowen Pipeline	Clinton Vessel Interaction	Pacificus Tourism	Toolooa Development	Maintenance dredging	TOTAL (out of 20)	Outcome
Direct removal of habitat	0	0	0	0	0	0	No change
Secondary and indirect impacts	0	0	0	0	0	0	No change
Injury and mortality	0	0	0	0	0	0	No change
Turbidity and sedimentation	0	0	0	0	0	0	No change
Mobilisation of contaminants	0	2	0	0	0	2	No change
Hydrodynamic & hydrological changes	0	0	0	0	0	0	No change
Change habitat type -rock	0	0	0	0	0	0	No change
Underwater or above ground noise	0	0	0	0	0	0	No change
Additional light	0	0	0	0	0	0	No change
Spread pests or weeds	0	1	0	0	0	1	No change
Environmental incident	0	0	0	0	0	0	No change
Bund wall failure/seepage	0	0	0	0	0	0	No change

Negligible = 0, Low =1, Medium = 2, High =3

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