walker

TOONDAH HARBOUR

APPENDIX 3 - B

MORETON BAY RAMSAR
SITE ASSESSMENT

saunders havill group

Moreton Bay Ramsar Site Impact Assessment

1.1. Definition and Scope

This report provides an assessment carried out on the potential for the Project to have a significant impact on the MBRS[1].

To determine if an action is likely to have a significant impact on a MNES, the Commonwealth Government has produced a series of guidelines. Most relevant for Ramsar wetlands are the Significant Impact Guidelines 1.1, which are used determine if an action is likely to have a significant impact on a MNES. These guidelines state that:

An action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:

- *Areas of the wetland being destroyed or substantially modified;*
- *A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland;*
- *The habitat or lifecycle of native species, including invertebrate fauna and fish species dependent upon the wetland, being seriously affected;*
- *A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health; or*
- *An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.*

The EPBC Act assessment process conforms to the approach recommended by the Ramsar Convention when considering how particular developments may impact upon the wetland. Importantly, under the EPBC Act, a significant impact is a threshold for further assessment to identify whether those impacts are considered acceptable. It is not a threshold for refusal of a Project.

A significant impact on a Ramsar wetland as defined by the EPBC Act also does not necessarily result in a change to the ecological character of the wetland as defined by the Ramsar Convention, which identifies ecological character as *the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time* (Ramsar Convention 2005). Intuitively, a change in ecological character would only occur if ecosystem components, processes, benefits and services are considerably impaired by an action. Impacts that do not result in a change in ecological character may still be both significant and acceptable.

This is evidenced by a range of developments carried out within Ramsar sites both nationally and internationally. For example, the Riverwalk development (EPBC 2006/3176) in Victoria was approved to deliver 2,200 residential lots and other urban uses over a 197 ha area within the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar Site.

[1] Wetlands of international importance are those wetlands nominated and listed under the *Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971*. This convention is also known as the 'Ramsar Convention on Wetlands' using the protocol of naming international agreements after the city in which it was first formulated. The convention was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975. In line with this nomenclature, wetlands listed under the Convention are referred to as Ramsar wetlands.

While the development is within the boundaries of the Ramsar site, the area was considered degraded, and approval conditions required a range of measures to be implemented to protect the ecological character of the site including improving habitat values for the Growling Grass Frog.

Internationally, Ramsar sites include a range of tourism and urban infrastructure within their boundaries including marinas, apartments and hotels within the Etang de Salses-Leucates Ramsar site in France, and a resort and mixed-use residential development within the Sungai Pulai Ramsar site in Malaysia.

While development has previously been approved in Ramsar sites there is little guidance on how to assess impacts, in particular for spatially large and ecologically diverse sites such as the MBRS. Due to a lack of clear guidance on identifying and assessing impacts on ecological character for large Ramsar sites with diverse ecological values, processes and human interactions, a method was developed by Adaptive Strategies (2021) and reviewed by a range of subject matter experts through the Project's Independent Advisory Panel (IAP). The method is summarised in this chapter and provided in full in Appendix 3-B. In accordance with the legal requirements, the method focusses on determining the scale, intensity and significance of any impacts to the ecological character of the MBRS.

The objective of the ecological character impact assessment is to:

- Identify the critical components, processes and services that contribute to the ecological character of the MBRS;
- Identify the presence or absence of these components, processes and services within the 'Zone of Influence' of the Project; and
- Assess the potential for the development to impact on these critical components, processes and services, and therefore the ecological character of the MBRS.

The Project's EPBC Act Draft EIS guidelines further define the requirements for analysing impacts on the ecological character of the Ramsar Site:

- Adequately describe in a substantive manner all aspects of the proposed development that may impact on the ecological character. This includes aspects associated with construction and ongoing operation and those facilitated by the proposed development;
- To quantify, where possible, the extent and importance of those impacts on the particular components, processes and services that make up the ecological character;
- Describe the mitigation measures that allow a robust and defensible decision to be made on their efficacy; and
- Describe the extent and importance of residual impacts (if any).

This assessment is designed to meet the requirements of the Draft EIS guidelines and provide an understandable and robust analysis of actual or potential impacts to the MBRS that may result from the Project.

1.1.1 Ramsar Convention on Wetlands

As a contracting party to the Ramsar convention Australia has made a commitment to:

- Designate suitable wetlands for inclusion on the List of Wetlands of International Importance;
- Formulate and implement planning to promote conservation of listed wetlands and as far as possible the wise use of all wetlands;
- Arrange to be informed at the earliest possible time if the ecological character of any listed wetland has changed, is changing or is likely to change as a result of technological developments, pollution or other human interference, and report any such changes to the Ramsar Convention;
- Promote the conservation of wetlands and waterfowl by establishing nature reserves on wetlands;
- Encourage research and exchange of data and publications;
- Promote the training of personnel in the fields of wetland research and management;

- Consult with other contracting parties to the Convention to review and promote the implementation of the Convention; and
- Represent Australia at the triennial Conference of the Contracting Parties, collating the National Report for these meetings and other reporting to the Convention

In Australia there are currently 66 wetlands listed under the Ramsar Convention the management of which falls primarily to the relevant state or territory government. The Ramsar Convention requires the development of a Ramsar Information Sheet (RIS) describing the critical features of the wetland to accompany the nomination of a site to the List of Wetlands. The RIS is to be updated at least every six years, or more frequently if there are significant changes in the site's ecological character.

In addition to the RIS, the Convention encourages the development of key documents once a site has been listed to assist in the management and increase awareness about the wetland. These documents include:

- An ecological character description (ECD) which describes the ecological character of the Ramsar Site; and
- Management plans, which are used to formulate and implement planning to promote the wise use and conservation of listed wetlands.

ECDs are documents that should be prepared by site managers at the time of a wetland's listing as a Ramsar site (DEWHA 2008). The development of ECDs is guided by the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands*. The framework lists the minimum elements that an ECD should contain. These include:

- Site details;
- A description of the critical components, processes, benefits and services of the site;
- Limits of acceptable change (LACs);
- Potential threats to the site; and
- Knowledge gaps and key monitoring needs.

LACs are the acceptable variation limits of an ecological characteristic or process in a Ramsar site, established at the time of listing by the site manager.

Under the Ramsar Convention a significant impact as defined by the EPBC Act does not necessarily equate to a change or likely change in ecological character. Ramsar Handbook 19: Addressing Change in Wetland Ecological Character outlines a process for detecting change in the ecological character of a Ramsar site, which can include natural change, positive human induced change and negative human induced change. If negative change is considered to be within the limits of acceptable change (LACs) it may be too too trivial to report.

Further, the Ramsar convention does not prohibit development in Ramsar wetlands, but they must demonstrate that they maintain or enhance the ecological character of the site and be in accordance with the principles of wise use. The wise use of wetlands is *the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development* (Ramsar Convention 2005). The wise use concept requires ecological character to be maintained, while at the same time delivering services and benefits now and into the future for human well-being. Wise use of Australia's wetlands involves achieving a balance of uses which will deliver ecosystem, economic and social/cultural benefits over the long term.

1.1.2 Assessment Requirements

Schedule 6 of the *Environment Protection and Biodiversity Conservation Regulations 2000* (EPBC Regulations) outlines the impact assessment and approval process for actions that are likely to have a significant impact on the ecological character of a Ramsar wetland (whether the action is to occur inside the wetland or not). The process includes the following steps:

1) Before the action is taken, the likely environmental impact of the action on the wetland's ecological character should be assessed under a statutory environmental impact assessment and approval process.
2) The assessment process should:
   a) identify any part of the ecological character of the wetland that is likely to be affected by the action; and
   b) examine how the ecological character of the wetland might be affected; and
   c) provide adequate opportunity for public consultation.
3) An action should not be approved if it would be inconsistent with:
   a) maintaining the ecological character of the wetland; or
   b) providing for the conservation and sustainable use of the wetland.
4) Approval of the action should be subject to conditions, if necessary, to ensure that the ecological character of the wetland is maintained.
5) The action should be monitored by the authority responsible for giving the approval (or another appropriate authority) and, if necessary, enforcement action should be taken to ensure compliance with the conditions.

The assessment of potential impacts to ecological character of the Project on the MBRS addresses steps 1 and 2 in this process. The assessment will be subject to statutory public notice as part of the EPBC Act approval process providing adequate opportunity for public feedback.

1.2. The Moreton Bay Ramsar Site

Moreton Bay was declared a Ramsar Wetland of International Importance in 1993. The listing covers an area of 120,654 ha which includes a semi-enclosed bay bounded by Mulgumpin (Moreton Island), Minjerribah (North Stradbroke Island) and Garadgi (South Stradbroke Island): three of the largest natural sand islands in the world (Figure 1). The MBRS includes:

- Mulgumpin (Moreton Island) and parts of Minjerribah (North Stradbroke Island) and Garadgi, Bribie Island and the Southern Bay Islands;
- Pumicestone Passage;
- Intertidal and subtidal areas of the western bay, southern bay and sandy channels of the Broadwater region;
- Marine areas and sand banks within the central and northern bay; and
- Areas of ocean beach habitats.

The MBRS provides significant areas of wetland, seagrass, mangrove and saltmarsh habitat for shorebirds and marine species including turtles and dugong.

The current status of the MBRS Ramsar documentation is:

- The most recent version of the RIS is September 2019. The boundary of the site was last updated in December 2018 adding several thousand hectares to the MBRS through minor realignments to better reflect pre-existing boundaries (i.e. cadastre, gazetted marine parks etc.) and data sources to define the boundary.
- A Draft ECD was completed but has not been finalised - the latest draft is dated 2008. As of September 2022, a formal ECD for the MBRS has not been published. Information on the ecological character of the site is also provided within the RIS.
- No specific management plan is in place for the MBRS. The Moreton Bay Marine Park Zoning Plan covers a similar spatial area as the MBRS and provides guidance on use, however, this is not a management plan for a Ramsar wetland.

Figure 1: Moreton Bay Ramsar Site

Legend

Project location

Moreton Bay Ramsar site

Toondah Harbour EIS

N

0 10 20 30 km

GDA 1994 MGA zone 56

Scale (A4):1:650,000

Layer Source: © State of Queensland Datasets (Department of Natural Resources, Mines and Energy 2020)

DATE 3/03/2021

FILE REF. 9858 E Figure 11 2 Moreton Bay Ramsar A

When listed, the MBRS was identified as meeting six of the nine Ramsar listing criteria (criterion 1 through 6). The 2019 version of the RIS has been updated to now show the site meeting all nine criteria (criterion 7 through 9). A summary of features within Moreton Bay that meet the listing criteria is included in Table 2.

Table 1: Summary of Moreton Bay Characteristics against Ramsar Listing Criteria.

Criterion Description	Moreton Bay Features
Criterion 1: the wetland contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region	Moreton Bay is one of the largest estuarine bays in Australia. The formation of large, vegetated sand dunes on the eastern side of the bay and river and creek flows entering the Bay to the west from the mainland have created a major wetland complex.
Criterion 2: the wetland supports vulnerable, endangered or critically endangered species or threatened ecological communities	The bay supports threatened turtle species including the vulnerable green and hawksbill turtles and endangered loggerhead turtles. Its intertidal habitats are particularly important for the critically endangered wintering eastern curlew. A number of threatened terrestrial flora and fauna are also present on the bay islands.
Criterion 3: the wetland supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region	The bay has a high diversity of marine plant and animal species including over 3,000 species of marine invertebrates; 40 species of shorebirds; 55 species of algae associated with mangroves; seven mangrove species and seven seagrass species. The intertidal habitats of the bay support over 28 species of migratory shorebirds.
Criterion 4: the wetland supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions	The bay is a significant feeding ground for green turtles. Dugongs also use the bay as a feeding and breeding ground. The area provides significant feeding areas for loggerhead turtles. The species is also known to nest on the bay islands. It also provides important feeding and roosting sites for 28 species of migratory shorebirds
Criterion 5: the wetland regularly supports 20,000 or more waterbirds	The bay supports greater than 50,000 wintering and staging shorebirds during the non-breeding season.
Criterion 6: the wetland regularly supports 1% of the individuals in a population of one species or subspecies of waterbird	The bay supports greater than 1% of the known flyway populations of nine migratory shorebirds including the eastern curlew and the grey-tailed tattler.
Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/ or values and thereby contributes to global biological diversity.	The bay supports diverse fish fauna due to the wide variety of habitats within and adjacent to it, including mangroves, saltmarsh, seagrass, sand and mud flats, offshore channels, reef environments, estuarine creeks, freshwater lakes and streams. For fish in the waters of Moreton Bay, two interacting zones of diversity exist: an inshore estuarine-dominated system and an eastern marine- dominated system. The bay is also a meeting point for tropical northern and temperate southern faunas which, combined with the diversity of habitats, has resulted in high faunal diversity with approximately 750 fish species recorded in the bay. In addition, at least 27 species of fish are only known to occur in Moreton Bay.
Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	Documented fish feeding habitats in Moreton Bay include saltmarshes, mangroves, intertidal flats, seagrasses as well as coral and rocky reefs. These include tidal marsh feeding habitats for commercially important species including whiting, mullet and the giant mud crab. Moreton Bay mangroves and seagrasses also provide refuge from predators and together with saltmarshes, function as nursery habitats for juvenile fish.
Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population	The bay provides or is likely to provide habitat for >1% of the population of the following wetland dependent non-avian species:

Criterion Description	Moreton Bay Features
of one species or subspecies of wetland dependent non-avian animal species.	▪ A number of acid frogs including Wallum froglet (*Crinia tinnula*), Cooloola sedgefrog (*Litoria cooloolensis*), Wallum sedgefrog (*Litoria olongburensis*) and Wallum rocketfrog (*Litoria freycineti*) ▪ Dugong (*Dugong dugon*) ▪ Oxleyan pygmy perch (*Nannoperca oxleyana*) ▪ Water mouse (*Xeromys myoides*) ▪ Illidge's ant blue butterfly (*Acrodipsas illidgei*) ▪ Loggerhead turtle (*Caretta caretta*) ▪ Green turtle (*Chelonia mydas*)

The EPBC Act Draft EIS Guidelines requires the Proponent to use the RIS and the 2008 Draft ECD in characterising wetland values and assessing impacts on the MBRS.

The Toondah Harbour Project occurs partly within the MBRS. The proposed reclamation areas overlap the MBRS by approximately 36.4 ha and the dredge area within Fison Channel overlaps the MBRS by a further 22.3 ha. Combined this represents 0.048% of the MBRS (refer to Figure 2).

It is generally acknowledged that it can be difficult to accurately assess potential impacts to the ecological character of a Ramsar site without a final or up to date ECD or management plan. For example, two Ramsar sites in Victoria, Western District Lakes and Gippsland Lakes, have potentially undergone human induced change to their ecological character, however it has been difficult to assess the level of change due to a lack of up-to-date ECDs, and in particular relevant Limits of Acceptable Change (LACs) for these sites (Parliament of Victoria's Inquiry into Auditor-General's Report No. 202: Meeting Obligations to Protect Ramsar Wetlands (2016)).

As a result, the method for assessing the impacts of the Project on the ecological character of the MBRS has adopted the precautionary principle in its assessment and drawn from reviews of current best practice management of Ramsar sites, rather than relying entirely on the RIS and the draft ECD for the MBRS.

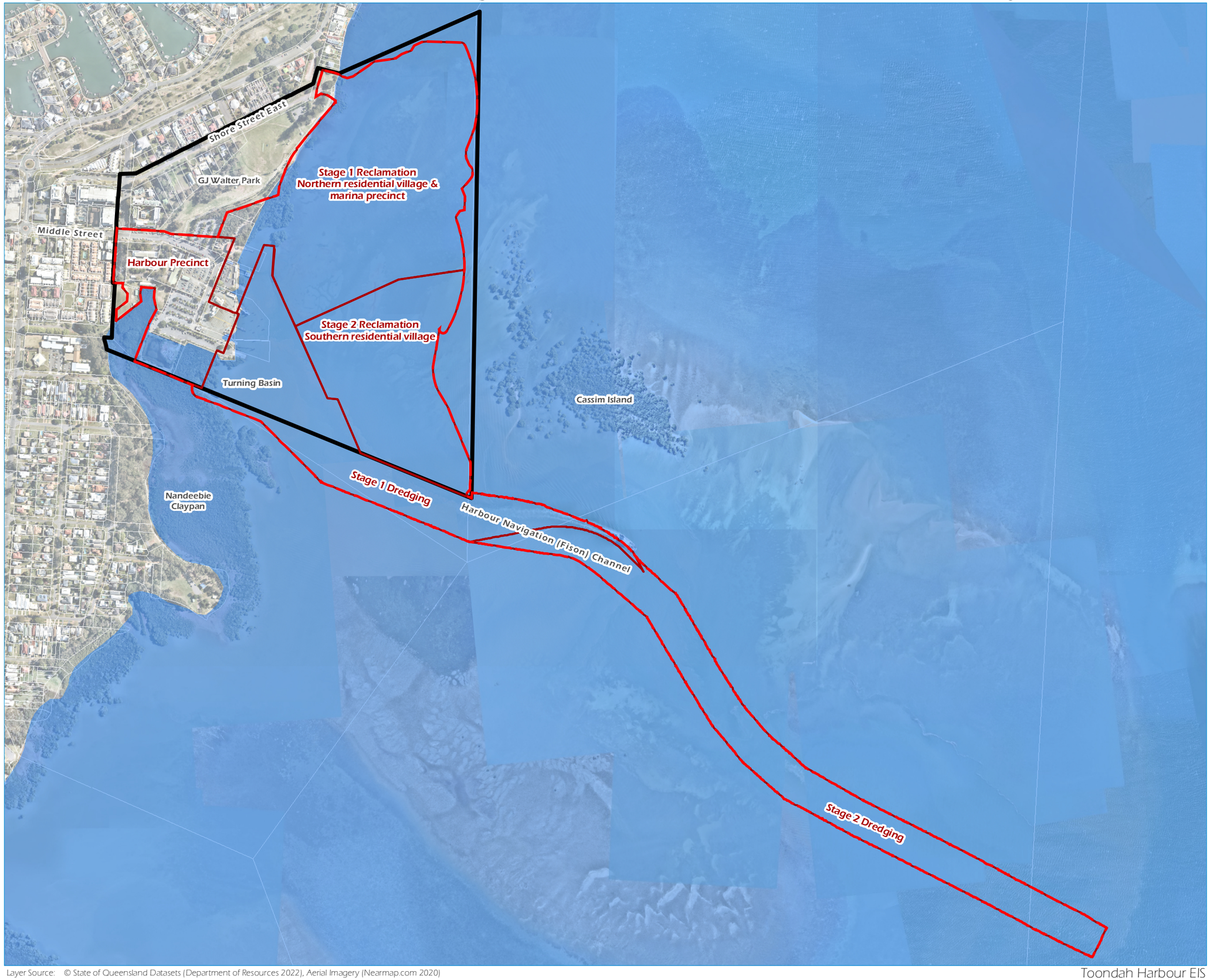
While no management plan has been developed for the MBRS the EPBC Act establishes a framework for managing Ramsar wetlands. Under Schedule 6 of the EPBC Regulations general principles are outlined for the management of wetlands of international importance. These are:

1) Does a Ramsar site's management plan describe the ecological character of the wetland?
2) Does the management plan clearly demonstrate that actions will be taken to maintain the ecological character of the wetland?
3) Does the plan promote and describe actions to conserve the wetland?
4) Does the plan promote and describe actions for the wise and sustainable use of the wetland for the benefit of all people, in a way that is compatible with and does not impact on the natural properties of the ecosystem?
5) Does the plan include public consultation where decisions and actions may have an impact on the wetland and where the public may have an interest?
6) Does the plan include the involvement of people who have a particular interest in the wetland and those who may be affected by the management of the wetland?
7) Does the plan include processes that provide for continuing community and technical input?
8) Does the management plan include a description of the characteristics that make the site a wetland of international importance under the Ramsar Convention?
9) Does the plan describe actions that will be taken to deal with any impacts that endanger the wetland's ecological character?

10) If the wetland requires restoration or rehabilitation, what actions have been identified to undertake this work?
11) Does the plan adequately consider monitoring and reporting on the state of the wetland's ecological character on a continuing basis?
12) Is the management plan based on an integrated catchment management approach?
13) Does the plan allow for a review process within a seven-year period?
14) Do all anticipated actions which are likely to have a significant impact on the ecological character of the wetland include assessment under a statutory environmental impact assessment and approval process?

This assessment of potential for change to ecological character as a result of the Toondah Harbour Project is not a management plan for the MBRS, nor is it intended to provide management measures to address MBRS management requirements at the whole-of-site scale, given that the MBRS exceeds 120 km^2. The assessment (and the broader draft EIS) does however include management approaches and strategies to avoid impacts on the ecological character of the MBRS from the Project.

Figure 4-1: Toondah Harbour Project Footprint within the Moreton Bay Ramsar Site and Marine Park



Legend

- Toondah Harbour PDA (Project Area)
- Qld DCDB
- Project Footprint

Moreton Bay Marine Park Zones

- Habitat Protection Zone
- Moreton Bay Ramsar site

Stage 1 Reclamation
Marine Park - 24.2ha
Ramsar - 22.9ha

Stage 2 Reclamation
Marine Park - 13.0ha
Ramsar - 12.3ha

Stage 1 Dredging
Marine Park - 14.2ha
Ramsar - 7.3ha

Stage 2 Dredging
Marine Park - 15.0ha
Ramsar - 15.0ha

Harbour Precinct
Marine Park - 1.5ha
Ramsar - 1.2ha

Total Project Footprint
Marine Park - 67.9ha
Ramsar - 58.7ha

TOONDAH HARBOUR

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0 100 200 300 400 m

GDA 1994 MGA zone 56

Scale (A3): 1:8,600

N

DATE: 26/09/2022

FILE REF: 9858 E Figure 4_1 Project Footprint in MP Ramsar

Layer Source: © State of Queensland Datasets (Department of Resources 2022), Aerial Imagery (Nearmap.com 2020)

Toondah Harbour EIS

1.3. Change to Ecological Character Assessment Method

The assessment method has been developed to evaluate the context, scale and significance of the potential impacts on the ecological character of the MBRS. In doing this the method seeks to:

- Identify the critical components, processes and services of the MBRS through a desktop analysis of available information;
- Identify how the critical components, processes and services are represented at a project site level through site specific technical studies and consultation with the community and Industry bodies;
- Conceptualise interactions between the critical components, processes and services at the project site level as well as how they link into the broader scale processes of the MBRS;
- Assess the contribution the critical components, processes and services present at the project site level provide to the overall ecological character of the MBRS; and
- Provide a process for determining the significance of any impacts from a proposed activity on the ecological character of the MBRS.

The assessment has adopted a similar approach to that normally used under the EPBC Act. The following steps have been identified that will ensure a repeatable and consistent approach that is transparent and evidence based:

- All aspects of the Project are considered from construction through to operation, including associated activities that may produce indirect or facilitated impacts (e.g., impacts from street and building lighting, boat traffic, etc).
- The concept of 'Zone of Influence' has been applied to determine how large an area needs to be examined to identify relevant features. The 'Zone of Influence' varies depending on the development type, the actions being undertaken during both the construction and operational phases and the component, process or service being assessed. In particular, actions that produce noise, dust or suspended sediment plumes may extend beyond the Project footprint.
- Assessment of significance of potential impacts that may lead to a change in ecological character involves analysis to quantify potential impacts, review of the adequacy of survey data and other available environmental information, developing a detailed understanding of relative habitat values, reference to relevant EPBC Act guidelines and consideration of existing environmental management and monitoring.

1.3.1 Reliability of Information

All information sources used for the MBRS and Project footprint assessments have been evaluated for their validity, reliability and accuracy. A confidence level has been assigned to each information source based on the scale below:

- High confidence - The study, or data used within the study, is contemporary (completed in 2015 or later) and supported by robust evidence (i.e. on ground surveys carried out using published methods) and has strong agreement with the outcomes of published studies or data from other sources.
- Moderate confidence - The study, or data used within the study, was completed prior to 2015 but is supported by robust evidence and/or has strong agreement with the outcomes of published studies and/or data from other sources.
- Low confidence - The study, or data used within the study, is supported by limited evidence and/or has agreement with the outcomes of other moderate or low confidence information sources.

No 'low confidence' information sources have been used in this assessment. An assessment of the reliability of the key data sources used in this assessment is included in Attachment 2.

1.3.2 Critical Components, Processes and Services of the MBRS

In Australia, the National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands (DEWHA 2008) provides direction on how to identify a wetland's critical components, processes and services. The guidance identifies several categories for processes, components and services (Table 2) and recommends as many are identified as possible under these categories, with critical ones selected using available information and expert advice.

Table 2: Categories of Wetland Components, Processes and Services.

Component	Process	Benefits/Services
Physical form **Wetland soils** **Physicochemical water** **Biota**	Climate Geomorphology Hydrology Energy and nutrient dynamics Processes that maintain animal and plant populations Species interactions Physical processes	Provisioning services — products obtained from the ecosystem such as food, fuel and fresh water Regulating services — benefits obtained from the regulation of ecosystem processes such as climate regulation, water regulation and natural hazard regulation Cultural services — benefits people obtain through spiritual enrichment, recreation, education and aesthetics Supporting services — services necessary for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans, or a direct benefit over a long period of time

The assignment of a given wetland component, process or service as critical is guided by the following considerations:

- It is important for supporting one or more of the Ramsar criteria under which the site was listed; or
- It is an important determinant of the uniqueness or representativeness of the site; or
- It is a component or process of high ecological value; or
- It may be subject to change that will cause potentially significant consequences (e.g. change the ecological character of the Ramsar site).

The draft Moreton Bay ECD and 2019 RIS are the two key information sources that describe the ecological character of the MBRS. The information in these two sources has been cross referenced with recent scientific studies and monitoring programs to identify the critical components, processes and services of the MBRS.

While the draft ECD is more than 10 years old, no significant developments or modifications have occurred within the MBRS and no notifications of any change to the ecological character have been published since its preparation. Occasional updates to the RIS also have not indicated any change in ecological character, although this does not necessarily indicate that change has not occurred. Factors such as climate change, sea level rise, ongoing urban encroachment and impacts on migratory species in other parts of the world may all have had an effect on the character of the MBRS.

1.3.2.1 Identifying Critical Components, Processes and Services at the Project Site Level

The process for determining the local representation and contribution of critical components, processes and services to the ecological character of the wetland is based around understanding which are present and how important they are within the context of the wider MBRS. The process involves:

1. Identifying the critical components, processes and services that are represented within the Project footprint and local area;
2. Conceptualising interactions between the critical services, components and processes at the Project footprint level as well as how they link into the broader scale processes of the MBRS; and
3. Analysing the 'importance' of the presence within the context of the MBRS.

For the purposes of the method, the 'local area' should at least encompass the area within the Project's 'Zone of Influence'. A Zone of Influence for indirect impacts from the Toondah Harbour Project has been identified based on potential indirect impacts from sources such as dredge plumes, noise and boating traffic as well as the potential for direct impacts to influence MNES outside of the Project footprint (i.e. consequential impacts to threatened marine species from the loss of a relatively small patch of seagrass). The 'local area' encompasses Western Moreton Bay and extends north to the Brisbane River and south to the Logan River as well as inland to include the mainland suburb of Cleveland. Areas of the MBRS within this extent make up the Zone of Influence for the analysis of critical components, processes and services represented at a Project footprint level. The Project's Zone of Influence on the MBRS is shown on Figure 3. In addition, migratory bird species can travel vast distances therefore impacts to these species must also be considered at the flyway level. As noted in the CIA, the Zone of Influence also includes a temporal component, therefore potential for changes in ecological character to occur over time will also be addressed.

1.3.2.2 Identifying the Critical Components, Processes and Services

Most components, processes and services are made up of multiple elements, such as various landforms, seascapes and biological entities. A biological component or process may be made up of multiple species habitats, interactions and locations (e.g. a specific migratory bird species may use several locations within the MBRS for foraging, but travel to a single location to roost at high tide).

Identification of the critical components, processes and services that occur within the local area has been based on the best available information. Technical studies carried out for the EIS have encompassed assessment not just at the site level, but have addressed the broader Moreton Bay area through detailed analysis of recent scientific studies and data collected through ongoing monitoring programs such as Healthy Land and Water's (HLW) Ecosystem Health Monitoring Program (EHMP) for water quality and Seagrass Watch.

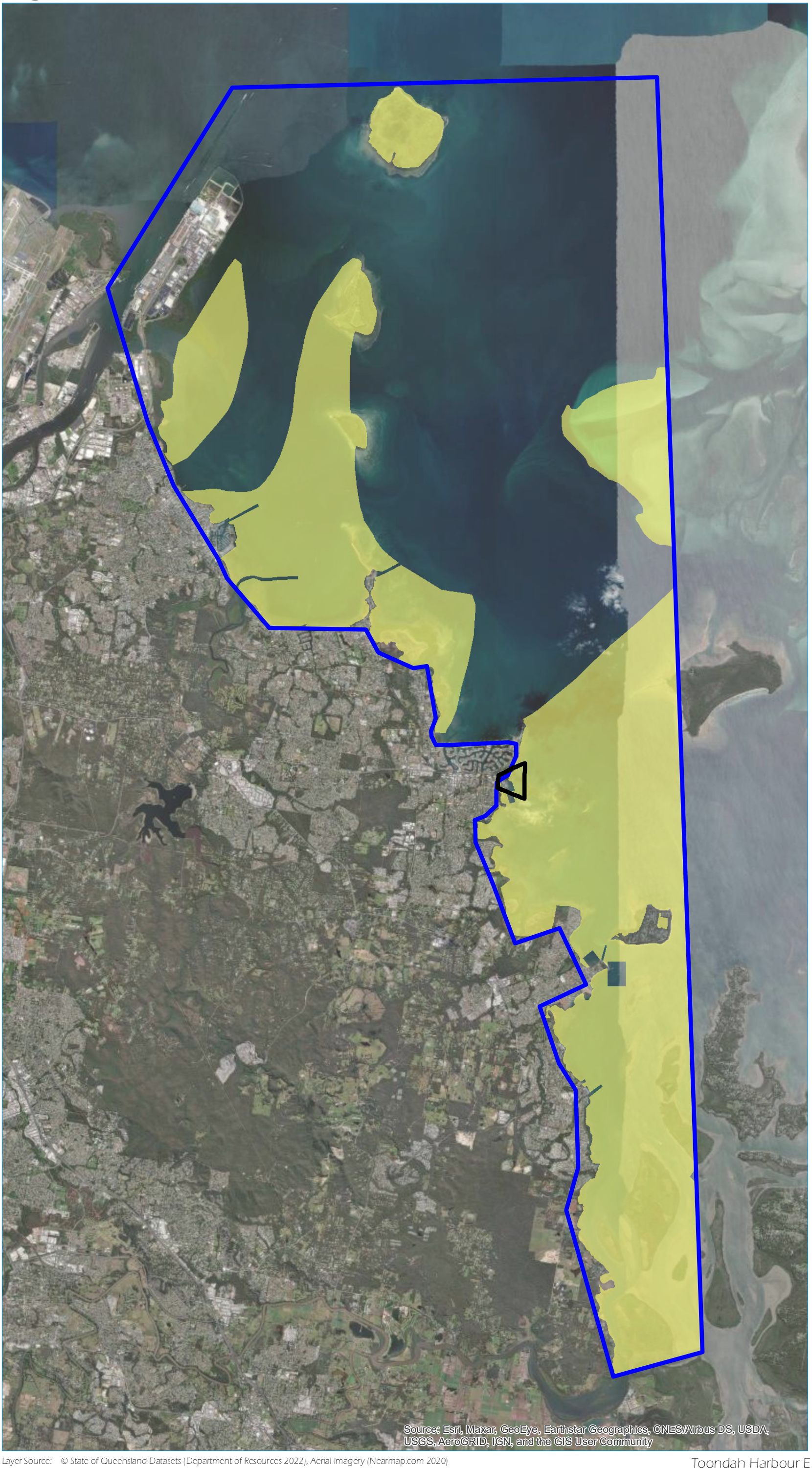
1.3.2.3 Conceptualising Interactions

Once the critical components, processes and services are understood this information has been used to conceptualise how they are represented and interact within the Project footprint and Zone of Influence. The conceptual representation includes:

- The relationships and dependencies between the components, processes and services and the representation of ecological character;
- Threats to the critical components, processes and services within the Project footprint and Zone of Influence that may result from the Project; and
- How, and in what ways, any changes to the critical components, processes and services may interact with the wider MBRS.

The conceptual representation can then be used as a tool to analyse the importance of the critical components, processes, and services for the MBRS and how any impacts may affect the ecological character.

Figure 3: Toondah Harbour MBRS Zone of Influence



Legend

- Toondah Harbour PDA (Project Area)
- MBRS Zone of Influence
- Moreton Bay Ramsar site

TOONDAH HARBOUR

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0 1 2 3 4 5 Kilometers

GDA 1994 MGA zone 56

Scale (A3): 1:120,000

N

Layer Source: © State of Queensland Datasets (Department of Resources 2022), Aerial Imagery (Nearmap.com 2020)

Toondah Harbour EIS

DATE: 29/06/2022

FILE REF. 9858 E Figure 27 3 Toondah Harbour MBRS ZOI A

1.3.2.4 Analyse Importance

For a critical service or process, the spatial extent may not necessarily influence importance. In these cases, presence can be interpreted in terms of the role played in maintaining the service or process. For example, a critical service of a Ramsar site may be that it supports an important population of a threatened species. At the Project level, assessment should focus on potential habitat present for that species and include targeted surveys using published and accepted survey methods. The extent and use of this habitat by the threatened species would then be reviewed in the context of the whole Ramsar site, including the proportion of the habitat type present and number of individuals located in comparison to known population within the Ramsar Site.

A component may be present in a particular location and be of importance due to its locally high value in terms of representation; while in another area it may be a lower value as it does not provide the same ecological function (e.g. recruitment and breeding), representation of value or amenity.

The following terms and definitions are used to classify the contribution of locally occurring critical components, processes and services to the ecological character of the MBRS:

- Not present: No evidence was available to indicate or suggest presence in the area of investigation.
- Minor contribution: Occurs in low abundance or across a small area (relative to the nature of its broader presence across the MBRS) and is not necessary for the ongoing function of a critical component, process or service. However, it is noted that a low abundant component that is rare may still be important and the assessment reflects this distinction. Temporary fluctuations or seasonal variation have also been considered, along with natural events that may affect short-term presence (e.g. storms).
- Moderate contribution: Occurs in moderate abundance or across a moderately large area (relative to its representation across the MBRS) and contributes to the function of a critical component, process or service in the area of investigation.
- Major contribution: Present in significant abundances or represent significant examples of the relevant critical component, process or service (relative to its nature across the MBRS) and is essential for the ongoing function of a critical component, process or service.

Assessment of the contribution of the critical components, processes and services within the Project footprint and Zone of Influence incorporates inputs from experts who have completed technical studies for the Project. Contributors include:

- Marine ecology and water quality – Carol Conacher (frc environmental);
- Migratory and threatened shorebirds – Dr Penn Lloyd (BAAM Ecology);
- Coastal processes – Craig Witt (BMT);
- Ecosystem processes - Tom Kaveney (Adaptive Strategies); and
- Commercial and recreational fisheries – Dr Daryl McPhee (Bond University).

1.3.3 Assessment of Significance of Potential Impacts

There are two key principles that guide EPBC Act significant impact assessments for Ramsar sites:

- Maintaining the ecological character of the Ramsar site (i.e. no change) – As a signatory to the Ramsar Convention, Australia is required to manage its Ramsar sites (including the MBRS) to maintain the critical ecosystem components, processes and services that characterise the wetland at a given point in time; and
- Addressing the significant impact criteria for Ramsar Sites identified in EPBC Act Significant Impact guidelines to identify whether the action is considered likely to have a significant impact on the ecological character of a Ramsar site.

Assessments against the above principles should also consider the LACs within the MBRS as a reference for the potential for impacts to affect the Ramsar site. These limits will vary based on the elements being altered and the context in which they occur. The Draft ECD provides LACs for the critical components, processes and services for the MBRS. These have been incorporated where appropriate.

Using these criteria, along with the results of the local contribution assessment, a consistent approach to determining activities with the potential to result in a significant impact to the ecological character of the wetland has been used. The process for this assessment is as follows:

1. Using the project description, including construction methods and ongoing uses, to determine activities with potential to have direct and indirect impacts on existing environmental values;
2. Using inputs from relevant experts and EIS studies to determine the likely extent of these impacts within the Project footprint and Zone of Influence; and
3. Reviewing the impacts against the critical components, processes, and services represented within the Project footprint and Zone of Influence to identify the potential for the Project to result in a change in ecological character to the Ramsar site or significant impact against the EPBC Act significant impact criteria (Table 3).

Table 3: Potential for Impacts on the Ecological Character of the MBRS.

Criteria	**Local contribution of critical processes, components or services to Ecological Character**			
	Not Present	Minor	Moderate	Major
Areas of wetland being destroyed or substantially modified	N/A	Unlikely	Possible if changes are permanent	Likely unless change is temporary (less than 1 year)
A substantial and measurable change in the hydrological regime of the wetland	N/A	Unlikely if not measurable or is within natural variability	Possible if change is measurable, permanent and beyond natural variability	Likely resulting in a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland
Habitat or lifecycle of native species being seriously affected	N/A	Unlikely	Possible if permanent Unlikely if temporary or in low season (e.g. outside migratory visitation)	Likely if permanent Unlikely if in low season or non-breeding (e.g. outside migratory visitation)
A substantial and measurable change in the availability or functioning of a critical process, component or service	N/A	Unlikely	Possible if change is measurable, permanent and beyond natural variability	Likely resulting in a substantial change to the quality or extent of the service or a complete loss of service
Permanent or long term substantial and measurable change in the water quality of the wetland	N/A	Unlikely	Possible	Likely
Establishment of invasive species	N/A	Likely*	Likely	Likely

* The establishment of an invasive species is likely to have broad reaching effects and so is likely to be significant in all scenarios.

Steps one and two in this process have been substantially addressed through the Draft EIS technical studies (refer to Volume 2 of the draft EIS). From the analysis undertaken, activities with the potential to impact on the local presence of critical components, processes and services that contribute to the ecological character of the MBRS have been identified.

Where there is a major contribution (i.e. unique, or of notable ecological importance), it is reasonable to assume that the presence and function of that critical component, process or service is part of the ecological character of the whole wetland and any impact has the potential to affect the ecological character of the MBRS.

Where the contribution is moderate or minor, the local representation can be considered less critical to maintaining the ecological character of the MBRS. Where this occurs, impacts are considered in the context of the framework set out in the Ramsar guidelines for avoiding, mitigating and compensating wetland losses.

For impacts that are likely or almost certain, a more detailed risk assessment is carried out to identify the severity and consequence of the impacts.

1.4. MBRS and Site Level Ecological Character

1.4.1 Critical Components, Processes and Services of the MBRS

As identified in Section 1.2, two documents have been developed by the Queensland and Australian Governments to describe the ecological character of the MBRS: the RIS and Draft Ecological Character Description - Moreton Bay Ramsar Site (BMT WBM 2008).

These two documents have been reviewed extensively by the EIS Project Team to identify the critical components, processes and services for the MBRS, in accordance with direction from the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

A number of recent studies have also been reviewed to ensure the assessment of impacts to the ecological character of the MBRS is based on the most up-to-date information available. While these studies are not specifically targeted at describing the components, processes and services of the MBRS, they provide data on key components and processes such as wetland habitat health and extent and fauna populations. Key studies reviewed include:
and features such as wetland habitat health and extent and fauna populations. Key studies reviewed include:

- Moreton Bay Quandamooka & Catchment: Past, present, and future (Tibbetts *et. al*. 2019);
- Environmental History and Ecology of Moreton Bay (McPhee 2017);
- Managing Threats to Migratory Shorebirds in Moreton Bay (Fuller *et al*. 2021);
- Integrating outcomes of IUCN red list of ecosystems assessments for connected coastal wetlands (Sievers *et al*. 2020); and
- HLW Ecological Health Monitoring Program (EHMP) Report Cards (https://hlw.org.au/report-card/).

1.4.1.1 Draft MBRS ECD Review

The Draft MBRS ECD identifies all of the wetland services, processes and components of the MBRS through a detailed review of existing information sources including scientific papers, state and local databases, EIS studies and academic thesis.

Using the categories and list of services from the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* as a guide, it was identified that the MBRS provides a broad spectrum of services. This includes:

- Provisioning services such as provision of food in the form of fisheries and fresh water supply (through groundwater extraction);
- Regulatory services such as erosion protection and climate regulation;
- Cultural services such as recreation, tourism, cultural heritage, education and research; and
- Supporting ecosystem services such as biodiversity and the presence of endangered and vulnerable species.

Likewise, given the scope, areal extent and diversity of wetland environments present within the MBRS, all wetland ecosystem processes from the National Framework were seen as occurring within the MBRS, including a broad range of hydrological, climatic, geomorphologic, physico-chemical, biogeochemical and biological processes.

Following the method within the National Framework, the assignment of a given wetland process, component or service as critical was guided by the following considerations:

- The service or underlying component or process is important for supporting one or more of the Ramsar Nomination criteria under which the MBRS was listed; or

- The service or component/process is an important determinant of the uniqueness of the MBRS; or
- The service or component/process may be subject to change in short to medium time frames (<100 years) and/or the change will cause potentially significant consequences (e.g. change the ecological character).

To supplement these criteria, additional consideration was given to:

- Suggestions or recommendations regarding critical components, processes and services by the Knowledge Management Committee or external experts (particularly where such information was documented in scientific literature); and
- For cultural services, reference to Ramsar's 9th Conference, Resolution IX.21 – "Taking into account the cultural values of wetlands" – which identified the following cultural characteristics as relevant in the designation of Ramsar sites:
    - Sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland;
    - Sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland;
    - Sites where the ecological character of the wetland depends on the interaction with local communities or Indigenous peoples; and
    - Sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland.

A list of critical services and the underpinning components has been developed and is provided in Table 4. Components and processes were identified as critical where they underpinned one or more of the critical services. The order of the critical services is arbitrary and does not reflect any importance or ranking.

Table 4: MBRS Critical Services Identified by the Draft ECD.

Critical Service	**Underlying Critical Components**
Contains a diversity of wetland habitat types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity between habitat types	22 Ramsar wetland types are represented in the broader MBRS. Of these: ▪ 11 are classified as coastal/marine; ▪ 10 are classified as inland waters; ▪ 1 is classified as manmade. Several habitat types are highly localised (i.e. rare) in the context of the bioregion and within the MBRS itself, including non-forested peatlands and permanent freshwater lakes. Of most relevance to the Project are the coastal/marine wetland types, which include: ▪ Permanent shallow marine waters (waters that are less than 6 m deep at low tide); ▪ Marine subtidal aquatic beds (i.e. seagrasses); ▪ Coral reefs; ▪ Rocky marine shores including rock offshore islands and sea cliffs; ▪ Sand, shingle or pebble shores; ▪ Estuarine waters; ▪ Intertidal mud sand or salt flats; ▪ Intertidal marshes;

Critical Service	Underlying Critical Components
	▪ Intertidal forested wetlands (mangrove forests to low closed forest on marine clays); ▪ Coastal brackish/saline lagoons; ▪ Coastal freshwater lagoons.
One of the largest estuarine bays in Australia that sits in an 'overlap zone' where both tropical and temperate species occur. It supports extensive intertidal areas of seagrass, mangroves and saltmarsh that provide vital habitat for waterbirds, including significant populations of migratory shorebirds	The MBRS contains marine, estuarine, palustrine, lacustrine and terrestrial biotopes. Several of these wetland habitats are considered, either individually or collectively, to represent particularly outstanding examples of near-natural areas within the biogeographic region. While there are examples of such habitat areas throughout the MBRS, the Draft ECD identified six key wetland representative areas. These are: 1. Seagrass and shoals in the Eastern Banks area; 2. Intertidal flats and estuarine assemblages in the Pumicestone Passage area; 3. Mangroves and saltmarsh associated with the islands in the Southern Bay 4. Coral communities of the Eastern Bay; 5. Freshwater wetlands (including wallum and peatlands) of Mulgumpin (Moreton) and Minjerribah (North Stradbroke) Islands; 6. Ocean beaches and foredunes on Mulgumpin (Moreton Island).
Site supports an assemblage of vulnerable or endangered marine/aquatic fauna	Species of note identified in the MBRS include dugongs, green turtles, loggerhead turtles, oxleyan pygmy perch and honey blue-eye, although any protected marine/aquatic species supported by the MBRS should be considered within this critical service.
Supports an assemblage of vulnerable or endangered wetland dependant terrestrial fauna species	Species of note include little tern, beach stone-curlew, water mouse, Illidge's ant-blue butterfly, wallum sedgefrog, Australian painted snipe, Australasian bittern and eastern curlew. Any protected wetland-dependant terrestrial fauna species should also be considered within this critical service.
Supports a number of vulnerable or endangered marine fauna species	Moreton Bay provides habitat for humpback whales and dolphins, as well as six of the world's seven species of marine turtles. Other threatened animals, including the grey nurse shark, dugong, wallum sedge frog, water mouse and oxleyan pygmy perch fish, also live in Moreton Bay or in surrounding waters and wetlands.
Supports an assemblage of vulnerable or endangered wetland flora species and endangered and of concern wetland regional ecosystems	The MBRS is home to five nationally threatened plant species that are wetland dependant: swamp daisy, knotweed, lesser swamp orchid, yellow swamp orchid and swamp orchid. Any protected wetland flora species and endangered and of concern wetland regional ecosystems should also be considered within this critical service.
Supports significant populations of shorebirds	Moreton Bay is one of the most important migratory shorebird sites in Australia, supporting both a large number and high diversity. During the summer months some 32 species of migratory shorebirds comprising over 40,000 individuals visit the bay. This includes significant worldwide populations, including 20% of all eastern curlews and 50% of all grey-tailed tattlers. Based on the 2016 revised EAAF population estimates, the MBRS provides habitat for >1% of the estimated EAAF population of the following species: ▪ Bar-tailed godwit (*Limosa lapponica*); ▪ Curlew sandpiper (*Calidris ferruginea*); ▪ Eastern curlew (*Numenius madagascariensis*); ▪ Grey-tailed tattler (*Heteroscelus brevipes*); ▪ Red-necked stint (*Calidris ruficollis*); ▪ Australian pied oystercatcher (*Haematopus longirostris*);

Critical Service	Underlying Critical Components
	▪ Whimbrel (*Numenius phaeopus*); ▪ Sharp-tailed sandpiper (*Calidris acuminata*); ▪ Lesser sand plover (*Charadrius mongolus*); and ▪ Double-banded plover (*Charadrius bicinctus*).
The tidal fish habitats and fish and invertebrate populations of the MBRS support valuable recreational and commercial fishing activities	Notable species include: ▪ Bream, flathead, whiting, luderick, mullet, tailor, mackerel, sharks, baitfish, eels, and pink snapper fin fish; ▪ King, tiger, endeavour, banana, greasyback and school prawns; ▪ Blue swimmer, mud, red spot, spanner and coral crabs; and ▪ Callianasid shrimp (yabbies), squid, cuttlefish, rock oysters, bivalves and beche-de-mer (sea cucumber).
The perched wetlands on Moreton Island (Mulgumpin) and North Stradbroke Island (Minjerribah), including lakes and swamps.	Perched wetlands are abundant in the coastal Wallum regions of south-eastern Queensland and northern NSW, but are scarce in most parts of the world.
Submarine groundwater discharge	Moreton Bay is subject to a large submarine groundwater discharge (SGD) rate estimated to be approximately 18 times greater than the average annual discharge of all the major river inputs into the bay. The SGD has been suggested as a major component of the hydrological and biogeochemical cycles of Moreton Bay and has a major influence on the export of alkalinity and dissolved carbon into the bay.
Has important cultural values and significance to indigenous peoples	Sites of significant Aboriginal cultural heritage are located throughout the MBRS including on Bribie, North Stradbroke (Minjerribah), Peel (Jercuruba), St Helena (Noogoon), Macleay (Janguwajah), Lamb (Ngudjuru), Karragarra and Russell (Kanaipa) Islands as well as Toorbul Point, Caboolture River and Victoria Point (Warrer Warrer). Types of sites include middens, fish traps, artefact scatters, quarries and scarred trees. Tangible evidence of past occupation is found in many forms throughout the MBRS. The archaeological heritage of the Moreton Bay islands is an extensive, rich and diverse cultural record. It comprises over 1,000 known sites, including shell middens, stone artefact scatters, stone artefact quarries, burials, scarred trees, earthen ceremonial rings, story places, pathways, and stone fish traps. Archaeological sites are found on all the Moreton Bay islands, although the type and character of the evidence varies according to a range of factors including the resource availability, accessibility, seasonal use and social factors. Contemporary cultural knowledge relating to these sites and landscapes remains strong, and is tangibly associated with living traditions, ideas and beliefs. Although there have been significant impacts on parts of the islands, much of the cultural landscape is intact and remains associated with living traditions and beliefs. There is abundant evidence of traditional human settlement, land and sea use.
Is an important site for research and education	Several of the key species and habitat types identified above have been subject to long term research and education activities.
Provides and supports significant tourism and recreational uses in the region	Specific importance is placed on the marine and estuarine waters, sandy beaches and dunes, freshwater lakes located on the bay islands, and sites located on the string of sand islands forming the eastern barrier of Moreton Bay.

While critical processes are not listed in Table 4, those identified as underpinning the critical services include:

- Physical coastal processes – Hydrodynamic controls on habitats through tides, currents, erosion and accretion;
- Hydrology - Patterns of tidal inundation and freshwater flows to wetland systems;
- Groundwater – For those wetlands influenced by groundwater interaction, the level of the groundwater table and groundwater quality;
- Energy and nutrient dynamics – Primary productivity and the natural functioning of carbon and nutrient cycling processes;
- Biological processes - Important biological processes such as growth, reproduction, recruitment, migration and dispersal;
- Water quality - Water quality that provides aquatic ecosystem values within wetland habitats;
- Climate – Patterns of temperature, rainfall and evaporation; and
- Geomorphology - Key geomorphologic/topographic features of the wetland.

Limits of Acceptable Change (LACs)

The Draft ECD is the only study that has attempted to define the LACs for the critical processes, components and services of the MBRS. Critical habitat types within the MBRS as well as specific wetland species of conservation significance (and the various wetland processes that underpin them) are the focus of the LACs. Where there was insufficient data to set a LAC with confidence, interim LACs were supplied, which trigger further investigation and action to assess if a change to ecological character has or may occur. A summary of the LACs is provided in Table 5. The Draft ECD includes specific LACs for key species such as Oxleyan Pygmy Perch. These have not been included in the summary as they are reflected by the more general criteria. The specific LACs are discussed in the Project area and Zone of Influence-level analysis where relevant.

No LACs were provided in the Draft ECD for the cultural, educational or tourism/recreational services of the MBRS. It is difficult to develop criteria for these services as the value provided is subjective based on the individual opinions of users. Any impacts on those services would need to be assessed on a case-by-case basis.

Table 5: Summary of the Draft ECD Limits of Acceptable Change for the MBRS.

LAC No	Critical Service	Definition of an unacceptable change to the Ecological Character	Interim LAC
1	Contains a diversity of wetland habitat types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity between habitat types. Contains several critical wetland habitat types	A change in natural or near-natural condition at one of the six reference sites or more broadly across that habitat type at a whole-of-site scale are defined as follows: ▪ **Seagrass meadow** cover and extent has declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (Eastern Bay) or has resulted in measurable changes to the local population status of dugongs and green turtles, or fisheries stocks (all seagrass areas); ▪ **Unvegetated intertidal flats** and associated microphytobenthos and marine fauna community structure has changed to such levels that it in the medium to long-term (>5 years), can no longer be considered to be in pristine or near-pristine condition (Pumicestone Passage) or has resulted in measurable changes to avifauna populations or fisheries stocks (all tidal flat areas); ▪ **Mangrove and saltmarsh** habitat extent and community structure has changed to such levels that in the medium to long-term (>5 years), it can no longer be considered to be in pristine or near-pristine condition (Southern Bay) or has resulted in measurable changes to avifauna populations or fisheries stocks (all mangrove and saltmarsh areas); ▪ **Coral community** and reef habitat structure has changed to such levels that in the medium to long-term (>5 years), it can no longer be considered in pristine or near-pristine condition (Eastern Bay coral communities) or has resulted in measurable changes to the extent or condition of the habitat (e.g. coral dominated reefs algal dominated); ▪ **Freshwater wallum wetland /peatland** habitat conditions have declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (North Stradbroke or Moreton Islands) or has resulted in measurable changes to the local population status of threatened flora and fauna species or communities; ▪ **Ocean beach and foredune** habitat conditions have declined to such levels that it can no longer be considered to be in pristine or near-pristine condition (Moreton Island) or has resulted in measurable changes to the local population status of avifauna or nesting usage by avifauna and marine turtles (all ocean beaches and foredune areas).	There should not be a >10% change in marine habitat extent, relative to the total area of available habitat within Moreton Bay, and also relative to natural background temporal variability, in the medium term (>2-5 years). At a local scale*, >10% change in habitat extent, relative to natural background variability, and causes measurable, medium-term (>2 to 5 years) flow-on effects to the key species, communities or habitat identified in the critical services. No measurable medium term (>5 years) change to hydraulic, wave and/or sedimentation patterns at spatial scales measured in km or greater above background. A change in frequency, duration and magnitude of tidal inundation Such that it results in >10% change (above background) in the extent of unvegetated habitat between MHW and MSL, MSL and MLW and MLW and LAT
2	Supports an assemblage of vulnerable or endangered marine/aquatic fauna Supports an assemblage of vulnerable or endangered	There are several species/communities within the MBRS that meet this criterion which include: ▪ Marine Species – i.e. Dugongs, Green and Loggerhead Turtles; ▪ Freshwater Fish – i.e. Oxleyan Pygmy Perch and Honey Blue-eye; ▪ Avifauna – i.e. Little Tern, Beach Stone-curlew, Painted Snipe, Australasian Bittern; ▪ Wetland-dependant non-avian fauna – i.e. Illidge's Ant-blue Butterfly, acid frogs and Water Mouse;	Detectable decline in local abundance/ population of threatened, endangered or critically endangered species

LAC No	Critical Service	Definition of an unacceptable change to the Ecological Character	Interim LAC
	wetland dependant terrestrial fauna species Supports an assemblage of vulnerable or endangered wetland flora species and endangered and of concern wetland regional ecosystems	▪ Nationally Endangered wetland flora species including several swamp orchids, Knotweed and Swamp Daisy. An unacceptable change will have occurred if it can be demonstrated that one or more of these threatened species or threatened communities is lost within the MBRS. A change to ecological character would be demonstrated if the following were to occur: ▪ The wetland becomes unsuitable as habitat for one or more threatened species or communities; or ▪ Threatened animal and plant species no longer occur at the site.	
3	Refer to LAC 2	An unacceptable change will have occurred if it can be demonstrated that there has been a reduction in the number of species occurring within the MBRS, and that this has resulted in a loss in biodiversity within the bio-region. In this context, a change to character would be demonstrated if the following were to occur: ▪ Habitats have become unsuitable for threatened, endangered or critically endangered wetland flora or fauna species or populations ▪ Noteworthy animal and plant species are no longer present ▪ Populations of noteworthy species are no longer recorded in previous abundances (i.e. possible loss of genetic diversity) ▪ Overall vertebrate fauna biodiversity is measurably and significantly reduced.	Refer to LACs 1 and 2
4	Refer to LAC 2	An unacceptable change will have occurred if it can be demonstrated that the MBRS no longer provides a refugia function for important flora and fauna species, or if critical lifecycle processes are no longer being supported. The following are considered to represent the key critical life-cycle functions in the MBRS: ▪ Feeding and nesting habitat for Green and Loggerhead Turtles that could impact the local population ▪ Feeding and breeding habitat for Dugong that could impact the local population ▪ Refuge habitat for freshwater fish of conservation significance that could impact the local population ▪ Roosting habitat for migratory shorebirds that could impact the local population ▪ Critical overwintering habitat and a flyway staging area for migratory shorebirds.	Refer to LACs 1 and 2

LAC No	Critical Service	Definition of an unacceptable change to the Ecological Character	Interim LAC
5	Supports significant populations (more than 20,000 in total and over 1% of the population size) of shorebirds	The MBRS no longer supports the required abundance of waterbirds under this Criterion	That the total number of waterbirds at the site always exceeds 20,000 individuals Greater than 10% reduction over a 10-year period of numbers of Bar-tailed Godwit, Eastern Curlew, or Pacific Golden Plover, which are surrogates for assessing shorebird abundance generally
6	Refer to LAC 5	The MBRS no longer supports the 1% of individuals of populations for the key species in the ECD which are: Bar-tailed Godwit, Whimbrel, Eastern Curlew, Terek Sandpiper, Grey-tailed Tattler, Curlew Sandpiper, Pied Oystercatcher, Pacific Golden Plover and Lesser Sand Plover.	Greater than 20% reduction in any three-year period over five years for any of the eight migratory shorebird species which exceed the 1% threshold.
7	The tidal fish habitats and fish and invertebrate populations of the MBRS support valuable recreational and commercial fishing activities	Long term impacts on the sustainability of populations of important commercial and recreational species that occur within the MBRS (or in adjacent areas of the Bay) including: ▪ Bream, Flathead, Whiting, Luderick, Mullet, Tailor, Mackerel, sharks, baitfish, eels, Pink Snapper and other key finfish species; ▪ King, Tiger, Endeavour, Banana, Greasyback and School prawns; ▪ Blue Swimmer, Mud, Red Spot, Spanner and Coral crabs and Callianasid shrimp (yabbies); ▪ Squid, cuttlefish, gastropods, rock oysters, bivalves and beche-de-mer.	A long-term loss of fish/shellfish stocks, which results in the reduction in the sustainability of key Bay fisheries, should be considered a trigger for assessing potential changes to ecological character
8	Refer to LAC 7	Medium to long-term (>5 years) reduction in the extent or condition of wetlands or other areas and a corresponding measurable impact on important spawning, nursery or migration pathways for fisheries.	At a local scale, >10% change in habitat extent, relative to natural background variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to key species, lifestages, communities or habitat at this spatial scale In assessing this interim LAC, attention should be given to assessing changes in the extent of mangroves, saltmarsh, seagrass and tidal flat environments, which represent key nursery habitats to many commercially important species within the site

*The 'local' spatial scale is not well defined in the Draft ECD however it does refer to the local scale being measured in kilometres.

10.1.1.1 Moreton Bay Ramsar Information Sheet (RIS) Review

In addition to the information contained in the Draft MBRS ECD, the Australian and Queensland Governments have described the values of the wetland in the Ramsar Information Sheet (RIS - DoEE 2019).

While the RIS does not explicitly list the critical processes, components and services of the MBRS, it does describe key features and values where it addresses listing criteria and through a brief description of ecological character. Key values of the MBRS identified in the RIS are summarised below:

- One of the largest estuarine bays in Australia that sits in an 'overlap zone' where both tropical and temperate species occur. It supports extensive intertidal areas of seagrass, mangroves and saltmarsh that provide vital habitat for waterbirds, including significant populations of migratory shorebirds.
- The site is part of a functioning major coastal system and contains a diversity of wetland habitat types with a high degree of connectivity between many of these habitats. Many of its diverse habitat types retain a near-natural character and are interconnected with other habitats supporting biodiversity. Coastal wetland types present and their extent within the MBRS are:
    - Permanent shallow marine waters
    - Marine subtidal aquatic beds (seagrasses)
    - Coral reefs
    - Rocky marine shores including rock offshore islands and sea cliffs
    - Sand, shingle or pebble shores
    - Estuarine waters
    - Intertidal mud sand or salt flats
    - Intertidal marshes
    - Intertidal forested wetlands (mangrove forests to low closed forest on marine clays)
    - Coastal brackish/saline lagoons
    - Coastal freshwater lagoons.
- Home to five nationally threatened plant species that are wetland dependant, such as the endangered Swamp Daisy, *Olearia hygrophila*, which is only found on North Stradbroke Island.
- Habitat for humpback whales and dolphins, as well as six of the world's seven species of marine turtles. Other threatened animals, including the Grey Nurse Shark, Dugong, Wallum Sedge Frog, Water Mouse and Oxleyan Pygmy Perch fish, also live in the Bay or in surrounding waters and wetlands.
- A wetland habitat providing feeding areas, dispersal and migratory pathways, and spawning sites for many fish species. The region supports one of the most productive fisheries in Queensland.
- The perched wetlands on Moreton Island (Mulgumpin) and North Stradbroke Island (Minjerribah), including lakes and swamps. Perched wetlands are abundant in the coastal Wallum regions of south-eastern Queensland and northern New South Wales, but are scarce in most parts of the world.
- The site includes natural and near-natural freshwater wetlands and critical habitats such as peat swamps, clay pans, window water-table lakes, perched lakes, freshwater creeks and other groundwater dependent ecosystems.
- Moreton Bay is subject to a large submarine groundwater discharge (SGD) rate estimated to be approximately 18 times greater than the average annual discharge of all the major river inputs into the Bay. The SGD has been suggested as a major component of the hydrological and biogeochemical cycles of Moreton Bay and has a major influence on the export of alkalinity and dissolved carbon into the Bay.
- A number of services contributing to the social and economic wellbeing of people, including tourism and recreational opportunities, fishery products, aesthetic benefits, health and wellbeing, cultural services, storm surge mitigation, climate regulation through carbon sequestration and local temperature moderation, and treatment of pollutants (e.g. denitrification processes).

- Contains the most extensive seagrass, mangrove and saltmarsh communities on the east coast of Australia and provides important primary production for a range of species, including commercially valuable fish and crab species. The total value of commercial fishery production in the Bay is estimated to be $24-30 million.
- Primary productivity is a central ecosystem service provided by the major wetland habitats – mangroves, saltmarsh, seagrass and vegetated swamps. These plants support local and regional marine/estuarine and freshwater food webs. Mangrove primary production varies between communities, with influencing factors such as soil nutrient status, redox potential, salinity, temperature, light intensity, associated fauna and tidal flushing.
- Moreton Bay's proximity to a major population centre makes it a very popular recreational fishing area. Estimates of the total expenditure by recreational fishers in Moreton Bay range from $156 million to $194 million per year.
- One of the most important migratory shorebird sites in Australia, supporting both a large number and high diversity. During the summer months some 32 species of migratory shorebirds comprising over 40,000 individuals visit the Bay. This includes significant worldwide populations, including 20% of all Eastern Curlews and 50% of all Grey-tailed Tattlers.
- Based on the 2016 revised East Asian-Australasian Flyway (EAAF) population estimates, the site provides habitat for >1% of the estimated EAAF population of the following species:
    - Bar-Tailed Godwit (*Limosa lapponica*)
    - Curlew Sandpiper (*Calidris ferruginea*)
    - Eastern Curlew (*Numenius madagascariensis*)
    - Grey-Tailed Tattler (*Heteroscelus brevipes*)
    - Red-Necked Stint (*Calidris ruficollis*)
    - Australian Pied Oystercatcher (*Haematopus longirostris*)
    - Whimbrel (*Numenius phaeopus*)
    - Sharp-tailed Sandpiper (*Calidris acuminata*)
    - Lesser Sand Plover (*Charadrius mongolus*)
    - Double-banded Plover (*Charadrius bicinctus*).

While not part of the RIS a statement on Cultural Heritage of the MBRS is provided on the DCCEEW website. The statement reads:

> *Sites of significant Aboriginal cultural heritage are located throughout the site including on Bribie, North Stradbroke (Minjerriba), Peel (Turkrooar), St Helena (Noogoon), Macleay, Lamb (Ngudooroo), Karragarra and Russell (Canaipa) Islands as well as Toorbul Point, Caboolture River and Victoria Point. Types of sites include middens, fish traps, artefact scatters, quarries and scarred trees.*
>
> *Tangible evidence of past occupation is found in many forms throughout the site. The archaeological heritage of the Moreton Bay Islands is an extensive, rich and diverse cultural record. It comprises over 1000 known sites, including shell middens, stone artefact scatters, stone artefact quarries, burials, scarred trees, earthen ceremonial rings, story places, pathways, and stone fish traps. Archaeological sites are found on all the Moreton Bay islands, although the type and character of the evidence varies according to a range of factors including the resource availability, accessibility, seasonal use and social factors.*
>
> *Contemporary cultural knowledge relating to these sites and landscapes remains strong, and is tangibly associated with living traditions, ideas and beliefs. Although there have been significant impacts on parts of the islands, much of the cultural landscape is intact and remains associated with living traditions and beliefs. There is abundant evidence of traditional human settlement, land and sea use.*

Within the Quandamooka state, traditional management practices are being progressively introduced through collaboration between the Department of Environment and Science and the Quandamooka Aboriginal traditional owners, who have consented to the formal declaration of National Parks over their Aboriginal Land Act land.

While not identified as critical, the RIS highlights ecosystem services considered to be of high importance or significance to the MBRS. The services are listed as either provisioning (i.e. providing food and water for human populations), regulating (i.e. contributes to controlling floods, droughts, etc), cultural (i.e. provide recreational, spiritual, religious, and other non-material benefits) or supporting (i.e. provide habitat for fauna and nutrient cycling). These services are outlined in Table 6 along with a brief description.

The RIS also identifies underlying critical processes that are integral to the services provided by the MBRS as physical coastal, hydrological, energy and nutrient dynamics, biological, climatic and geomorphologic.

Table 6: MBRS Significant Services Identified by the RIS.

Service type	Significant service	Description / Examples
Provisioning	Food for humans	Fish, molluscs, grain production
	Fresh water	Water for industry and drinking water
	Genetic materials	Ornamental species for aquariums, etc
Regulating	Maintenance of hydrological regimes	Groundwater recharge and discharge
	Erosion protection	Retention of soils and sediments
	Pollution control and detoxification	Purification and dilution of waste water
	Climate regulation	Regulation of greenhouse gases, temperature, precipitation and other climactic processes
	Hazard reduction	Stabilisation of the shoreline, storm protection and flood storage
Cultural	Recreation and tourism	Nature observation and nature-based tourism, water sports and activities, fishing and hunting
	Spiritual and inspirational	Historic and contemporary cultural significance, aesthetic sense of place
	Scientific and educational	Educational activities and opportunities, major scientific study area
Supporting	Biodiversity	Supports a variety of life forms including plants, animals and microorganisms
	Soil formation	Accumulation of organic matter and sediment retention
	Nutrient cycling	Storage, recycling, processing and acquisition of nutrients
	Pollination	Support for pollinators

1.4.2 Critical Components, Processes and Services Represented at the Project Site

Key components, processes and services identified as being present and contributing to the ecological character of MBRS at the Project footprint and zone of influence level are summarised in Table 7 and ecosystem interactions are shown conceptually in Figure 4 and Figure 5.

Given the wide range of processes, components and services provided by the MBRS, it is difficult to develop prescriptive criteria for assessing the level of contribution to ecological character. The following were used as a guideline for assessing the contribution of components and services unless components displayed unique or comparatively high values:

- Less than 1% of the overall representation in the MBRS, the contribution was considered minor;
- Between 1% and 10% of the overall representation in the MBRS, the contribution was considered moderate; and
- Greater than 10% of the overall representation in the MBRS the contribution was considered major.

Cultural and regulating services and processes are more difficult to quantify therefore contribution has been based on qualitative assessment and presence of key features or components at in the Project area and Zone of Influence, and application of the precautionary principle. Processes, components and services identified as being present and contributing to the ecological character of MBRS are shown visually in the Toondah Harbour conceptual ecosystem services model

It should be noted that the Project footprint is not entirely within the MBRS with approximately 7 ha of the dredge area and 1.7 ha of the reclamation area located outside the Ramsar boundary (Figure 6). This accounts for small differences in habitats such as seagrass being impacted when compared to the whole Project footprint.

Table 7: Local Representation of MBRS Critical Services.

Critical process, component and service	Presence in the Project footprint and Zone of Influence	Contribution to Ecological Character
Contains a diversity of wetland habitat types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity between habitat types. Wetland habitats provide important primary production for a range of species including threatened species and commercially valuable fish and crab species.	The **Project footprint** contains representations of three of the 11 coastal wetland types identified by the Draft ECD: mangroves, seagrass and unvegetated sand/mud. The extent of these habitat types in the MBRS are (values sourced from the 2019 RIS): ▪ At least 11,847 ha of mangrove forest; ▪ At least 23,759 ha of seagrass; and ▪ At least 4,681 ha of unvegetated mud/sand. The habitat types present within the **Project footprint** are: ▪ 2.5 ha of mangroves (0.02% of MBRS); ▪ 34.8 ha of seagrass (0.15% of MBRS), including 10 ha in the Fison Channel, which is expected to at least partially regrow; and ▪ 7.5 ha of unvegetated intertidal sand and mudflats (0.18% of MBRS). These habitat types are also represented in the **Zone of Influence**. Broadscale mapping databases indicate the presence of: ▪ 1,336 ha of mangroves; ▪ 2,225 ha of seagrass; and ▪ 920 ha of unvegetated sand/mud. The mix of mangrove habitat fringing mudflats and sandbanks containing some seagrasses found at Toondah Harbour is not unique in Western Moreton Bay. Within the Zone of Influence approximately 19.8 km of similar habitat mix. The Project footprint contains less than 0.5 km of this habitat mix.	The small area of **mangroves in the Project area** represents less than 0.03% of all mangroves in the MBRS. They are in moderate health and did not display any features that would make them unique or of high value in the context of the MBRS. They are considered to provide a **minor contribution** to the ecological character of the MBRS. Mangroves within the Z**one of Influence** represent 11% of all mangroves in Moreton Bay therefore are considered to provide a **major contribution** to the ecological character of the MBRS. **Seagrass in the Project area** represents less than 0.2% of all seagrass in the MBRS and is considered to provide a **minor contribution** to the ecological character of the MBRS. Seagrass within the **Zone of Influence** represents 12% of all seagrass habitat in Moreton Bay therefore is considered to provide a **major contribution** to the ecological character of the MBRS. **Unvegetated sand/mud in the Project area** represents less than 0.2% of all mudflat in the MBRS and is considered to provide a **minor contribution** to the ecological character of the MBRS. Unvegetated sand/mud within the **Zone of Influence** represents 20% of all unvegetated sand/mud habitat in the MBRS therefore is considered to provide a **major contribution** to the ecological character of the MBRS.

Critical process, component and service	Presence in the Project footprint and Zone of Influence	Contribution to Ecological Character
Contains several critical wetland habitat types	The Draft MBRS ECD identified six key wetland representative areas (refer to *Table 4*). 1. Seagrass and shoals in the Eastern Banks area 2. Intertidal flats and estuarine assemblages in the Pumicestone Passage area 3. Mangroves and saltmarsh associated with the islands in the Southern Bay 4. Coral communities of the Eastern Bay 5. Freshwater wetlands (including Wallum and Peatlands) of Moreton and North Stradbroke Islands 6. Ocean beaches and foredunes on Moreton Island.	None of the key wetland areas are present within the **Project footprint** or **Zone of Influence**.
Supports an assemblage of vulnerable or endangered marine/aquatic fauna	A range of vulnerable and endangered marine and aquatic fauna have the potential to be present within the Project footprint. These include dugong, Australian humpback dolphin, and loggerhead, hawksbill and green turtles. Seagrass beds within the Project footprint provide a potential source of food for marine turtle species and dugong, although the species present are widely available through Western Moreton Bay and the site would not be considered important foraging or breeding areas for any of these species. Analysis of recent and historical literature shows dugong and marine turtle species are predominantly found in Eastern Moreton Bay as they prefer seagrass beds on the western shores of Moreton Island (Mulgumpin) and North Stradbroke Island (Minjerribah). Surveys carried out in 2014 to 2018 by Dolphin Research Australia found that areas frequented by humpback dolphins also include Amity Point (Pulan), the eastern side of Peel Island (Jercuruba), and the bottom of Bribie Island. Dugongs, marine turtles and Australian humpback dolphins were sighted at low densities during field surveys within and adjacent to the Project footprint. Sightings were generally offshore to the north east or south east of Cassim Island or further south of the site in the embayment south east of Oyster Point.	Vulnerable and endangered marine or aquatic fauna have been observed near the Project area in low densities. Habitat present would not be considered important for any of these species. Preferred habitat for these species is located in Eastern Moreton Bay adjacent to the outer Bay islands. None these areas are located within the **Zone of Influence**. The **Project area** and broader **Zone of Influence** is considered to provide a **minor contribution** to the ecological character of the MBRS.
Supports an assemblage of vulnerable or endangered wetland dependant terrestrial fauna species	Wetland dependent vulnerable and endangered fauna species have the potential to use habitat within the Project footprint. Species that occur are generally also considered migratory shorebirds and include the critically endangered eastern curlew, great knot and curlew sandpiper; the endangered red knot and lesser sand plover and the vulnerable bar-tailed godwit and greater sand plover. Of these species, eastern curlew and bar-tailed godwit are known to regularly utilise the mudflats within the Project footprint as feeding habitat, with lesser sand plover and great knot observed infrequently in very low numbers. Bar-tailed godwits also occasionally use the adjacent Cassim Island as a high tide	Feeding habitat for threatened wetland fauna species provides a **minor contribution** to the ecological character of the MBRS within the **Project area** and a **major contribution** within the **Zone of Influence**.

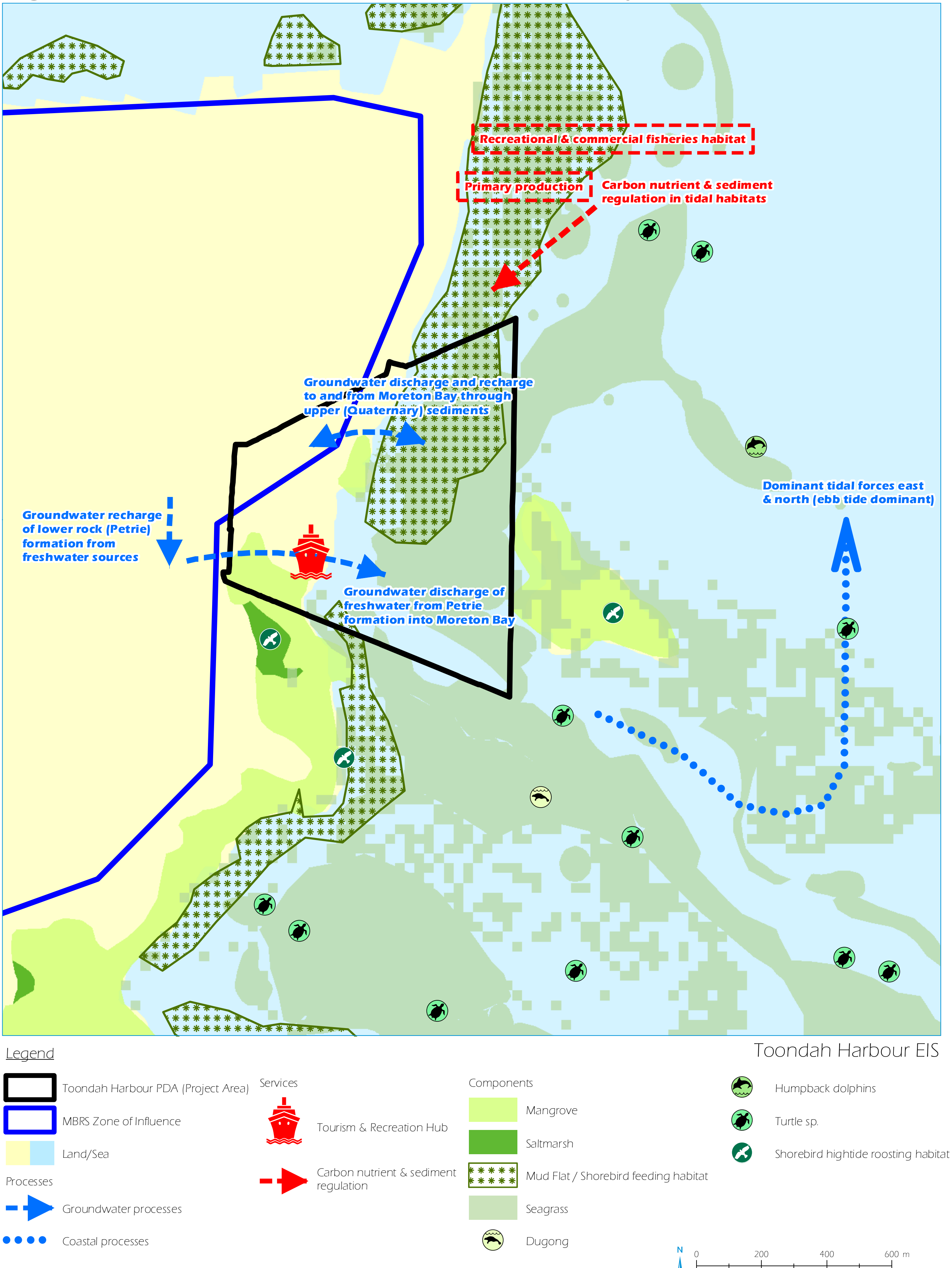
Critical process, component and service	Presence in the Project footprint and Zone of Influence	Contribution to Ecological Character
	roost site. Shorebird use of Nandeebie Claypan and Oyster Point has significantly reduced in the last five years with no migratory shorebirds observed at the Nandeebie Claypan for several years. Eastern curlews are observed regularly on the mudflat feeding areas in low numbers (average of 3.5 and maximum of 5 birds over the last 5 years) in the Project footprint. This is approximately 0.3% of the average number seen in Moreton Bay between 1978 and 2006. Bar-tailed godwits have also been observed consistently but in low numbers on the mudflat feeding areas (average of 10 and maximum of 19 birds) in the Project footprint. This is approximately 0.15% of the average number seen in Moreton Bay. Approximately 25.6 ha of potential feeding habitat within the MBRS will be impacted by the Project footprint. This is 0.6% of potential feeding habitat within the MBRS (RIS 2019). The **Zone of Influence** contains additional areas of feeding habitat with analysis of aerial imagery identifying an area of approximately 920 ha. Shorebird surveys carried out at feeding habitat throughout South Western Moreton Bay found eastern curlews present at a density of about 1 per 10 ha and bar-tailed godwits at a density of about 6 per 10 ha meaning these areas provide feeding habitat for hundreds of threatened wetland dependent terrestrial species.	Roosting habitat within the **Project area** and **Zone of Influence** are considered to provide a **major contribution** to the ecological character of the MBRS.
Supports an assemblage of vulnerable or endangered wetland flora species and endangered and of concern wetland regional ecosystems	No vulnerable or endangered wetland flora species were observed in the Project area. A search of the *Nature Conservation Act 1992* Protected Plants Database, Wildnet database and regional ecosystem database did not find any wetland flora species or endangered or of concern remnant vegetation within the marine or tidal areas of the **Zone of Influence.**	This ecosystem service is **not present** within the **Project area or Zone of Influence** of the Project.
Supports significant populations (more than 20,000 in total and over 1% of the population size) of shorebirds	The maximum number of shorebirds observed at the roost sites were: ▪ Cassim Island - 1,290 (2019) with grey-tailed tattler the dominant species (~1,000); and ▪ Oyster Point – 842 (2019) with bar-tailed godwit the dominant species (825) The maximum number of shorebirds observed on the tidal flats at Toondah Harbour at any survey was 160 with grey-tailed tattler (60) and terek sandpiper (42) the dominant species. Over 1,500 migratory birds were observed feeding at mudflats within South Western Moreton Bay.	Feeding habitat for migratory shorebirds provides a **minor contribution** within the **Project area** and a **major contribution** within the **Zone of Influence** to the ecological character of the MBRS. Roosting habitat within the **Project area** and **Zone of Influence** are considered to provide a **major contribution** to the ecological character of the MBRS.

Critical process, component and service	Presence in the Project footprint and Zone of Influence	Contribution to Ecological Character
The tidal fish habitats and fish and invertebrate populations of the MBRS support valuable recreational and commercial fishing activities	Many commercial fisheries can operate within the Southern Moreton Bay area. Most of these fisheries however do not operate at or adjacent to the Project area, either due to regulation or a lack of suitable target species. Commercial tunnel netters access part of the Project area at times, but it did not represent a key location for the activity of this fishery. This was also the case for the commercial blue swimmer crab fishery. Consultation with the recreational fisheries sector found the site had little to no recreational fisheries values. Compared to current arrangements, the Project will improve opportunity and amenity for land based recreational fishers along the eastern foreshore of the Project. Commercial fisheries logbook data was reviewed as part of the fisheries assessment. Commercial fisheries such as net fishing, crab fishing and trawl fishing occur throughout Moreton Bay, however, northern Moreton Bay is more significant in terms of commercial catches than southern Moreton Bay providing more than 75% of the total annual catch (tonnes). This is particularly the case for the trawl fishery where approximately 99% of the trawl catch is from northern Moreton Bay. The southern Moreton Bay area does provide a source of catch for several commercial net and crab fishers targeting blue swimmer crabs, and this contributes to their income. Tunnel netting in Moreton Bay is restricted to a number of specific locations, many of which are within the **Zone of Influence**, including: ▪ Either side of Moogurrapum Creek, Redland Bay; ▪ Point Halloran to 700 m south of Oyster Point; ▪ 800 m south of the southern bank of Hilliards Creek to 1 km south of Wellington Point; ▪ The eastern shore of Fisherman Island to north of Wynnum Creek; and ▪ From Juno Point to the northern bank of Serpentine Creek.	Fisheries habitat and values in the **Project area** provide a **minor contribution** to ecological character of the MBRS. Fisheries habitat and values in the **Zone of Influence** provide a **moderate contribution** to ecological character of the MBRS.
Has important cultural values and significance to indigenous peoples in Moreton Bay	Four sites of Aboriginal cultural heritage were recorded within the Project footprint during pedestrian survey. These sites included two artefact scatters and two isolated artefacts. Five test pits were excavated to test for sub-surface deposits. One test pit in the northern part of GJ Walter Park yielded Aboriginal cultural heritage that may be significant for understanding contact sites in Moreton Bay and the initial relationships between European settlers and the Quandamooka People.	Indigenous cultural heritage values in the Project area provide a **major contribution** to the ecological character of the MBRS.
Provides and supports significant tourism and recreational uses in the region	Toondah Harbour serves as the base for water taxi, passenger and vehicle ferry services between the mainland and Minjerribah (North Stradbroke Island), as well as a public boat ramp for recreational vessels.	

Critical process, component and service	Presence in the Project footprint and Zone of Influence	Contribution to Ecological Character
Provisioning services - Provides food for humans, freshwater and genetic materials	The Project footprint and Zone of Influence are entirely composed of marine or brackish water and are not a source of freshwater. In Queensland, two small but valuable fisheries exist to supply the marine aquarium and ornamental trade. The Marine Aquarium Fish Fishery (MAFF) and the Queensland Coral Fishery (QCF) operate primarily on the Great Barrier Reef. In 2018 Moreton Bay accounted for less than 2% of the Queensland MAFF (Queensland Fisheries Summary Report 2018/19 financial year). The Project footprint and Zone of Influence are not known to provide any genetic materials such as ornamental species.	The Project area and Zone of Influence do not provide food for humans, freshwater or genetic materials. These services are **not present**.
Regulates hydrological regimes (groundwater discharge and recharge)	A study by Stewart *et. al.* (2015) suggests significant submarine groundwater discharge into Moreton Bay. However, Dennison and Abal (1999) previously noted that groundwater does not constitute a major flow or nutrient contributor into Moreton Bay and, as such, is likely to have minimal impact on wetland functions. The horizontal and vertical groundwater flow direction in Petrie Formation shows that lateral groundwater flow is towards the coast and vertical contribution moving upwards. This indicates that groundwater discharges into the shallow marine environment at Toondah Harbour. Groundwater from the site was considered unlikely to provide significant inputs to existing uses (agricultural bores, etc) or groundwater dependent ecosystems and any potential changes as a result of the Project would be highly localised.	The Project area and Zone of Influence provide a **minor contribution** to regulating hydrological regimes in the MBRS.
Stabilises the shoreline through erosion protection and hazard reduction including storm protection, flood storage and regulation of coastal processes	Moreton Bay plays a significant role in protecting the South East Queensland shoreline from large waves and oceanic currents. The dominant features in performing this function are the three large sand islands: Moreton Island (Mulgumpin), North Stradbroke Island (Minjerribah) and South Stradbroke Island (Curragee/Garaji). The northern section of Moreton Bay is considerably wider than the south and is more exposed to the ocean through a northeast opening between Moreton Island (Mulgumpin) and Bribie Island. There are several other smaller openings to the bay to the east and south however, the northern entrance presents a significant larger tidal exchange volume. Consequently the flooding tide at Toondah Harbour flows in a southerly direction, and the ebb tide flows north. Contrasting to the oceanic exchange, an extensive river network flows into the west coast of Moreton Bay including, from north to south, the Caboolture, Pine, Brisbane, Logan, Albert, Pimpama and Coomera Rivers. These rivers, and a larger number of creeks, discharge significant volumes of fresh water into the bay, most notably during sizeable rainfall events.	The Project area and Zone of Influence provide a **minor contribution** to regulating hydrological regimes in the Ramsar site.

Critical process, component and service	Presence in the Project footprint and Zone of Influence	Contribution to Ecological Character
	Toondah Harbour has very little influence on the dominant drivers of coastal processes in Moreton Bay. The current patterns in the vicinity of the Project footprint are complex and influenced by the presence of Cassim Island and surrounding intertidal shoals. Cassim Island itself provides a local shadowing effect on the general southwards and northwards flood and ebb tide currents respectively.	
Regulates water quality by transforming and retaining nutrients and sediment	Seagrass beds are important sites for fixing nitrogen via nitrogen-fixing bacteria, with 0.2 to 0.4knN/Ha/Day being fixed in Moreton Bay seagrass sediments (Clouston 2002). Mangrove forests have also been shown to play an important role in nitrogen fixation and de-nitrification (Adame and Lovelock 2011). The Project footprint represents less than 0.03% of mangroves and 0.2% of seagrass in the MBRS. The Zone of Influence contains less than 11% of mangroves and 12% of seagrass in MBRS.	The Project area provides a **minor contribution** to the storage, recycling, processing and acquisition of nutrients. The **Zone of Influence** provides a **moderate contribution** to the storage, recycling, processing and acquisition of nutrients.
Purifies and dilutes wastewater	At least 35 wastewater treatment plants (WWTP) ultimately discharge into Moreton Bay. Five of these discharge within the **Zone of Influence**: Wynnum, Thorneside, Capalaba, Cleveland and Victoria Point. The closest discharge points to Toondah Harbour is the Cleveland WWTP, which is released into Moreton Bay via Hilliards Creek approximately 5 km north of the Project footprint, and Victoria Point, which releases into Eprapah Creek approximately 4.5 km south of the Project footprint. Significant investments have been made to upgrade sewage and wastewater treatment plants in the past decade to reduce nutrient loads and associated phytoplankton blooms in the western embayments and water quality in Moreton Bay is in excellent condition (EHMP 2020) with nutrient levels reducing over the past several years. All discharge points are several kilometres from the Project footprint and any pollutants would have assimilated into the bay before reaching Toondah Harbour.	The **Project area** has minimal to no role in purifying or diluting wastewater therefore this service is **not present**. The **Zone of Influence** would assist in the dilution process for five of the 35 WWTPs that release into Moreton Bay therefore provides a **minor contribution** to this service.
Regulates climate through greenhouse gases, temperature, precipitation, and other climactic processes	Mangrove forests are known to play an important role in the carbon cycle by sequestering and storing carbon dioxide (Lovelock *et al*. 2014). Wetlands are also known to play a role in localised climate regulation (Marsden *et al*. 2012). Wetland soils hold 35% or more of the estimated 1,500 gigatons of organic carbon that is stored in soils even though they only cover 5% to 8% of the earth's surface. In particular saltmarsh, mangroves and seagrass have a high ability to act as a carbon sink for carbon and greenhouse gases (Ramsar Briefing Note 10 – Wetland restoration for climate change resilience). The Project footprint represents less than 0.03% of mangroves and 0.2% of seagrass in the MBRS. The Zone of Influence contains less than 11% of mangroves, 12% of seagrass and 16% of saltmarsh in the MBRS.	The **Project area** provides a **minor contribution** to climate regulation and other climatic processes. The **Zone of Influence** provides a **moderate contribution** to climate regulation and other climatic processes.

Figure 4: : Toondah Harbour Conceptual Ecosystem Interactions



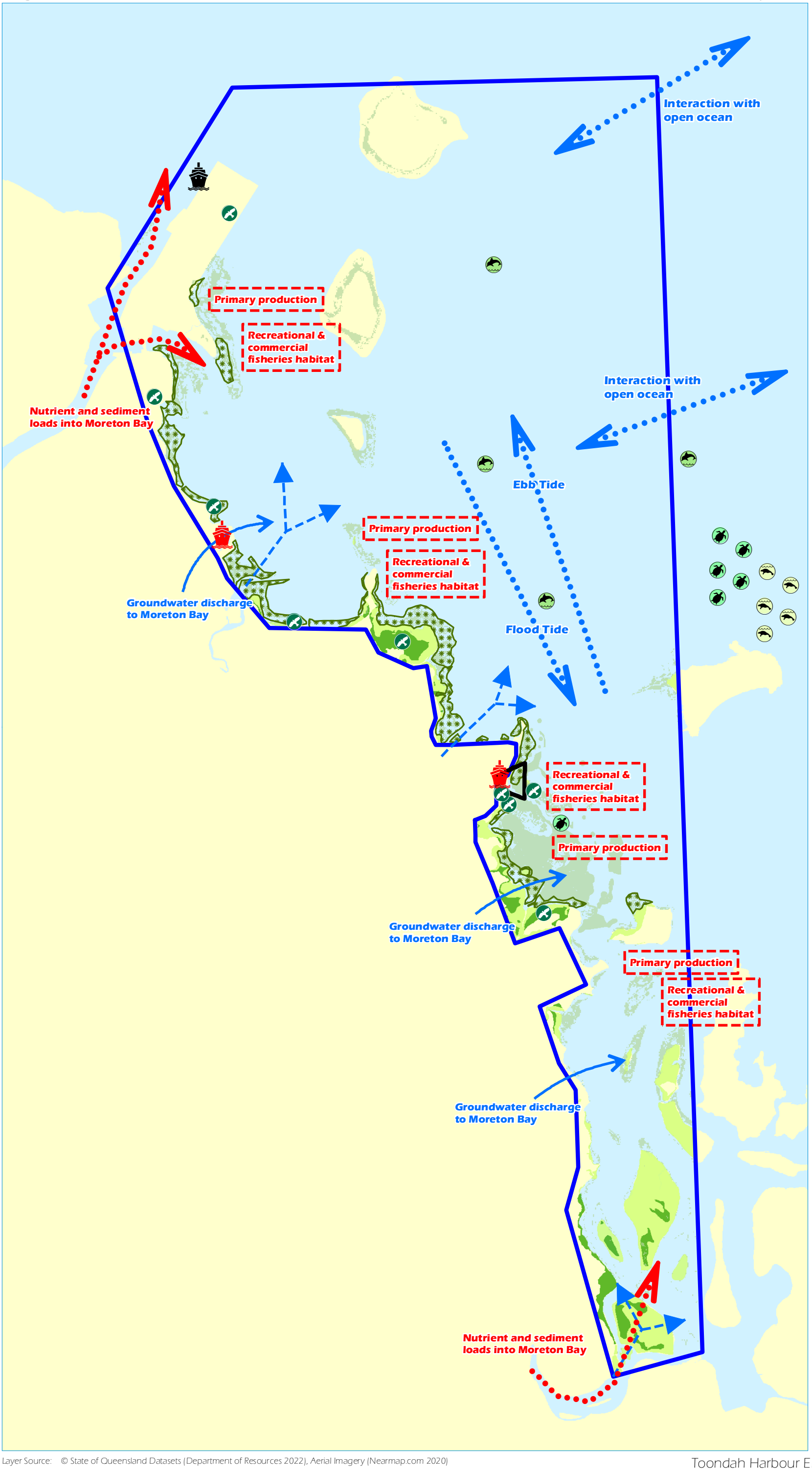
GDA 1994 MGA zone 56

Scale (A4):1:15,000

Layer Source: State of Queensland Datasets (© State of Queensland 2022), Aerial (© Nearmap 2020), Fauna records (© State of Queensland 2020)

DATE 29/06/2022 FILE REF 9858 E Figure 27 4 Toondah Habour Concept Ecosystem A

Figure 5: Toondah Harbour Zone of Influence Conceptual Ecosystem Interactions



Legend

- Toondah Harbour PDA (Project Area)
- MBRS Zone of Influence

Processes

- Groundwater disharge to Moreton Bay
- Dilution of Waterwater Releases

Services

- Tourism & Recreation Hub
- Port of Brisbane Industry Hub

Components

- Mangrove
- Saltmarsh
- Mud Flat
- Seagrass
- Shorebird hightide roosting habitat
- Dugong
- Humpback dolphins
- Turtle sp.

TOONDAH HARBOUR

walker

0 1 2 3 4 5 Kilometers

GDA 1994 MGA zone 56

Scale (A3): 1:120,000

N

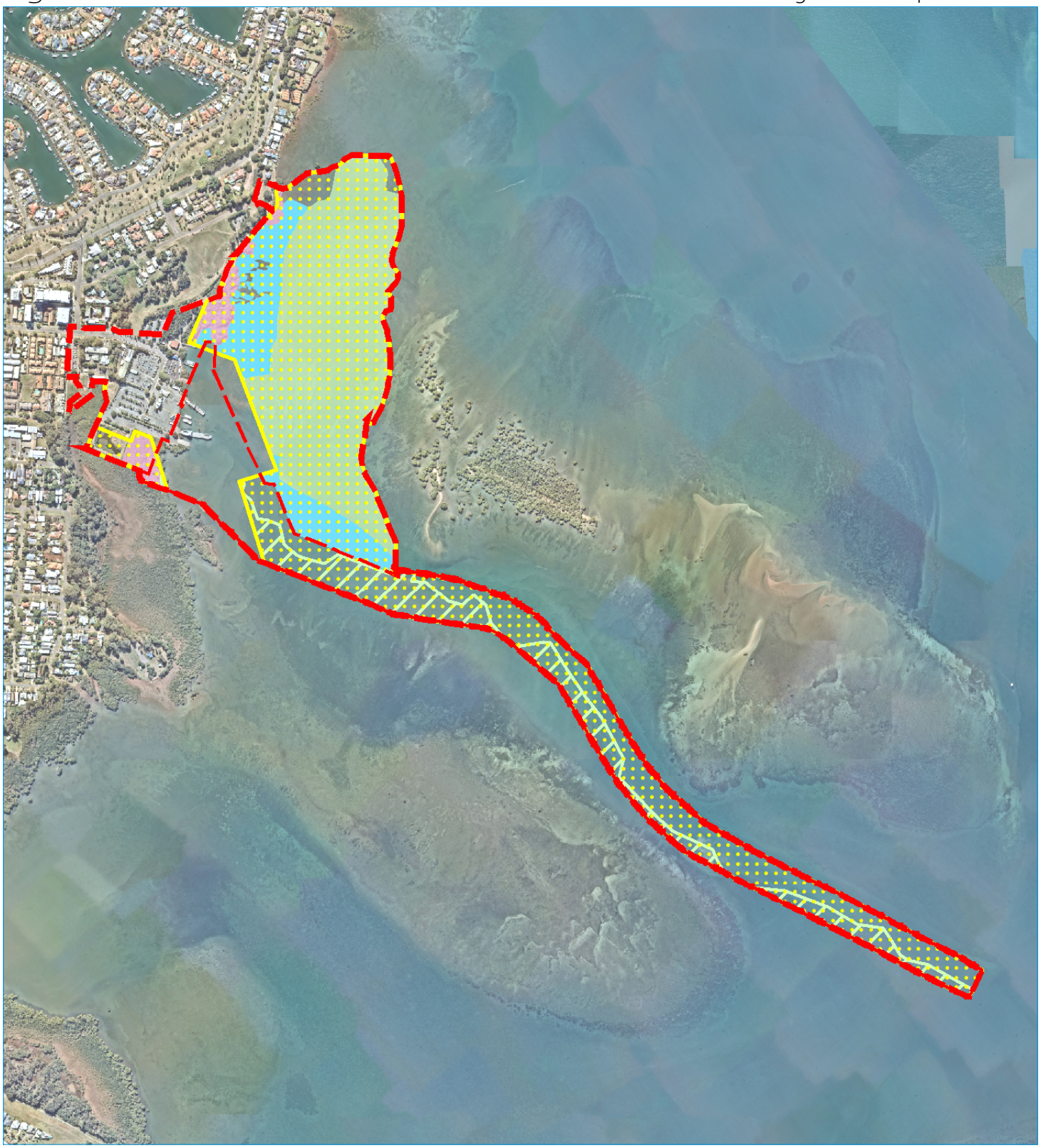
Layer Source: © State of Queensland Datasets (Department of Resources 2022), Aerial Imagery (Nearmap.com 2020)

Toondah Harbour EIS

DATE: 29/06/2022

FILE REF. 9858 E Figure 27 5 Toondah Habour ZOI Concept A

Figure 6: Marine Wetland Habitats within the MBRS and Project Footprint



Toondah Harbour EIS

Legend

- Project Footprint
- Dredge boundary
- Ramsar within development footprint (58.7 ha)

Reclamation Significant Residual Impacts

- Mangrove - 2.5ha
- Unvegetated Sand/Mud - 7.5ha
- Seagrass - 24.8ha

Dredging Significant Residual Impacts

- Seagrass - 10ha

N

0 100 200 300 400 Meters

GDA 1994 MGA zone 56

Scale (A4): 1:14,000

TOONDAH HARBOUR

walker

Layer Source: © State of Queensland Datasets (Department of Resources 2022), Aerial (Nearmap 2020)

DATE 26/09/2022

FILE REF. 9858 E Figure 27 5 Marine Wetland Habitats in MBRS and Project A

1.5. Assessment of Significance of Potential Impacts

Critical components, processes and services of the MBRS present in the Project footprint and Zone of Influence, and their contribution to the ecological character of the MBRS are summarised in Table 8. A conceptual flowchart showing how these components, processes and services that underpin them interact at the Project footprint level is included as Figure 7.

The flow of impacts is represented by the red arrows connecting the components, processes and services. Broadly, the Project can impact directly on critical components, processes and services, however impacts to services and components may also occur through indirect means, for example a change in the regulation of coastal processes (service) may indirectly impact on seagrass beds (component). Impacts to components may also indirectly affect biological services which may also then impact on services. To further the previous example, loss of seagrass may impact on primary productivity for fish species (process), which would in turn impact on commercial and recreational fisheries (service).

Table 8: Critical Services of the MBRS Present in the Project Footprint and Zone of Influence.

No.	Critical process, component or service	Contribution in Project footprint	Contribution in Zone of Influence
1	**Wetland habitats and primary production**		
1a	mangroves	minor	moderate
1b	saltmarsh	minor	moderate
1c	seagrass	minor	moderate
1d	unvegetated sand/mud	minor	moderate
2	**Critical wetland habitat types**	NP	NP
3	**Threatened marine fauna**	minor	minor
4	**Threatened wetland flora species**	NP	NP
5	**Threatened wetland fauna and Migratory Shorebirds**		
5a	feeding habitat	minor	major
5b	roosting habitat	major	major
6	**Recreational and commercial fisheries**	minor	moderate
7	**Indigenous cultural heritage**	major	major
8	**Research and education**	NP	NA
9	**Tourism and recreation**	moderate	moderate
10	**Source of Food, freshwater and genetic material**	NP	NP
11	**Regulation of hydrological regimes**	minor	minor
12	**Regulation of coastal processes**	minor	minor
13	**Regulates water quality by transforming and retaining nutrients and sediment**	minor	moderate
14	**Wastewater dilution**	NP	minor
15	**Regulates Climate**	minor	moderate

NP = Not present; NA = Not applicable

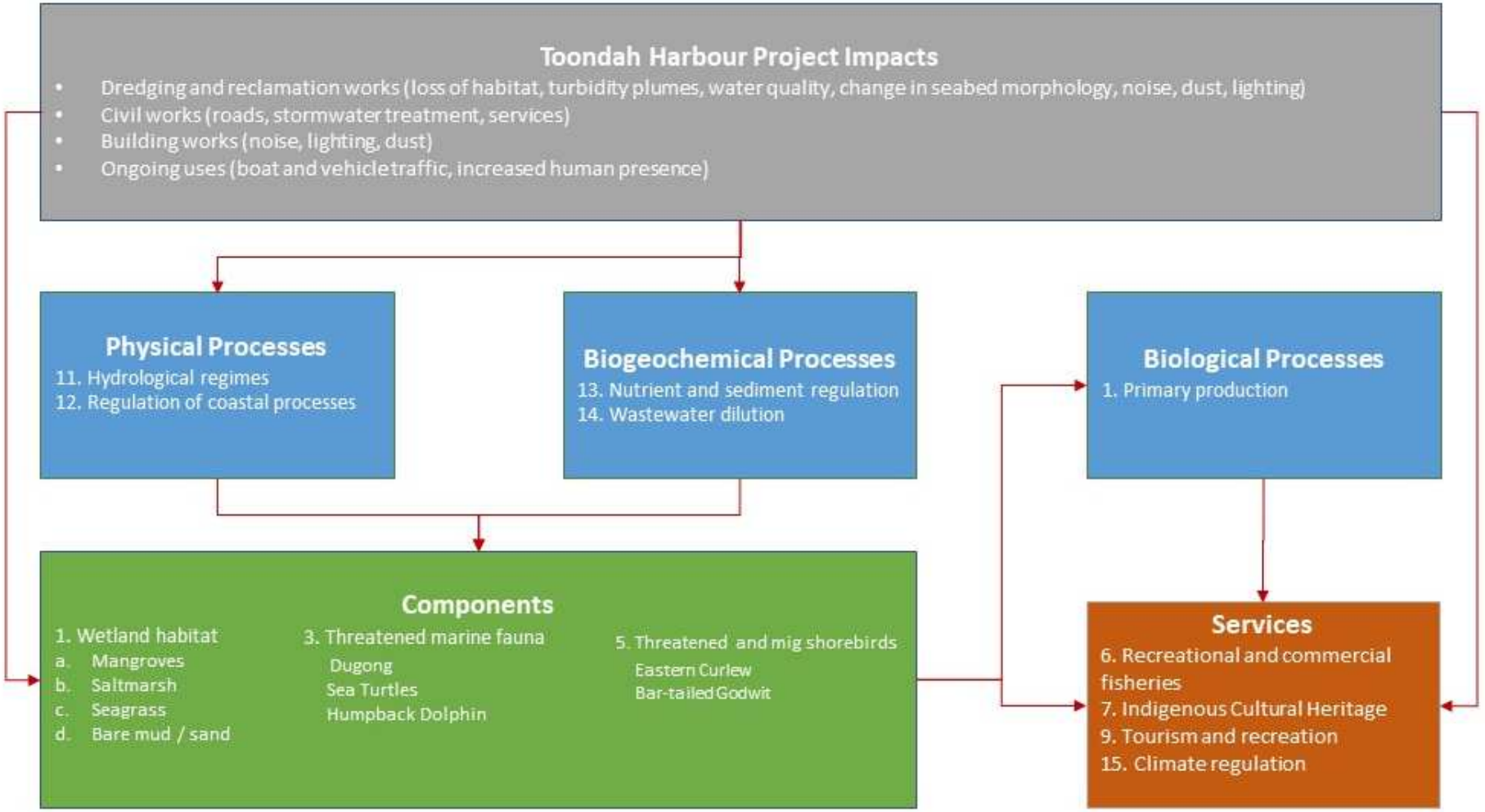


Figure 7: Conceptual Flowchart of Impact Pathways to MBRS Components, Processes and Services.

Impacts to specific components, processes and services have been addressed through the Draft EIS technical studies. A summary of the relevant potential impacts is provided below. The description of impacts is structured to follow the interactions shown in *Figure 7*.

1.5.1 Impacts to Critical Physical and Biogeochemical Processes

Impacts to critical processes resulting from the Project will include changes to groundwater flows from the reclamation and sheet piling, changes to coastal processes from reclamation of marine intertidal areas and reduction in water quality (increase in sediments and nutrients) from stormwater runoff and dredge plumes. Even though it would occur within the Zone of Influence, wastewater dilution would not occur within the Project footprint therefore the Project would not impact on that process.

1.5.1.1 Hydrological Regime (Groundwater Quality and Quantity)

Background sampling and conceptual modelling was carried out to identify existing groundwater values at the Project footprint. Key potential impacts to groundwater and management measures include:

- Installation of a sheet pile wall has the potential to cause a build-up of groundwater (mounding) behind the inland side of the wall. Without mitigation, this may cause impacts such as further saturation and mobilisation of metals within the rehabilitated landfill in GJ Walter Park. Impact analysis found that any mounding would be highly localised in areas adjacent to the sheet pile walls which could be dealt with easily through ongoing monitoring and immediate remediation in response to any exceedances.
- Dewatering of the reclamation can potentially lower the groundwater table and thus desaturate the Quaternary sediments and Petrie Formation. The extent is anticipated to be minimal and localised to underneath the reclaimed areas of the Toondah Harbour PDA, as groundwater availability is primarily controlled by replenishment from seawater. The sheet piling and bund wall will contain any impacts and ongoing monitoring will be implemented to ensure impacts do not occur outside the footprint.

Modelling shows that impacts to the hydrological regime are expected to be minimal and highly localised around the Project footprint.

1.5.1.2 Coastal Processes

Numerical modelling was carried out to assess any changes to coastal processes resulting from the Project. The model was calibrated using a substantial quantity of site and Project specific data covering waves, current wind speed and direction, and suspended sediments. Key outcomes included:

- Current patterns in the vicinity of the Project will be modified, with the diversion of tidal flows generating higher velocity magnitudes to the east of the Project footprint, most notably on spring ebb tides. While localised areas of higher ebb tide velocities are predicted between the Project footprint and Cassim Island and extending to the northeast following construction of the Stage 1 bund, these velocities are reduced following construction of the Stage 2 bund (and in particular the rockwall breakwater). There is a general reduction in ebb tide velocities immediately to the north of the Project. Importantly, these localised velocity changes are not expected to have any significant effect on Cassim Island.
- The significant wave height magnitude is generally reduced in most areas surrounding the Project due to sheltering provided by the new reclamation. However, there are some small areas where the model indicates that wave heights may increase slightly. Wave energy in Toondah Harbour is already dissipated significantly by the shallow areas to the north and east of the Project footprint, so the additional sheltering effect of the new landform is not considered to be a major change to existing conditions.
- Some areas of net erosion or sedimentation are expected to result from the changes to currents and wave patterns. However, these are expected to be minor and the modelled impact to Cassim Island is negligible.

Where additional areas of erosion have been identified, it is expected that the seabed morphology will adjust, and the erosion rate will reduce over time as a new equilibrium is established.

- No major changes to shoreline alignment or position are expected because of the Project, however, there may be some accumulation of sediment on the protected beach immediately to the north of the Project footprint. Sediment already accumulates in this area and the Project is not expected to significantly add to sediment accumulation in this area.
- The model indicates that the Project will not increase the water level or wave impacts associated with extreme events at the site. The Project is however likely to provide some benefits to adjacent areas during extreme storm events due to reduced wave height in the lee of the Project footprint.

Impacts to coastal processes are expected to be highly localised around the Project footprint with even minor effects unlikely outside of the immediate area.

1.5.1.3 Water Quality (Nutrient and Sediments)

Receiving water quality modelling was carried out including existing and future stormwater treatment to assess potential impacts to water quality at the Project footprint and MBRS scales. The outcomes of the modelling indicate that:

- The marina and internal waterways created by the Project are likely to be well flushed, and it is unlikely there will be phytoplankton blooms or eutrophication within these waterways.
- While there may be slight increases in the concentration of total nitrogen and phosphorous in the marina and internal waterways, these increases are very small compared to current concentrations.
- In wet weather conditions, there is likely to be a reduction in the concentration of total suspended solids, total nitrogen and total nutrients in the intertidal area southwest of the ferry terminal, due to an increase in the proportion of treated stormwater flows.

Dredge plume modelling was also carried out and indicates that dredging-related turbidity and deposition rate impacts are relatively small compared to the natural variation in the ambient turbidity. Impacts are limited to areas in close proximity to the Project.

A combination of regional and local tidal dynamics results in the net northward transport of the dredge sediment plume, particularly over the ebbing tide phase. Plumes reach as far north as Cleveland Point; however, turbidity levels are very low (less than 10 NTU above ambient levels) outside of the immediate Project footprint. Other key outcomes from the modelling include:

- During the dredge campaigns most of the increases to turbidity are confined to the Fison Channel. There are likely to be some minor increases in turbidity to the north of the channel, over seagrass and unvegetated sand/mud and in mangroves to the south of the ferry terminal.
- Increases in sediment deposition are largely confined to the entrance channel. In the first dredging campaign sediment is also likely to be deposited:
    - slightly to the north of the channel, over seagrass and unvegetated sand/mud; and
    - a small increase in the deposition rate leading to a build-up of sediment (2 to 3 mm) during the dredging campaign in an area to the north-east of the project, over unvegetated sand/mud, seagrass, macro-algae and hard corals.
- Increases in deposition rates are lower in the second dredging campaign than in the first dredging campaign. In the second dredging campaign there were some brief increases in deposition rates over the seagrass and algae on sand close to the channel area being dredged.
- In the context of existing regularly high turbidity in the vicinity of the proposed works, changes to the concentration of turbidity and sedimentation due to dredging are likely to be brief (in the order of days), short

term (in that they are predicted to only increase during the dredging activity) and will not result in increases significantly greater than existing conditions.

It is of note that dredge plume and sedimentation modelling assumed no use of silt curtains to provide an indication of the 'worst case' impacts. Silt curtains will be used whenever conditions and dredge location allow, therefore actual impacts are expected to be significantly less than shown in the modelling.

1.5.2 Impacts to Critical Components

Potential impacts to critical components of the MBRS present at Toondah Harbour include direct loss of wetland habitat from dredging and reclamation works, disturbance of protected marine fauna during construction and ongoing operations (e.g. from boat strike or elevated noise), and disturbance of threatened and migratory shorebird species (due to noise, light, increased human activity). Indirect impacts may also have an effect on critical components including turbidity and sedimentation impacting on habitat outside of the Project footprint.

1.5.2.1 Wetland Habitat

There will be a direct loss of wetland habitat within the MBRS due to the Project, comprising:

- 2.5 ha of mangroves;
- 34.8 ha of seagrass, including 10 ha in the Fison Channel; and
- 7.5 ha of unvegetated sandbanks and mudflats, excluding 16.2 ha in the Fison Channel which will be retained as unvegetated mud/sand post dredging.

Some seagrass is likely to regrow in the Fison Channel once dredging has been completed, as it did after the maintenance dredging event in 2019.

The areas of clearing represent 0.03% of mangroves, 0.15% of seagrass and 0.18% of unvegetated sand/mud in the MBRS.

The mix of mangrove habitat fringing mudflats and sandbanks containing some seagrasses found at Toondah Harbour is not unique in Western Moreton Bay or the Redlands Coast. Within the Zone of Influence there are approximately 19.8 km of similar habitat mix. The Project would result in the removal of less than 0.5 km of this habitat mix, or about 2.5%. A significant area of this habitat mix is also present in the northern reaches of the MBRS, north of the Redcliffe peninsula and within Pumicestone Passage.

1.5.2.2 Threatened Marine Fauna

Five threatened marine fauna species use the area and are likely to be impacted by the proposed works: loggerhead turtles, green turtles, hawksbill turtles, dugongs and Australian humpback dolphins. While dugong and marine turtles feed on seagrass, the Project footprint does not contain significant habitat for them, with population densities far higher on the Eastern Banks of Moreton Bay. While Australian humpback dolphins are found throughout Moreton Bay, Toondah Harbour is not part of their core habitat. Consequently, the direct loss of 34.8 ha of seagrass in the MBRS is unlikely to have a significant impact on threatened marine fauna species. It is noted that approximately 10 ha of the seagrass lost will be removed as a result of the expansion of Fison Channel. Seagrass has recolonised the existing dredge area within two years of maintenance dredging events and therefore would also be expected to regrow in the future channel.

There is a risk that fish, turtles, dugongs and dolphins may be trapped within the reclamation areas as they are bunded off. However, this risk will be considerably reduced by:

- Installing barriers at low tide;
- Capturing fish and crabs and releasing them outside the area;

- Using trained marine megafauna spotters and removalists to ensure no megafauna are trapped within the bunded areas; and
- Using mechanical noise and boat activity to deter marine mammals from entering areas.

While the Project is not expected to result in the generation of significant additional boat traffic in the vicinity of Toondah Harbour or in the broader MBRS (refer to Section 3.1), there is a risk that a small increase in boating activity in the area may result in more collisions with threatened marine species. During dredging operations this will be mitigated through a comprehensive management plan that includes fauna spotters, restrictions on vessel movement when marine megafauna are sighted, vessel exclusion zones around megafauna, and adherence to speed limits.

In the longer-term educational signage, explicitly stating the risk to wildlife of travelling too fast, and establishing go slow areas in the shallow waters surrounding the Project footprint will mitigate risk of vessel strike in the Project's operational phase. Sea-life friendly propellers are commercially available, and their use will be encouraged under the management plan for marina operations.

Other potential risks, such as disturbance of ASS, spills of hydrocarbon and other contaminants, introduction and spread of pest species and increased litter, are relatively low and can be reduced through appropriate site management.

1.5.2.3 Threatened and Migratory Shorebirds

Loss of Feeding Habitat

Dredging and reclamation within the Project footprint will result in a permanent direct impact on 25.6 ha of tidal flat habitat within the MBRS that provides feeding habitat for migratory shorebird species. While the loss of habitat will adversely affect feeding habitat and area of occupancy for a number of species including the critically endangered eastern curlew and vulnerable bar-tailed godwit, it corresponds to only 0.29 % of the approximately 10,000 ha of tidal flat habitat within Moreton Bay or 0.6% of the approximately 4,681 ha of habitat in the MBRS. As noted previously this area also represents less than 1% of unvegetated mud/sand within the Zone of Influence, which would make up most of the feeding habitat within this area.

A key question in the assessment of the impact of the loss of a small area of tidal flat feeding habitat on threatened and migratory shorebird species is the extent to which migratory shorebird numbers in Moreton Bay are currently regulated by local density-dependent factors, such as food availability, that set a ceiling on the carrying capacity. If Moreton Bay was currently operating at carrying capacity, then the loss of an area of feeding habitat would be predicted to result in a reduction in the numbers of migratory shorebirds in direct proportion to the area of habitat lost. The birds displaced from the lost habitat would move into the remaining habitat creating competition for limited food resources with birds already using that habitat, eventually resulting in a loss of birds from the area due to density-dependent factors. Alternatively, if Moreton Bay is not at carrying capacity, the displaced birds would move to other feeding habitat with little disturbance to shorebirds already using those areas as there would be sufficient resources to avoid competition. While there is little published data that specifically tests this prediction, the studies outlined below suggest feeding habitat has significant remaining carrying capacity within Moreton Bay.

Several migratory shorebird species are known to have suffered severe population declines across the flyway population, including within Moreton Bay, due to factors operating outside of Australia. This is expected to have reduced their feeding densities in suitable feeding habitat across Moreton Bay to the point where their current populations are well below the original carrying capacity of Moreton Bay. Thompson (1990) conducted a single survey on 10 February 1990 of all migratory shorebirds foraging along the mainland coastline from Eprapah Creek to Redland Bay. This survey area incorporated the same length of mainland coastline from Point O'Halloran to Redland Bay that has been surveyed during the EIS surveys, and an additional 38 ha of tidal flats between Eprapah Creek and Point O'Halloran and between the boat ramp and ferry terminal at Victoria Point. A comparison between the survey results of Thompson (1990) and the EIS

survey 30 years later (refer to Section 8.2.7.6), shows there has been a substantial reduction in the density of eastern curlew in particular foraging in this area, from a density of 6.2 birds per 10 ha 30 years ago to an average density of 1.7 birds per 10 ha today. The overall feeding density for all declining species has similarly decreased from an observed density of 26.2 birds per 10 ha 30 years ago to an average density of 9.7 birds per 10 ha currently, whereas the overall feeding density for all species that have not declined showed little change (17.8 birds per 10 ha 30 years ago versus an average of 17.2 birds per 10 ha currently). The extent of foraging habitat has remained unchanged over this period.

A further consideration when assessing the risk of impact is the relatively low numbers of threatened shorebird species that utilise feeding habitat at Toondah Harbour. Eastern curlews are observed regularly on the mudflat feeding areas in low numbers (average of 3.5 and maximum of 5 individual birds) which is approximately 0.3% of the average number seen in Moreton Bay between 1978 and 2006 (1,299) and 0.02% of the estimated EAAF population of 35,000.

Bar-tailed godwits are also observed consistently using foraging habitat at Toondah Harbour in low numbers (average of 10 and maximum of 19 birds). This is approximately 0.15% of the average number seen in Moreton Bay between 1978 and 2006 (6,018) and 0.005% of the estimated EAAF population of 325,000.

Disturbance from Recreational Activities

Some Project construction activities (dredging, reclamation sheet piling and installation of the rockwall breakwater) are proposed to be undertaken at distances of 50 m to 130 m from the closest edges of the Cassim Island and Nandeebie Claypan roost sites, which is within the flight initiation distances for some shorebird species. However, the critically endangered species eastern curlew does not roost at Cassim Island and has not been observed at Nandeebie Claypan for several years. Similarly, the vulnerable bar-tailed godwit has only been observed in small number at Cassim Island and has not been observed at Nandeebie Claypan for several years. Construction activities will be short term and implemented during periods when the majority of migratory birds are not roosting within Moreton Bay (i.e. March to November).

No dwellings or retail areas will be located within 200 m of the roost site however, the completed development will house an estimated 5,700 to 5,800 new residents, which is expected to increase public use of the existing public walkway/cycleway alongside Nandeebie Claypan and Oyster Point Park recreational facilities. It is noted that no migratory shorebirds have been observed at the Nandeebie Claypan for several years and the roosting site is considered to be abandoned due to mangrove encroachment. Consequently, there is potential for the Project to increase the risk of disturbance to shorebird species using the Oyster Point roost site. However, migratory shorebirds are expected to habituate to some repetitive activities over time since they will be non-lethal. The potential for disturbance will be further minimised through careful placement of designated walking tracks, use of exclusion fencing and educational signage and materials.

Noise Disturbance

Without mitigation, noise from Project activities has the potential to disturb shorebird species using the Cassim Island and Nandeebie Claypan roost sites. High noise generating activities will only occur during construction periods and will be short term and carried out during periods when the majority of migratory birds are not roosting within Moreton Bay (i.e. March to November), minimising risk of impacts to these species.

Light Disturbance

The lighting strategy proposed for the Project will minimise light spill to the receiving environment to less than 1 lux (refer to Chapter 13). Consequently, there is low potential for Project lighting to have impacts on migratory shorebird use of roosting and feeding habitats adjacent to the Project footprint.

The Project is not predicted to have significant residual impacts on migratory shorebirds using roost sites adjacent to the Project footprint.

1.5.3 Impacts to Critical Biological Processes and Services

Impacts to the critical services and biological processes provided by the MBRS include direct impacts from the loss of wetland habitats. There is minimal risk of change from indirect impacts given critical components are unlikely to be impacted by changes in the physical and biogeochemical processes.

1.5.3.1 Recreational and Commercial Fisheries

Recreational fishing is the dominant activity within Moreton Bay, which is also the most important commercial fishing region in the state by volume and value of fish per unit area. Indigenous fisheries are important for the Traditional Custodians, the Quandamooka People. A variety of limited entry commercial fisheries are licenced to operate within Moreton Bay. The potential impacts of any coastal development on fisheries includes two main considerations:

- Potential impacts to access by fishers; and
- Loss or modification of habitats that may alter populations of fished species.

Through discussion with representatives of peak commercial fishing bodies, it was identified that the eastern and northern side of Cassim Island is utilised by commercial tunnel net fishers and there is some utilisation by commercial blue swimmer crab fishers of the area. The area is not utilised by commercial otter trawl fishers. There is some boat-based access by recreational fishers around Cassim Island and some land-based access at GJ Walter Park but neither of these two locations are identified as important locations for recreational fishing activities.

The Project will result in the removal of up to 34.8 ha of seagrass and 2.5 ha of mangroves, some coral rubble and shallow unvegetated habitats from the MBRS. Partly in place of this habitat will be artificial habitats including rock walls and marina infrastructure such as pontoons and deeper unvegetated habitat. Impacts during construction on areas adjacent to the Project footprint will be minimised or eliminated through standard procedures. Rock walls can be engineered to enhance them as fisheries habitat, while still remaining fit for purpose, as well as incorporating small patches of oyster reef which was one of the dominant habitats in western Moreton Bay at the time of European arrival. The loss of seagrass habitat is expected to have local impacts on the abundance of some fished species that utilise this habitat in preference to other types, including garfishes and tiger prawns. It is highly unlikely that these localised impacts will have impacts on these species at the population level or on their overall spatial distribution within Moreton Bay. Other fished species such as yellowfin bream adapt readily to artificial habitats and can become abundant in them.

The Project will result in the closure of the current public boat ramp at Emmett Drive, which is underutilised. Within the Project footprint a launching point for non-powered vessels (e.g., kayaks and dinghies) will be constructed, with associated parking. The Proponent has agreed to make a financial contribution to the upgrade of the William Street boat ramp at Cleveland Point to compensate for the reduced access for motorboats as a result of the closure of the Emmett Drive boat ramp. Compared to current arrangements, the Project will improve opportunity and amenity for land based recreational fishers along the eastern foreshore of the Project.

In summary, the three main potential impacts on fisheries from the Project are:

- Construction-related impacts on habitats that can be effectively managed using standard procedures;
- Minor loss of fishing access which, for the recreational fishing sector will be addressed by enhanced facilities and amenities, and for the commercial sector through further discussion and offsets; and
- Loss of habitat, which will not impact all harvested species equally and does not represent a risk to the populations of fished species.

1.5.3.2 Indigenous Cultural Heritage

Six locations within the Toondah Harbour PDA were identified as being of risk to Aboriginal cultural heritage (i.e. having the potential to contain further sub-surface cultural heritage). Two areas of 'high risk' were identified along the foreshore/intertidal resource zone where Aboriginal cultural heritage exists. Four areas of 'moderate risk' were identified in the least disturbed portions of the PDA and the intertidal resource zone that offers pedestrian access to Cassim Island. The remainder of the cultural heritage study area has been assessed as being of 'low risk' for Aboriginal cultural heritage. Importantly, even where areas are identified as 'low risk', the Proponent's cultural heritage duty of care remains.

The Project will address potential impacts to Indigenous heritage by implementing the following recommendations from QYAC:

- Registration of identified cultural heritage sites on the Queensland Government's Aboriginal and Torres Strait Islander Cultural Heritage Database and Register (in progress); and
- Negotiation of a cultural heritage management plan (CHMP) under the ACH Act, which will detail the procedures and protocols to avoid harm to Aboriginal cultural heritage.

The Project will also interpret Aboriginal cultural heritage through the incorporation, in consultation with QYAC, of educational signage, place naming, wayfinding and public art in open space areas and providing a mainland location for delivery of cultural and nature-based tourism activities.

1.5.3.3 Tourism and Recreation

The Project will improve existing facilities and access to Moreton Bay and Minjerribah (North Stradbroke Island) from the mainland, increasing the contribution of this service to the character of the MBRS.

The revitalisation of Toondah Harbour will support the economic transition of Minjerribah from sand mining towards a sustainable cultural and nature-based tourism-based economy and provide an enhanced gateway to the broader natural attractions of Moreton Bay. The delivery of a dedicated tourism precinct at Toondah Harbour is a key action in RCC's Tourism Strategy and Action Plan.

The proposed new ferry precinct will replace the existing dilapidated, industrial facilities. The master plan for the proposed development includes:

- Three roll on/roll off vessel berths (same number as the existing facility);
- Vehicle queuing areas;
- Two passenger ferry berths;
- Integrated ticket and tourist information centre;
- 1,010 public ferry car parks with capacity for RCC to provide a further 500 car parks in a multi deck structure if demand warrants it;
- Public plaza;
- Bus-ferry interchange;
- Marine services building; and
- Opportunity for charter boat berthing to facilitate new tourism operations.

The Project will improve community access to the foreshore and Moreton Bay by delivering new public open space and community amenities. These include:

- A new 3.5 ha foreshore parkland providing open space, water park, artificial beach and landside opportunities for recreational fishing;
- Marine recreational facilities including a ramp for non-motorised vessels (kayaks, canoes, etc.), trailer parking and other amenities;

- A public pontoon;
- An education centre, which will operate as a focal point for promoting environmental awareness and culture and nature-based tourism experiences;
- A range of boardwalks, plazas, and neighbourhood parks integrated throughout the development; and
- Minor embellishments to GJ Walter Park, the existing public park, which will be retained. Importantly, there will be no net loss of green space in GJ Walter Park.

The Project will contribute to realising the potential for Minjerribah and Moreton Bay to become great Australian tourism assets by enhancing and future proof the regional gateway to Minjerribah and Moreton Bay with modern, safe port facilities and a vibrant mainland destination, including hotel and conference facilities, that will grow visitation to Cleveland and the Redlands Coast.

Economic analysis found the additional tourism expenditure to be facilitated by the Project is estimated to result in the following beneficial impacts:

- For Minjerribah, the following increases by 2030:
    - $152 million in additional gross output;
    - $83 million in added Gross Regional Product;
    - Additional employment of 357 FTEs; and
- For the rest of the Redland City LGA (i.e., Toondah Harbour and other locations), the following total impacts, based on projected increased in tourist visitations and expenditure from 2026 to 2041:
    - $440 million in additional gross output;
    - Additional employment of up to 135 FTEs.

The Project provides a tourism gateway to the southern Moreton Bay and the establishment of a tourism precinct on the mainland at Toondah Harbour. The key characteristics of the Project that are expected to attract visitors to the region are:

- A comprehensive, well-connected tourism offering with high amenity, that offers good access to Brisbane and destinations in SEQ. The tourism-based harbour, coastal open space, hotel and conference facilities, recreational marina and retail and dining precinct represent an attractive proposition to a range of tourist types, including holiday makers, people visiting friends and relatives, cultural and eco-tourists, and organisers of corporate events and private functions.
- The provision of a mainland base for cultural and eco-tourism operators providing services throughout southern Moreton Bay, including Minjerribah, which will create a new market for day-trippers seeking to access ecotourism services on the mainland and in southern Moreton Bay.
- An offering that complements the other major tourism projects throughout the region, including the Queen's Wharf Development, the Brisbane Airport Parallel Runway, and International Cruise Terminal at the Port of Brisbane. These developments are focused on increasing Brisbane's profile as an international tourist destination, in particular targeting high-growth Asian markets.

The beneficial impacts outlined above are particularly significant given the importance of facilitating the growth of a sustainable eco-cultural tourism industry for southern Moreton Bay following the cessation of sand mining on Minjerribah in 2019 and the limited alternative drivers of employment growth in the Redland City LGA. These are also important outcomes for SEQ, which is in a significant 'region shaping' period afforded by the staging and legacy of the 2032 Brisbane Olympic and Paralympic Games and the announcement of the SEQ City Deal to be delivered by 2042.

1.5.3.4 Climate regulation and primary productivity

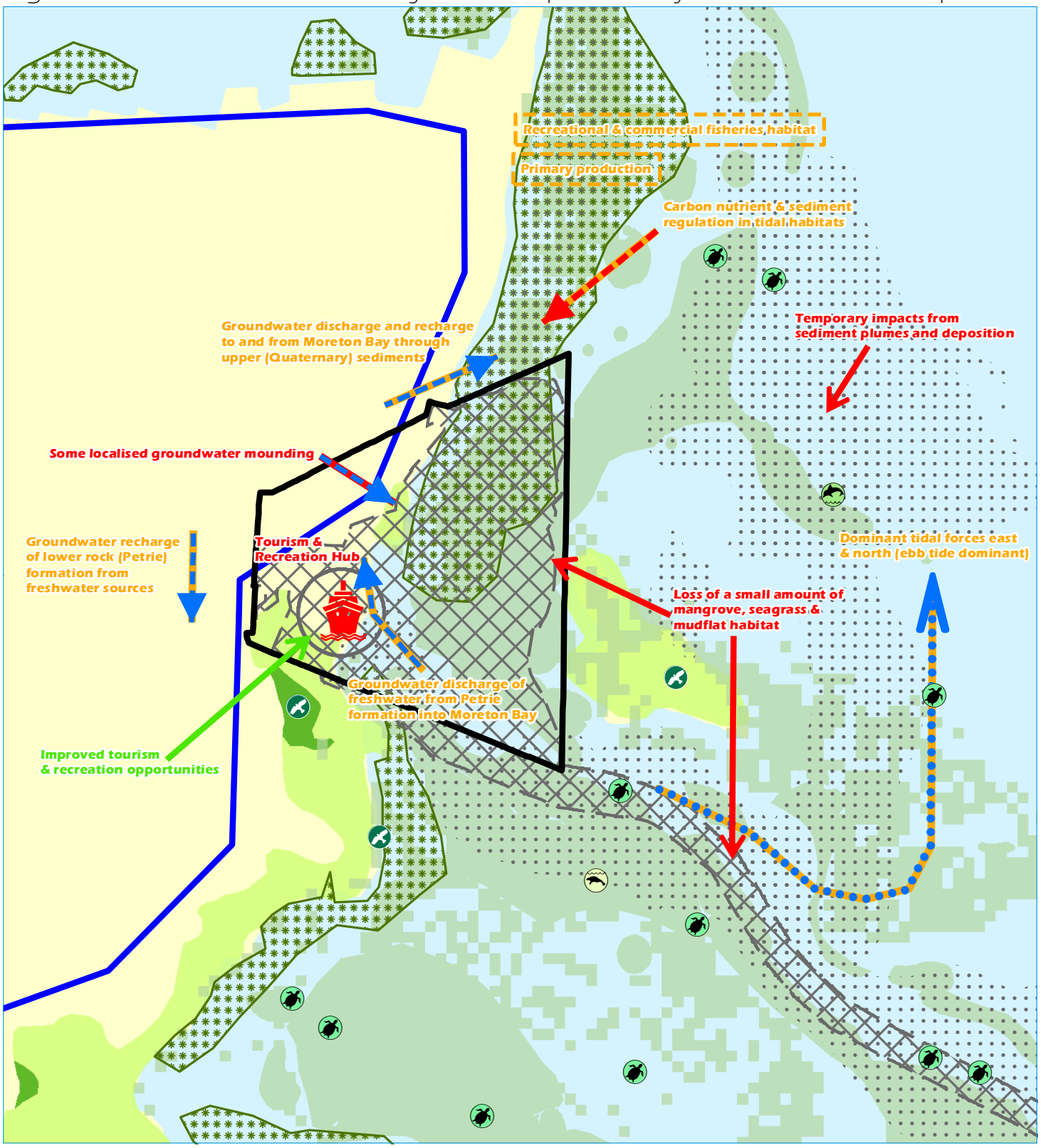
Potential impacts to climate regulation and primary production are difficult to quantify. Key drivers of these processes at the Project footprint-scale are wetland habitats, including seagrass and mangroves. Given the proportionally small area of seagrass and mangroves being impacted by the Project (0.2% of seagrasses and 0.03% of mangroves in Moreton Bay) impacts to these services and processes are considered to be negligible.

1.5.4 Summary of Potential Impacts

As the Project is unlikely to have any significant impact on critical services and components outside of its footprint, impacts to services will only occur at the site level. Impacts to recreational and commercial fisheries are expected to be minor and will not impact on broader fisheries in Moreton Bay. The Project is expected to improve access and the existing facilities at Toondah Harbour for recreational fishers. The Proponent will work with QYAC, as the registered cultural heritage body for the area, to identify, protect and manage the Aboriginal cultural heritage values of Toondah Harbour under a cultural heritage management plan (CHMP) for the Project. Indigenous heritage will also be highlighted through cultural heritage interpretation and awareness raising, land and sea country management activities and opportunities for cultural and nature-based tourism to be provided out of the education centre. The Project will dramatically improve the existing tourism and recreational services Toondah Harbour provides to the MBRS and will add significantly to the Redlands' economy.

Impacts from the Project on the critical components, processes and services of the MBRS are represented visually in Figure 8. Impacts are shown at the Project-footprint scale as no impacts are predicted to occur to the broader Zone of Influence.

Figure 7: : Toondah Harbour Project Conceptual Ecosystem Interactions Impacts



Toondah Harbour EIS

Legend

- Toondah Harbour PDA (Project Area)
- MBRS Zone of Influence
- Land/Sea

Impacts

- Project area (loss of some seagrass & mudflats)
- Sediment plumes (temporary impact)

Processes

- Groundwater processes
- Coastal processes

Services

- Tourism & Recreation Hub
- Carbon nutrient & sediment regulation

Components

- Mangrove
- Saltmarsh
- Mud Flat / Shorebird feeding habitat
- Seagrass
- Dugong
- Humpback dolphins
- Turtle sp.
- Shorebird hightide roosting habitat

N

0 200 400 600 m

GDA 1994 MGA zone 56 Scale (A4):1:15,000

TOONDAH HARBOUR walker

Layer Source: State of Queensland Datasets (© State of Queensland 2022), Aerial (© Nearmap 2020), Fauna records (© State of Queensland 2020) DATE 29/06/2022 FILE REF. 9858 E Figure 27 7 Ecosystem Impacts Toondah Habour Concept A

1.6. Potential for Change in Ecological Character or Significant Impact to the Ramsar MNES

To determine if significant impacts to the ecological character of the MBRS are likely, two levels of assessment have been carried out:

- Review of the impacts against the critical components, processes and services represented within the Project footprint and Zone of Influence and assess the contribution to the ecological character of the MBRS (refer to Table 3); and
- Assessing the impacts against the EPBC Act significant impact criteria for wetlands of international importance.

Based on the findings of this assessment, an analysis of the potential for the Project to change the ecological character of the MBRS or result in an impact on the Ramsar wetlands of international importance MNES has been carried out and the results summarised in Table 9.

The Project will result in the loss of wetland habitat including mangroves, saltmarsh, seagrass and unvegetated mud/sand. The area of wetland habitat being lost is relatively small and are well under 1% of comparative habitats in the MBRS.

Potential for impacts outside of the Project footprint, including on adjacent high tide roost sites, is considered to be minimal with any minor impacts expected to be short term (e.g. construction noise) or activities that shorebirds will habituate to over time (e.g. increased pedestrian use of foreshore public open space and walking/cycle paths). The potential for disturbance will be further minimised through careful placement of designated walking tracks, use of exclusion fencing and educational signage.

As the Project is unlikely to have any significant impact on critical components and processes outside of its footprint, impacts to services will only occur at the local scale. Impacts to these services are expected to be minor and the Project will provide a range of benefits in the context of sustainable development to balance these minor impacts including:

- Creation of approximately 1.5 km of rockwall that will be designed to provide fish habitat and roosting habitat for a number of migratory bird species, including grey-tailed tattler, ruddy turnstone and terek sandpiper.
- Marine structures such as dolphins and jetties will provide habitat for fish species.
- Creation of oyster reefs within the Project footprint will provide further habitat for fisheries species.
- Stormwater treatment will reduce nutrient loads released into Moreton Bay during storm events given that the existing harbour currently has no treatment measures.
- The upgrade of the ferry terminal, turning basin and Fison Channel, and the provision of an education centre as well as a visitor information centre, will add significantly to the recreational, tourism and educational values of Moreton Bay, both of which are considered critical services of the MBRS.
- The interpretation and awareness raising of Aboriginal cultural heritage values through signage, public art and opportunities for land and sea country management and cultural and nature-based tourism activities will promote the Indigenous cultural heritage of Moreton Bay, which is considered a critical service of the MBRS.
- A 3.5 ha foreshore park including an education centre, providing for a range of recreational activities and community engagement with Moreton Bay.

Accordingly, a change in ecological character of the MBRS as defined by the Ramsar Convention will not result from the Toondah Harbour Project. While impacts will be localised and not result in a change to the ecological character of the MBRS, a small area of the wetland (less than 0.02%) will be substantially modified resulting in a significant impact to a wetland of international significance under the EPBC Act.

While the Project is considered likely to have a significant impact as defined by the EPBC Act, avoidance and management measures will ensure impacts are contained to the Project footprint. The habitats impacted are not considered to provide significant or unique values in comparison to other similar areas with the MBRS.

Unavoidable residual impacts to wetland habitats within the MBRS resulting from the Project are:

- 2.5 ha of mangroves;
- 24.8 ha of seagrass, excluding 10 ha in the Fison Channel which are likely to recolonise; and
- 7.5 ha of unvegetated intertidal sandbanks and mudflats.

These residual impacts will be offset through the implementation of a fund that will deliver $4.75 million of beneficial projects in the Redland LGA and broader MBRS providing an overall benefit to migratory birds and wetland habitats in the MBRS. The offsets strategy is outlined in Chapter 29 of the draft EIS.

Table 9: Potential for Project Impacts to Result in a Change in Ecological Character of the MBRS or Significant Impact on MNES.

EPBC Act Sig Impact Criteria	Summary of Impacts to Critical Components, Processes and Services	Potential for change in Ecological Character	Potential for significant impacts on MNES
Areas of wetland being destroyed or substantially modified	▪ The Project will result in a small area of the MBRS being substantially modified through reclamation the area impacted represents less than 0.02% of the entire 120,000+ ha of the MBRS. ▪ Most of the critical processes, components and services that contribute to the ecological character of the MBRS provide only a minor contribution at the Project footprint scale. ▪ While the Project will have a direct impact on wetland habitat, the area of impact is very small when viewed in the context of the whole MBRS and even the Zone of Influence, which encompasses a large portion of south western Moreton Bay. ▪ The habitats present are not considered to be core or of high value to any threatened marine fauna species. ▪ While the Project footprint provides feeding habitat for a small number of threatened and migratory shorebird species, recent studies have shown Moreton Bay contains an abundance of feeding habitat available for shorebirds. ▪ Indirect impacts to adjacent high tide roost sites will be avoided through implementation of a range management measures. ▪ The Project's environmental offsets strategy outlined in Chapter 29 will provide an overall benefit to migratory birds and wetland habitats in the MBRS.	While a small area of the Ramsar site will be substantially modified as a result of the Project, these areas do not provide a major contribution to the ecological character of the wetland therefore no change is likely.	Likely – the project will result in a small area of the MBRS being substantially modified.
A substantial and measurable change in the hydrological regime of the wetland	▪ The Project footprint was assessed as providing a minor contribution to the regulation of coastal processes for the MBRS. ▪ Detailed modelling identified impacts to coastal processes are expected to be highly localised around the Project footprint with even minor changes unlikely outside of the immediate area. ▪ Changes are not expected to have any impact on nearby features such as Cassim Island.	Unlikely	Unlikely
Habitat or lifecycle of native species being seriously affected	▪ The Project footprint was assessed as having a minor contribution to threatened marine fauna, minor contribution to threatened and migratory bird feeding habitat and a major contribution to threatened and migratory bird roosting habitat. ▪ Five threatened marine fauna species are known to use habitats within and surrounding the footprint: loggerhead turtles, green turtles, hawksbill turtles, dugongs and Australian humpback dolphins.	Unlikely	Unlikely

EPBC Act Sig Impact Criteria	Summary of Impacts to Critical Components, Processes and Services	Potential for change in Ecological Character	Potential for significant impacts on MNES
	▪ While dugong and marine turtles feed on seagrass, the Project footprint does not contain significant of high value habitat for them, with population densities far higher on the Eastern Banks of Moreton Bay. ▪ Australian humpback dolphins are found throughout Moreton Bay, Toondah Harbour is not part of their core habitat. ▪ Dredging and reclamation to accommodate the Project footprint will result in a permanent direct impact on 25.6 ha of tidal flat habitat within the MBRS that provides feeding habitat for migratory shorebird species. This corresponds to only 0.18% of the approximately 4,681 ha of habitat in the MBRS. ▪ Potential for impacts outside of the Project footprint, including on adjacent high tide roost sites, is considered to be minimal. Any minor impacts are expected to be short term (e.g. construction noise) or activities that shorebirds will habituate to over time (e.g. increased pedestrian use of foreshore).		
A substantial and measurable change in the availability or functioning of a critical process, component or service	Change to critical components, processes or services that contribute to the ecological character of the MBRS within the Project footprint and the larger Zone of Influence have been assessed within this chapter. All impacts are considered to be minor.	Unlikely	Unlikely
Permanent or long term substantial and measurable change in the water quality of the wetland	Receiving water quality modelling was carried out to assess potential impacts to water quality at the Project footprint and whole-of-Moreton Bay scales. The outcomes of the modelling indicate that: ▪ The marina and internal waterways within the Project are likely to be well flushed, and it is unlikely phytoplankton blooms or eutrophication will occur within these waterways. ▪ While there may be slight increases in the concentration of total nitrogen and phosphorous in the marina and internal waterways, these increases are very small compared to current concentrations. ▪ In wet weather conditions, a reduction in the concentration of total suspended solids, total nitrogen and total nutrients in the intertidal area southwest of the ferry terminal is likely due to an increase in the proportion of treated stormwater flows. Dredge plume modelling was also carried out and indicates that dredging-related turbidity and deposition rate impacts are relatively small compared to the natural variation in the	Unlikely	Unlikely

EPBC Act Sig Impact Criteria	Summary of Impacts to Critical Components, Processes and Services	Potential for change in Ecological Character	Potential for significant impacts on MNES
	ambient turbidity and impacts are limited to the areas in close proximity to the Project footprint.		
Establishment of invasive species	Marine pests are introduced invasive, non-native plants and animals that damage the health of the native marine environment. They often reproduce quickly, in large numbers and can spread rapidly. Once established, they are difficult to eradicate and can kill or out-compete native plants and animals for space and food. Marine pests can be introduced via ballast water and hull fouling. While this risk is predominantly from vessels that have been in international waters, there is also a risk of boats spreading pests established in other ports. At Toondah Harbour, the risk from the introduction of marine pests is low, where appropriate management measures are taken.	Unlikely	Unlikely

Comparison of predicted impacts to critical processes, components and services against the Draft MBRS ECD LACs is also provided in Table 10. The Draft ECD did not include LACs for all critical services, therefore the assessment has been carried out where relevant.

While the LACs in the Draft ECD are considered interim, it is a useful comparison for considering potential for changes in ecological character. The interim LACs in the MBRS Draft ECD were benchmarked against finalised ECDs for other Ramsar sites in Australia, including:

- The Draft Great Sandy Strait Ramsar site (GCCRS) published in 2009;
- Lake Gore Ramsar site (LGRS) published in 2009; and
- The Macquarie Marshes Ramsar site (MMRS) published in 2012.

The benchmarking exercise found the LACS for the MBRS were generally in accordance with acceptable change criteria applied at other Ramsar sites.

Table 10: Comparison of Project Impacts to the MBRS ECD Limits of Acceptable Change.

Critical Service	Interim LAC – Draft MBRS ECD	Comparison of Toondah Harbour Project Impacts
Contains a diversity of wetland habitat types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity between habitat types. **Contains several critical wetland habitat types**	At a local scale, >10% change in habitat extent, relative to natural background variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to the key species, communities or habitat identified in the critical services. No measurable medium term (>5 years) change to hydraulic, wave and/or sedimentation patterns at spatial scales measured in km or greater above background. A change in frequency, duration and magnitude of tidal inundation Such that it results in >10% change (above background) in the extent of unvegetated habitat between MHW and MSL, MSL and MLW and MLW and LAT	None of the key wetland representative areas identified by the Draft MBRS ECD were present in the site or Zone of Influence. Critical wetland habitat types were identified on site including seagrass, mangroves, saltmarsh and unvegetated mud/sand. Areas impacted represent less than 1% of the habitat type within Moreton Bay. They also represent less than 1% of those habitat types within the Zone of Influence aside from seagrass, which was 1.6% of the habitat type within the Zone of Influence. Importantly, these areas were not considered core habitat for any protected species and loss of habitat is not expected to impact on protected flora or fauna. Modelling found that changes to tidal hydraulic, wave and/or sedimentation patterns will be highly localised to the Project area and will not have any impact on the broader MBRS.
Site supports an assemblage of vulnerable or endangered marine/aquatic fauna **Supports an assemblage of vulnerable or endangered wetland dependant terrestrial fauna species** **Supports an assemblage of vulnerable or endangered wetland flora species and endangered and of concern wetland regional ecosystems**	Detectable decline in local abundance/ population of threatened, endangered or critically endangered species.	While the site provides habitat for several threatened marine fauna species including Dugong, Green turtles, Hawksbill turtles and Australian Humpback Dolphins, it is not considered to be core of high value habitat for any of these species and is unlikely to have any impact on any of these populations. The Project area provides feeding habitat for a number of shorebirds with the critically endangered Eastern Curlew and vulnerable Bar-tailed Godwit visiting the site in very low numbers (less than 0.3% and 0.15% respectively of known populations in Moreton Bay). A number of recent studies suggest Moreton Bay contains significant carrying capacity for feeding habitat and any individuals displaced by the Project would likely move to other areas of feeding habitat and are unlikely to be lost from the area. Both threatened shorebird species utilise the adjacent Nandeebie Claypan shorebird roost site, although counts have substantially declined in recent years. The Project has been designed and management measures will be put in place to avoid impacts on this area that would disturb shorebird use.

Critical Service	Interim LAC – Draft MBRS ECD	Comparison of Toondah Harbour Project Impacts
Supports significant populations (more than 20,000 in total and over 1% of the population size) of shorebirds	That the total number of waterbirds at the site always exceeds 20,000 individuals. Greater than 10% reduction over a 10-year period of numbers of Bar-tailed Godwit, Eastern Curlew, or Pacific Golden Plover which are surrogates for assessing shorebird abundance generally	The loss of a comparatively small area of feeding habitat within the Project footprint is not expected to result in any reduction in overall numbers of waterbirds utilising the MBRS. Dredging and reclamation to accommodate the Project footprint will result in a permanent direct impact on 25.6 ha of tidal flat habitat that provides feeding habitat for migratory shorebird species. While the loss of habitat will adversely affect feeding habitat and area of occupancy for a number of species including critically endangered Eastern Curlew and vulnerable Bar-tailed Godwit, it only corresponds to 0.29 % of the approximately 10,000 ha of tidal flat habitat within Moreton Bay or 0.6% of the approximately 4,681 ha of habitat in the MBRS. In the extremely unlikely event of all shorebirds utilising feeding habitat at Toondah Harbour being lost to the MBRS the reduction would be relatively insignificant when compared to the 35,000 birds that annually utilise Moreton Bay. Bar-tailed Godwit and Eastern Curlew both utilise feeding habitat at Toondah Harbour, however have only been observed in low numbers. Moreton Bay also contains significant feeding habitat carrying capacity for individuals that are displaced.
	Greater than 20% reduction in any three-year period over five years for any of the eight migratory shorebird species which exceed the 1% threshold.	See above responses
The tidal fish habitats and fish and invertebrate populations of the MBRS support valuable recreational and commercial fishing activities	A long-term loss of fish/shellfish stocks, which results in the reduction in the sustainability of key Bay fisheries, should be considered a trigger for assessing potential changes to ecological character.	The assessment of commercial and recreational fisheries found the Project will not result in any significant impacts to fish species of commercial or recreational importance.
	At a local scale, >10% change in habitat extent, relative to natural background variability, such that it results in measurable impacts at sub-km spatial scales, and causes measurable, medium-term (>2 to 5 years) flow-on effects to key species, life stages, communities or habitat at this Spatial scale. In assessing this interim LAC, attention should be given to assessing changes in the extent of mangroves, saltmarsh, seagrass and tidal flat environments.	See above responses

Attachment 1

Ramsar Assessment Methodology (Adaptive Strategies

Method for assessing impacts on the ecological character of a Ramsar Wetland – Moreton Bay Ramsar Site

Prepared by: Tom Kaveney, Adaptive Strategies Pty Ltd.

January 2021, version 11

BASIS FOR METHOD

This paper presents a method for identifying and assessing impacts on the ecological character of the Moreton Bay Ramsar Site.

The method is adapted from a previously accepted approach developed for the Great Barrier Reef World Heritage Area (Adaptive Strategies 2016). While there are differences in the listing criteria and assessment of environmental and cultural values between the two international conventions, there are also similarities in terms of scale, ecological process and protection.

The previous method was used to identify the contribution to Outstanding Universal value (OUV) at a local scale to inform impact assessments and port master planning in the Great Barrier Reef Region. The method was initially developed and applied to understand the relevant OUV attributes of the GBRWHA at the Port of Abbot Point for the purposes of a cumulative impact assessment of proposed port expansion (ELA and Open Lines 2013). This work was informed by contributions from eminent environmental scientists and world heritage experts, in particular:

- *Associate Professor Peter Valentine (James Cook University)*
- *Professor Peter Harrison (Southern Cross University)*
- *Emeritus Professor Peter Saenger (Southern Cross University)*
- *Dr Peter Driscoll (consulting scientist).*

Due to a lack of clear guidance from the Federal Government on identifying and assessing impacts for large area wetlands with diverse ecological values, processes and human interactions, such as the Moreton Bay Ramsar Site, a similar approach is considered appropriate. Where World Heritage Areas focus on protection of its OUV, as part of the Ramsar Convention, contracting parties are expected to manage Ramsar sites to maintain the ecological character of each site, remain informed of any changes to the ecological character of Ramsar sites and notify the Ramsar Secretariat of any changes or likely change at the earliest opportunity.

The objective of this paper is to provide a method to:

- *identify the critical services, components and processes that contribute to the ecological character of the Moreton Bay Ramsar Site;*
- *identify the presence or absence of these critical services, components and processes at the local scale of the proposed development; and*
- *assess the potential for the development to impact on these critical services, components and processes, and therefore the ecological character of the Ramsar Site.*

EIS GUIDELINES

The Department of Agriculture, Water and the Environment have, as part of the assessment under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), issued a set of guidelines for an Environmental Impact Statement (EIS) for the Toondah Harbour redevelopment. These guidelines form an integral part of the assessment process and under the Act the Minister must be satisfied that the EIS has fulfilled the requirements set out in the guidelines.

The EIS Guidelines state that:

- *The EIS should enable interested stakeholders and the Minister to understand the environmental consequences of the proposed development.* [1]
- *Information provided in the EIS should be objective, clear, and succinct.*
- *The level of analysis and detail in the EIS should reflect the level of significance of the expected impacts on the environment.*
- *Any and all unknown variables or assumptions made in the assessment must be clearly stated and discussed, and*
- *The extent to which the limitations, if any, of available information may influence the conclusions of the environmental assessment should be discussed.*

More specifically, in relation to the assessment of impacts on the ecological character of a Ramsar listed wetland, the role of the proponent in analysing impacts on the ecological character of a Ramsar Site are:

- *To adequately describe in a substantive manner all aspects of the proposed development that may impact on the ecological character. This includes aspects associated with construction and ongoing operation and those facilitated by the proposed development.*
- *To quantify, where possible, the extent and importance of those impacts on the particular components, processes and services that make up the ecological character.*
- *Describe the mitigation measures that allows a robust and defensible decision to be made on their efficacy.*
- *Describe the extent and importance of residual impacts (if any).*

This assessment method is designed to meet the requirements of the EIS guidelines and provide an understandable and robust analysis of actual or potential impacts to the Moreton Bay Ramsar Site.

1. INTRODUCTION AND RATIONALE

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides protection for matters of national environmental significance (MNES). These include nationally threatened species and ecological communities, migratory species and wetlands of international importance (amongst other things). Under the EPBC Act, any activities that may have a significant impact on a MNES should be referred to the Australian Government Minister for the Environment and Energy for assessment and approval.

Wetlands of international importance are those wetlands nominated and listed under the ***Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971.*** This convention is also known as the 'Ramsar Convention on Wetlands' using the protocol of naming international agreements after the city in which it was first formulated. The convention was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975. In line with this nomenclature, wetlands listed under the Convention are referred to as Ramsar wetlands.

In Australia there are currently 65 wetlands listed under the Ramsar Convention.

The Convention uses a broad definition of wetlands. It includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs and salt pans.

Under the Convention signatory countries commit to:

- work towards the wise use of all their wetlands
- designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and maintain their ecological character through effective management
- cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

In Australia management of Ramsar listed wetlands falls primarily with the relevant state or territory government. The Ramsar Convention requires the development of a Ramsar Information Sheet (RIS), to

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[1] Significant stakeholder engagement has been carried out for the EIS including community focus groups on coastal processes, marine ecology and koalas and multiple open community sessions. The Draft EIS will also need to go through the legislated public notification process.

accompany the nomination of a site to the List of Wetlands, and is to be updated at least every six years or more frequently if there are significant changes in the site's ecological character. In addition to the RIS the convention encourages the development of key documents once a site has been listed to assist in the management and increase awareness about the wetland, these documents include:

- an Ecological Character Description which describes the ecological character of a Ramsar Site
- Management Plans, which are used to formulate and implement planning to promote the wise use and conservation of listed wetlands.

In addition, a number of guidelines and documents have been published to assist in the management and wise use of Ramsar listed wetlands. The following publications are of particular relevance:

- Ramsar Convention Handbook 1 - Wise use of wetlands: Concepts and approaches for the wise use of wetlands.
- Ramsar Convention Handbook 13 - Inventory, assessment, and monitoring
- Ramsar Convention Handbook 16 - Impact assessment: Guidelines on biodiversity-inclusive environmental impact assessment and strategic environmental assessment.
- Ramsar Convention Handbook 19 - Addressing change in wetland ecological character: Addressing change in the ecological character of Ramsar Sites and other wetlands.
- Ramsar Conference of the Parties 11 Resolution XI.9 - An integrated framework and guidelines for avoiding, mitigating and compensating for wetland loss.
- A Framework for assessing the vulnerability of wetlands to climate change

EPBC ACT – MATTER OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

In addition to jurisdictional management and protection, Ramsar wetlands are protected under the Commonwealth's EPBC Act.

There are currently nine MNES protected under the EPBC Act these are:

- World Heritage properties
- National Heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a MNES require approval from the Australian Government Minister for the Environment. The Minister determines whether assessment and approval is required under the EPBC Act based on the referral by a proponent of a proposed action.

To assist proponents determine if their proposed action is likely to have a significant impact the Commonwealth Government has produced a series of guidelines on significant impacts. Most relevant for Ramsar wetlands are the *Significant Impact Guidelines 1.1 Matters of National Environmental Significance* (CoA 2013). These guidelines state that:

> *An action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:*
>
> - areas of the wetland being destroyed or substantially modified
> - a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland
> - the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected

- a substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
- an invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.

The 'ecological character' of a wetland is defined as the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time.

The EPBC Act assessment process conforms to the approach recommended by the Ramsar Convention when considering how particular developments may impact upon the wetland. It is important to note that under the EPBC Act significant impacts is a threshold for further assessment; it is not necessarily a threshold for refusal of a project.

Article 3.2 of the Ramsar Convention, for example, requires its Contracting Parties to "arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference". This implies a need to have the ability to anticipate and predict the effects of actions on wetland ecosystems, and, arguably, a need to go through a process of the kind typically embodied by EIA (Ramsar Convention Handbook 2010b).

In addition to the processes for impact assessment it should also be noted that the Ramsar Convention acknowledges the need to alter Ramsar wetland boundaries where there is an urgent national interest to do so. Article 2.5 of the Ramsar Convention states that "any Contracting Party shall have the right . . . because of its urgent national interests, to delete or restrict the boundaries of wetlands already included by it in the List". The process and arrangements for altering the boundary of a Ramsar wetland are not dealt with in this paper as it is not proposed as part of the Toondah Harbour Project. For further information on boundary adjustments of Ramsar Sites see:
https://www.ramsar.org/sites/default/files/documents/pdf/res/key_res_viii_20_e.pdf

Ramsar boundaries are also able to be amended where sites or parts of sites no longer meet the criteria for designation. This may occur where:

a) a Ramsar Site never met the Criteria for designation as a Wetland of International Importance;

b) part or all of a Ramsar Site unavoidably loses the services, components and processes for which it was included, or was included in error; or

c) a Ramsar Site at the time of listing met the criteria but, whilst its services, components and processes remain unchanged, it later fails to meet the Criteria because of a change in those Criteria or in the population estimates or parameters that underpin them.

Guidance on this process is provided in the Annex to Ramsar Conference of the Parties to the Convention on Wetlands Resolution IX.6 Guidance for addressing Ramsar Sites or parts of Sites that no longer meet the Criteria for designation. See:

https://www.ramsar.org/sites/default/files/documents/pdf/res/key_res_ix_06_e.pdf

2. RAMSAR GUIDELINES FOR AVOIDING, MITIGATING AND COMPENSATING FOR WETLAND LOSSES

Through the 11th meeting of the Conference of the Parties to the Convention on Wetlands Resolution XI.9 outlined an integrated framework and guidelines for avoiding, mitigating and compensating for wetland losses. The resolution notes that "*wetland losses are occurring despite the provisions of the Ramsar Convention on Wetlands and the existence of wetland protection laws and practices in many countries that require that adverse wetland impacts be avoided, and where this is not possible, mitigated or compensated by offsets such as wetland restoration*".

The resolution goes on to note a three-step approach to be undertaken in response to current or likely changes to the ecological character of wetlands, whether or not such wetlands are included in the Ramsar List:

a) avoiding impacts (e.g., systematic assessment of projected negative changes to ecological character of potentially impacted wetlands through strategic planning to systematically identify potential areas for conservation);

b) mitigating on-site for unavoidable impacts (e.g., through minimizing project impacts and restoring area after the project); and

c) compensating for, or offsetting, any remaining impacts (e.g., off-site restoration)

It is recognised that many contracting parties have adopted similar approaches in national laws and policies and that the intent of the framework is to provide advice to the contracting parties to assist in their application of these concepts in the management of potential impacts to wetlands within their territories. The framework should be implemented in the context of Article 3.1 of the Convention, which requires parties formulate and implement their planning to promote the conservation of Ramsar, and as far as possible, the wise use of wetlands in their territory. The present definition of wise use of wetlands is:

"the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development."

The framework goes on to set out an approach for avoiding, mitigating and compensating for wetland losses. The flow chart provided in Figure 1 and taken directly from the guideline provides a conceptual outline of the framework. The framework refers to avoiding impacts on the ecological character of the wetland. As previously noted ecological character is defined as the combination of the ecosystem components, processes and benefits/services that characterise the wetland at a given point in time.

Australia implements avoid, mitigate, offset environment assessment frameworks at a national level through the EPBC Act and EPBC Environmental Offsets Policy.

AVOIDANCE

The guidelines recognise that in some instance's avoidance may be difficult or impossible to achieve unless a decision is taken to abandon a proposal and therefore a risk-based approach to assessing impacts could be used to assist in deciding the appropriate response. As such a framework may be supplemented by undertaking a systematic process to identify and map priority areas for conservation, especially at catchment and river basin levels, in order to promote a more strategic approach to avoidance, mitigation and compensation. This concept is appropriate for the Moreton Bay Ramsar Site, which has a large geographical extent and diverse range of ecosystem components, processes, benefits and services spread heterogeneously throughout the site. Emphasis is placed on avoiding impacts on the ecological character of the wetlands.

MITIGATION

Where a risk-based evaluation has indicated that a project can proceed, but that a change in the ecological character is likely, and the risk associated with this is considered acceptable, then appropriate proactive mitigation should be undertaken. Where mitigation is possible, maximum consideration must be given to outcomes that are self-sustaining and maintain the ecological character of the wetland. In some scenarios it may not be possible to fully mitigate impacts on a wetland and, consequently, residual impacts may remain. Attempts should be made to ensure that the temporal extent, magnitude and scale of any residual impacts are minimized. Where residual impacts exist appropriate compensation measures should be provided.

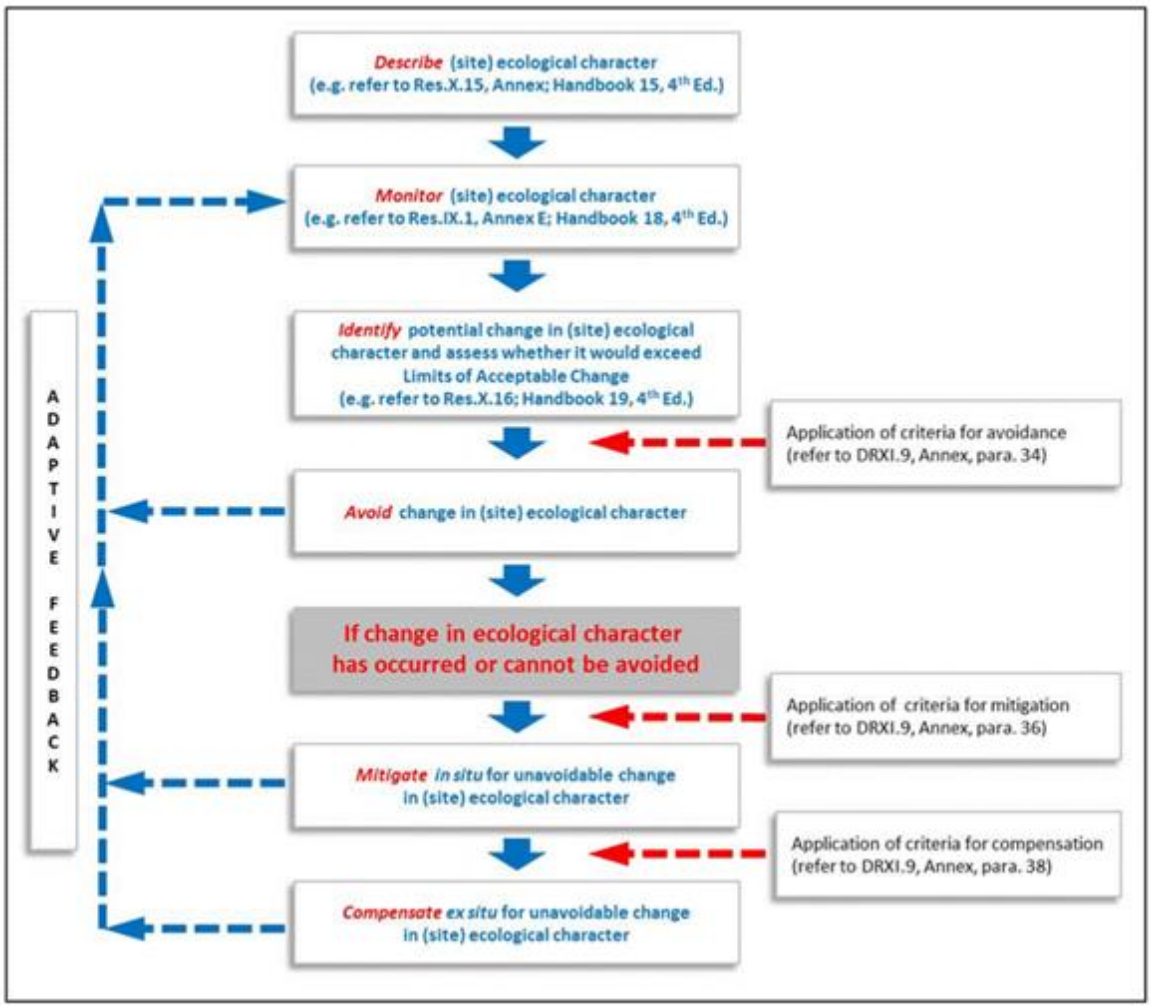

Figure 1: Conceptual framework for avoiding, mitigating and compensating for wetland losses (source: An integrated framework and guidelines for avoiding, mitigating and compensating for wetland losses - Resolution XI.9, 2012)

COMPENSATION

The guidelines set out a list of considerations for compensating impacts on a wetland, which are outlined below.

- Is the compensation type-for-type? The change of ecological character of one type of wetland should be compensated as appropriate, by the protection, enhancement, restoration or creation of a similar wetland type.
- Is the compensation function-for-function, component-for-component, or area-for-area? The residual change in ecological character may result in a loss of area and/or a loss of function or loss of provision of ecosystem services. The compensation provided should address the areal extent, significant ecosystem components, and the functional performance of the wetland. Therefore, it is necessary to understand the range of ecosystem services provided by the wetland, its physical size, and the type of biodiversity a wetland supports prior to developing compensatory habitat.
- Where should compensation be located? The location of any compensatory wetland habitat is important. Ideally it should be in close proximity to the impacted wetland and within the same hydrological catchment or coastal zone. Where compensation measures require habitat restoration or creation, the existing ecological character of the proposed restoration or creation site needs to be assessed to ensure that a) other existing important wetland values and services are not damaged, and b) other non-wetland impacts are not generated.

- How can compensation be achieved? Compensation may be achieved through the restoration, enhancement, and/or creation of wetlands. The compensation measures must address cumulative impacts on both area and function and promote integrity and resilience through a detailed scientific understanding of risks and uncertainties. The timing of implementing compensatory measures is important. Compensation must be established in advance of, or at least in consideration of, the timing of the proposed impacts. The monitoring of any compensatory measures needs to be undertaken to evaluate whether the residual impact to the ecological character has been adequately compensated, or whether further compensation provision proves to be necessary.
- How can long-term compensation be implemented? The security of any long-term success will depend on appropriate stewardship and resourcing. When considering compensation, the ability to ensure that the necessary technical, financial, management and legislative capabilities will exist into the future needs to be considered with sufficient care and consideration.
- Are the costs and risks associated with effective compensation considered too high? A risk-based approach may consider the full cost of compensation, including both initial or capital costs and the long-term cost to secure the future ecological character of the area in perpetuity, to be prohibitive. Alternatively, because of ecosystem complexity, irreplaceability and/or scientific uncertainty the risk of failure to successfully compensate an adverse decision may be unacceptably high.

Further information is provided when specifically assessing compensation for impacts to the ecological character of a Ramsar Site. If irreversible negative ecological character changes have occurred or will occur as the result of activities on- or off-site, and the Ramsar Site is not amended, the Convention text does not expressly require compensation. Nevertheless, in such cases, Resolution IX.6 calls upon Contracting Parties to make "at least equivalent provision of compensation" when there is unavoidable loss of ecological character at a Ramsar Site.

While the guidelines address compensation associated with negative impacts on the ecological character of a Ramsar site, compensation may also be applied where impacts occur but do not result in a change in the ecological character. In an instance such as this a project may provide an overall benefit to the Ramsar site.

3. MORETON BAY RAMSAR SITE

Moreton Bay was declared an internationally significant Ramsar Site in 1993. The listing covers an area of 120,654 ha which includes a semi-enclosed bay bounded by Moreton and Stradbroke Islands: three of the largest natural sand islands in the world (Figure 2). The boundary of the site includes:

- Moreton Island and parts of North and South Stradbroke Islands, Bribie Island and the Southern Bay Islands;
- Pumicestone Passage;
- intertidal and subtidal areas of the western bay, southern bay and sandy channels of the Broadwater region;
- marine areas and sand banks within the central and northern bay; and
- areas of ocean beach habitats.

The site provides significant areas of wetland, seagrass, mangrove and saltmarsh habitat for shorebirds and marine species including turtles and dugong (CoA 1999).

In the case of the Moreton Bay Ramsar Site:

- The most recent version of the RIS was September 2019. The boundary of the Site was most recently updated in December 2018 adding several thousand hectares of tidal and intertidal areas to the Ramsar Site.
- a draft ecological character description was completed but has not been finalised - the latest draft is dated 2008. Information on the ecological character of the Site is also provided within the RIS. The RIS includes a detailed analysis of the site against the Ramsar listing criteria as well as a description of the biological and physical components, ecosystem services and ecological processes that form the ecological character of the site.
- no management plan is in place for the Ramsar Site. It is noted the Moreton Bay Marine Park Zoning Plan covers a similar spatial area as the Ramsar Site, however, this is not a management plan but provides guidance on use. Management plans exist for some areas within the site including Bribie Island, Moreton Island and South Stradbroke Island.

When listed the site was identified as meeting six of the nine Ramsar listing criteria. The latest version of the RIS has been updated to now show the site meeting all nine criteria. A summary of features within Moreton Bay that meet the listing criteria is included in Table 1.

Table 1: Summary of Moreton Bay Characteristics Against Ramsar listing criteria

Criterion description	Moreton Bay features
Criterion 1: the wetland contains a representative, rare or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region	The Bay is one of the largest estuarine bays in Australia. The formation of large vegetated sand dunes on the eastern side of the Bay and river and creek flows entering the Bay to the west from the mainland have created a major wetland complex.
Criterion 2: the wetland supports vulnerable, endangered or critically endangered species or threatened ecological communities	The Bay supports threatened turtle species including the vulnerable green and hawksbill turtles and endangered loggerhead turtles. The area is particularly important for the critically endangered wintering eastern curlew. A number of threatened terrestrial flora and fauna are also present on the islands.
Criterion 3: the wetland supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region	The Bay has a high diversity of marine plant and animal species including: over 355 species of marine invertebrates; 40 species of shorebirds; 55 species of algae associated with mangroves; seven mangrove species and seven seagrass species. The intertidal habitats of the Bay support over 30 species of migratory shorebirds.
Criterion 4: the wetland supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions	The Bay is a significant feeding ground for green turtles. Dugongs also use the area as a feeding and breeding ground. The area provides significant feeding areas for loggerhead turtles. The species is also known to nest on the islands of the Bay.

Criterion description	Moreton Bay features
Criterion 5: the wetland regularly supports 20,000 or more waterbirds	The Bay supports greater than 50,000 wintering and staging shorebirds during the non-breeding season.
Criterion 6: the wetland regularly supports 1% of the individuals in a population of one species or subspecies of waterbird	The Bay supports greater than 1% of the known flyway populations of the eastern curlew and the grey-tailed tattler.
Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/ or values and thereby contributes to global biological diversity.	The Moreton Bay Ramsar Site supports diverse fish fauna due to the wide variety of habitats within and adjacent to it, including mangroves, saltmarsh, seagrass, sand and mud flats, offshore channels, reef environments, estuarine creeks, freshwater lakes and streams. For fish in the waters of Moreton Bay, two interacting zones of diversity exist; an inshore estuarine-dominated system and an eastern marine- dominated system. Moreton Bay is also a meeting point for tropical northern and temperate southern faunas which, combined with the diversity of habitats, has resulted the high faunal diversity with approximately 750 fish species recorded in the Bay. In addition, there are at least 27 species of fish that are only known to occur in Moreton Bay.
Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	Documented fish feeding habitats in Moreton Bay include saltmarshes, mangroves, intertidal flats, seagrasses as well as coral and rocky reefs. This includes tidal marshes feeding habitats for commercially important species including whiting, mullet and the giant mud crab. Moreton Bay mangroves and seagrasses also provide refuge from predators and; together with saltmarshes, function as nursery habitats for juvenile fish.
Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland dependent non-avian animal species.	The site provides or is likely to provide habitat for >1% of the population of the following wetland dependent non-avian species: • A number of acid frogs including Wallum froglet (*Crinia tinnula*), Cooloola sedgefrog (*Litoria cooloolensis*), Wallum sedgefrog (*Litoria olongburensis*) and Wallum rocketfrog (*Litoria freycineti*) • Dugong (Dugong dugon) • Oxleyan pygmy perch (Nannoperca oxleyana) • Water mouse (Xeromys myoides) • Illidge's ant blue butterfly (Acrodipsas illidgei) • Loggerhead turtle (Caretta caretta) • Green turtle (Chelonia mydas)

As of February 2020 a formal ecological character description for the Moreton Bay Ramsar Site has not been published.

The Queensland Government commissioned a report by BMT WBM (2008) on the ecological character of the Moreton Bay Ramsar Site. While not formalised, the report identifies the critical services, components and processes of the site and limits of acceptable change, knowledge gaps and monitoring requirements in relation to these critical elements. Accordingly, the Department of Agriculture, Water and Environment (DAWE) has recommended that this report along with the RIS, which contains descriptions of the site's ecological characteristics, as documents that should be used in assessing impacts.

The BMT WBM report provides a graphical depiction and conceptual model of the interactions of the critical services, components and processes of the Moreton Bay Ramsar Site. The flow charts are provided as **Figure 3** and **Figure 4.**

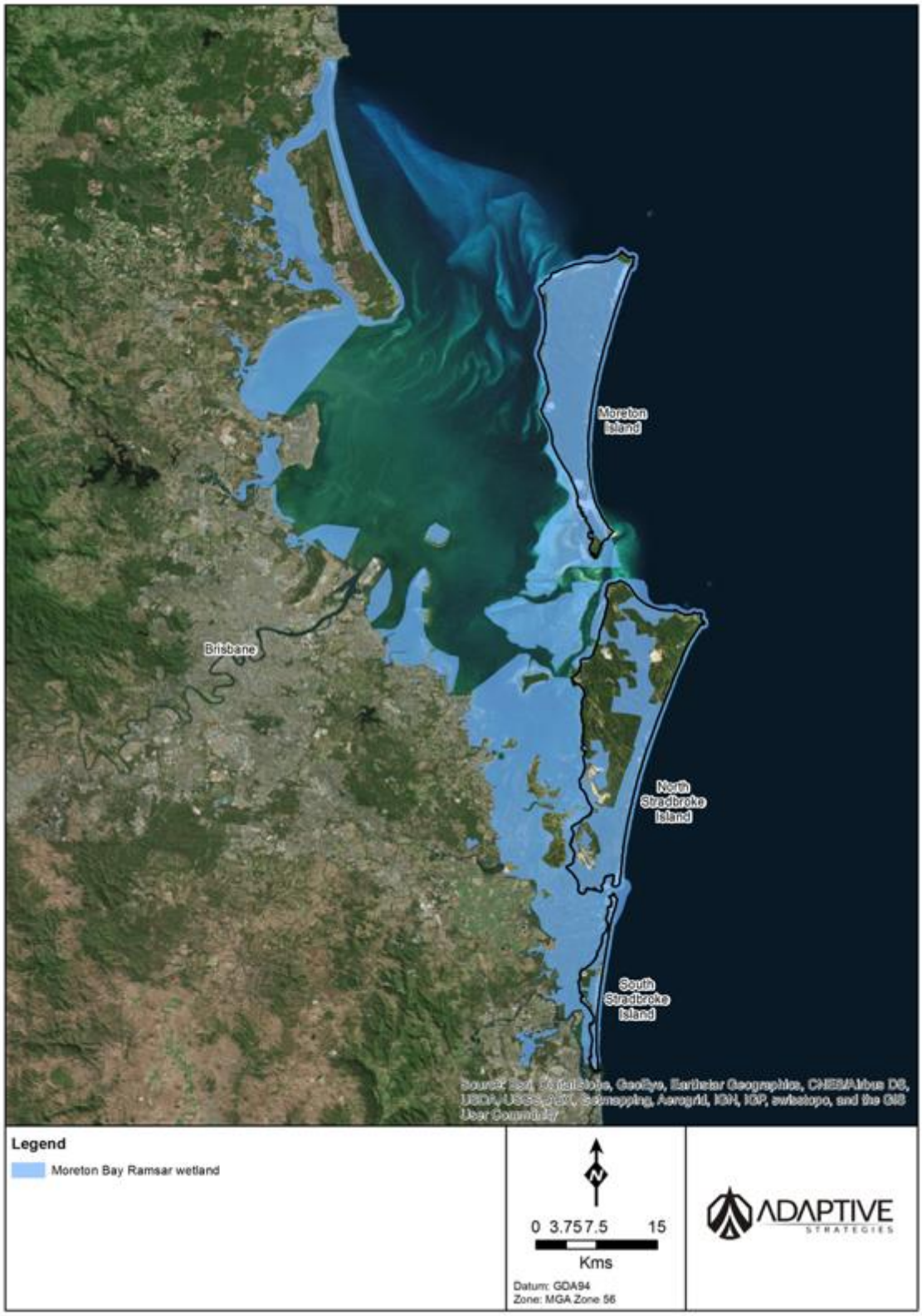

Figure 2: Moreton Bay Ramsar Site

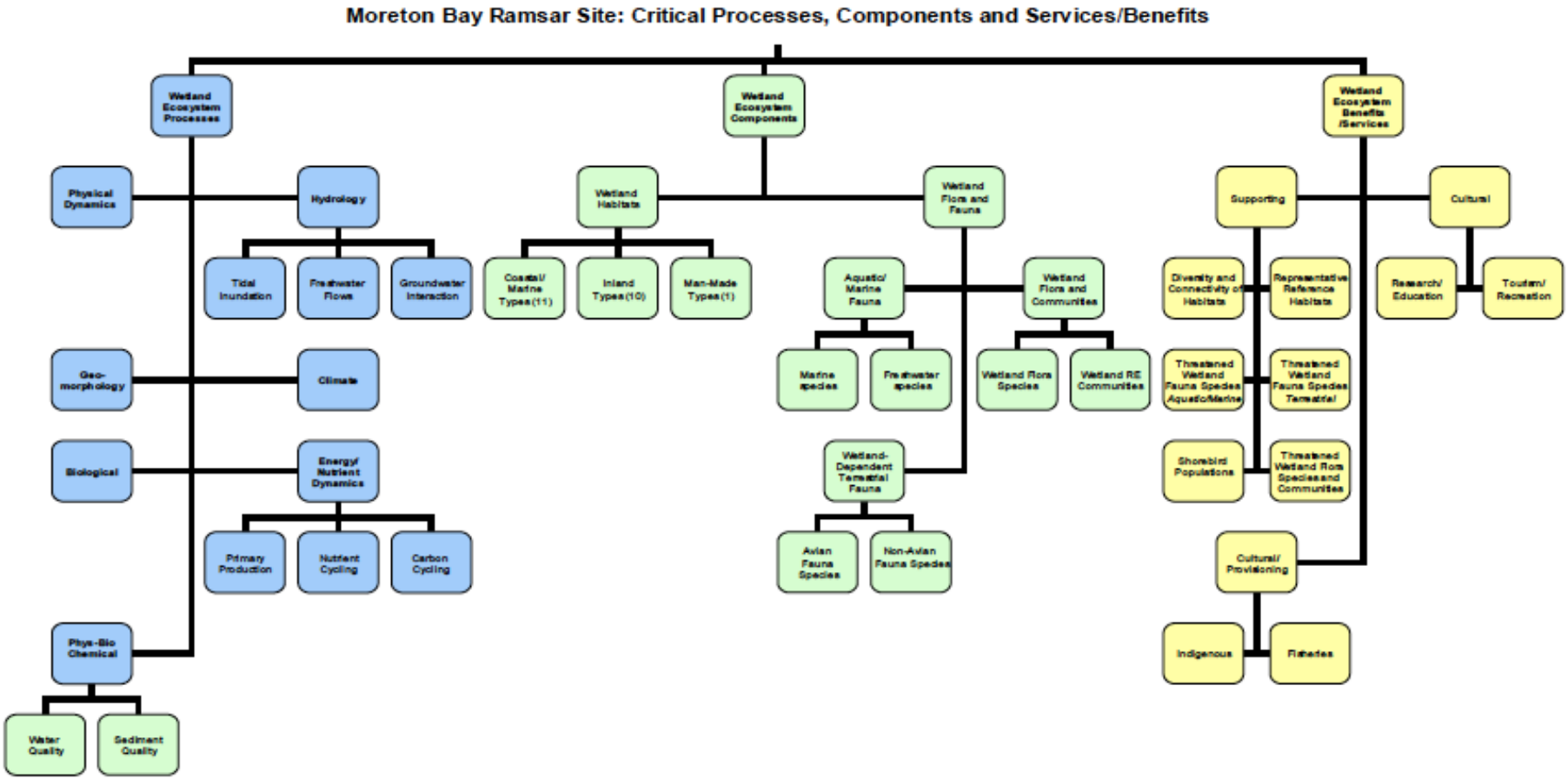

Figure 3: Graphical Depiction of the Critical Services, Components (BMT WBM 2008)

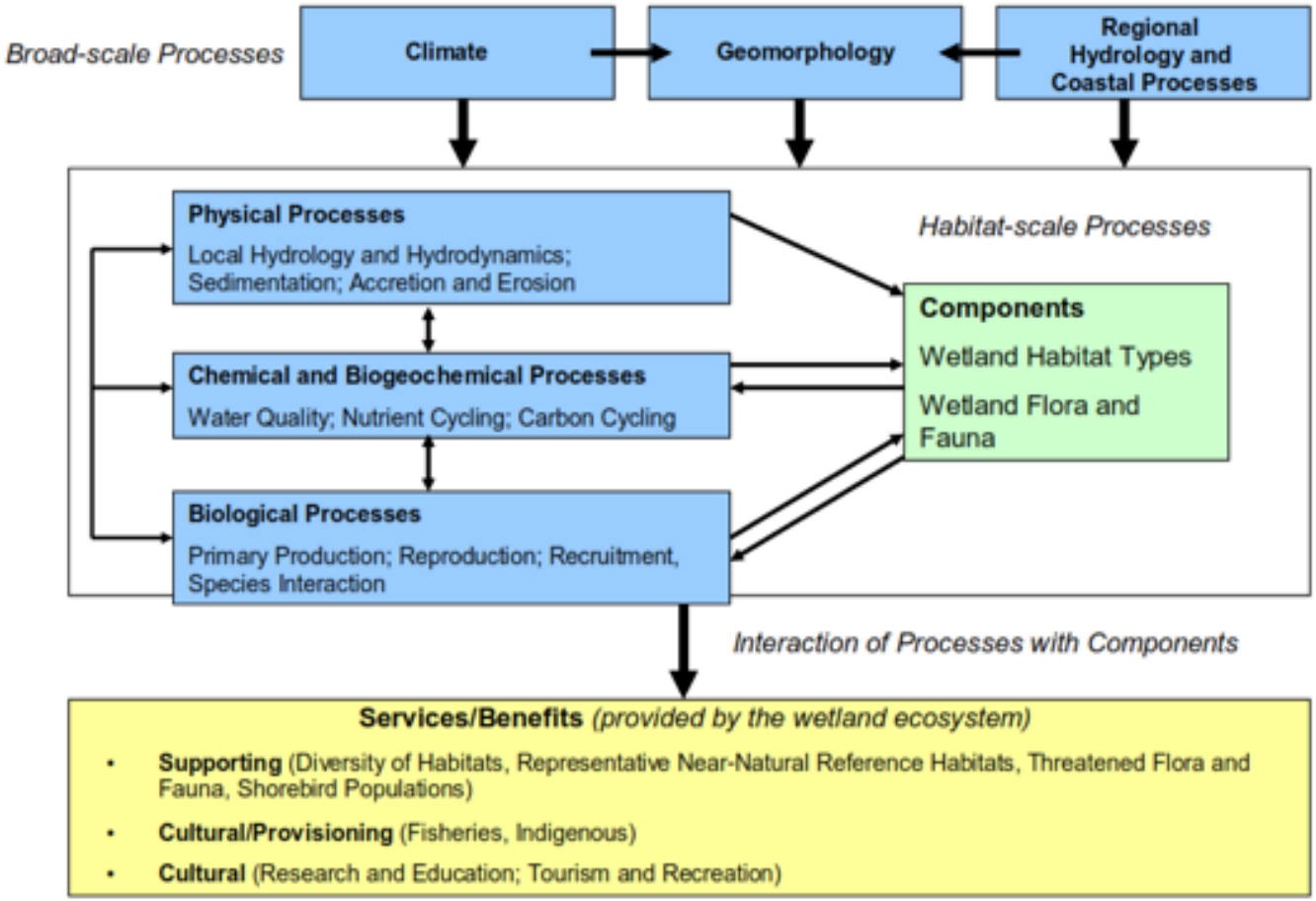

Figure 4: Processes and Conceptual Model of Interactions for the Moreton Bay Ramsar Site (BMT WBM 2008)

4. USING THIS METHOD

In addition to the framework and guidelines for avoiding, mitigating and compensating for wetland losses outlined in Resolution XI.9, Resolution VII.16 of the Convention calls upon the Contracting Parties to strengthen their efforts to ensure that any projects, plans, programmes and policies with the potential to alter the ecological character of wetlands in the Ramsar List, or impact negatively on other wetlands within their territories, will be subjected to rigorous impact assessment procedures, and it urges them to formalize such procedures with policy, legal, institutional and organizational arrangements. Moreover, the Resolution asks the Parties to ensure that impact assessment procedures seek to identify the true values of wetland ecosystems in terms of the many services, components and processes they provide and to include these environmental, economic and broader social values in decision-making and management processes (Ramsar Convention Handbook 2010b). The environmental assessment and approval processes contained in the EPBC Act fulfil this Ramsar Convention resolution and provide Australia with a robust means of assessing proposed projects and their implications on Ramsar Sites.

This method has been developed to evaluate impacts from a proposed project on the Moreton Bay Ramsar Site based on the context, scale and significance of the potential impacts on the ecological character of the site.

In doing this the method seeks to:

- identify the critical services, components and processes of the Moreton Bay Ramsar Site through a desktop analysis of available information;
- identify how the critical services, components and processes are represented at a project site level through site specific technical studies and consultation with the community and Industry bodies;
- conceptualise interactions between the critical services, components and processes at the project site level as well as how they link into the broader scale processes of the Moreton Bay Ramsar Site;
- Assess the contribution the critical services, components and processes present at the project site level provide to the overall ecological character of the Ramsar site; and
- provide a process for determining the significance of any impacts from a proposed activity on the ecological character of the Ramsar site.

The method should be applied with consideration of Commonwealth Government and Queensland Government legislation, and policies relevant to environmental protection, particularly to the relevant wetland, including::

- Commonwealth of Australia (CoA) 2013. Significant Impact Guidelines 1.1 Matters of National Environmental Significance.
- Commonwealth of Australia (CoA) 2015. EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species
- Commonwealth of Australia (CoA) 2015. Wildlife Conservation Plan for Migratory Shorebirds
- Department of the Environment, Water, Heritage and the Arts (2008). National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands. Module 2 of the National Guidelines for Ramsar Wetlands.
- Department of Environment and Energy (DoEE) 2018. Information Sheet on Ramsar Wetlands (RIS) Moreton Bay. Available at: http://www.environment.gov.au/water/topics/wetlands/database/pubs/41-ris.pdf
- Queensland Government 2017 Moreton Bay Ramsar internationally important wetland Internet page. Available at: https://wetlandinfo.ehp.qld.gov.au/wetlands/facts-maps/ramsar-wetland-moreton-bay/

Identifying the likelihood of significant impacts under the EPBC Act is a discretionary process that needs to be undertaken on a case-by-case basis. In the absence of a specific legislative definition of what constitutes a significant impact, the Government is guided by science, precedent and a small number of published guidelines when making a determination about significance.

This assessment has adopted a similar approach to that normally used under the EPBC Act. The following steps have been identified that will ensure a repeatable and consistent approach that is transparent and evidence based:

- All aspects of the development will be considered including construction (dredging, reclamation and civil/building works) through to operation, including associated activities that may produce indirect or facilitated impacts (for example Impacts from street and building lighting, boat traffic, etc).
- Identification of the critical processes, components or services at the site. The concept of 'zone of influence' can be applied to determine how large an area needs to be examined to identify relevant features. The 'zone of influence' varies depending on the development type, the actions being undertaken during both the construction and operational phases and the process, component or service being assessed. In particular actions that produce noise, dust or suspended sediment plumes may extend beyond the project site boundary. The zone of influence should incorporate all areas with the potential to be impacted by any stage of the development.
- Evaluation of the contribution of each process, component or service to the ecological character of the Ramsar Site and how these interact to maintain the wetland
- Assessment of significance of potential impacts. This involves analysis to quantify potential impacts, review of the adequacy of survey data and other available environmental information, developing a detailed understanding of relative habitat values, reference to relevant EPBC Act guidelines and consideration of existing environmental management and monitoring.

In order to undertake the assessment, evidential information and data is needed on the development site, adjacent areas and the 120,000+ hectare Ramsar Site more broadly. Information may be obtained from a variety of sources, likely references include:

- Specific studies undertaken as part of the proposed development (surveys, mapping etc.).
- Studies and monitoring undertaken for nearby developments (environmental impact assessments, development approvals etc.)
- Government studies and local environmental plans
- Community environmental monitoring programs, bird counts, whale watching activities etc.
- Publicly available peer reviewed reports
- Consultation with local cultural heritage groups, community members and industry bodies

RELIABILITY OF INFORMATION

All information sources used for the Ramsar and project level site assessment will be evaluated for their validity, reliability and accuracy. A confidence level will be assigned to each information source based on the below scale:

- Very High confidence - the study or data used within the study is contemporary (completed in 2010 or later) and supported by robust evidence (i.e. on ground surveys carried out using published methods) and has strong agreement with the outcomes of published studies or data from other sources.
- High confidence - the study or data used within the study was completed prior to 2010 but is supported by robust evidence and/or has strong agreement with the outcomes of published studies and/or data from other sources.
- Moderate confidence - the study or data used within the study is supported by robust evidence and/or has strong agreement with the outcomes of published studies and/or data from other sources.
- Low confidence - the study or data used within the study is supported by limited evidence and/or has agreement with the outcomes of other moderate or low confidence information sources.

In general information sources with a low confidence will only be used if it is the only information available for a specific topic and further data cannot be obtained in a reasonable time frame.

5. METHOD FOR IDENTIFYING CRITICAL PROCESSES, COMPONENTS AND SERVICES AT THE RAMSAR SITE LEVEL

In Australia the *National Framework and Guidance for Describing the Ecological Character of Australia's Ramsar Wetlands* provides direction on how to identify a wetlands critical processes, component and services. The guidelines identify a number of categories for processes, components and services (Table 2) and recommends as many are identified as possible under these categories with critical ones selected using available information and expert advice.

Table 2: Categories of processes, components and services

component	Process	Benefits/Services
Physical form **Wetland soils** **Physicochemical water** **Biota**	Climate Geomorphology Hydrology Energy and nutrient dynamics Processes that maintain animal and plant populations Species interactions Physical processes	Provisioning services — products obtained from the ecosystem such as food, fuel and fresh water Regulating services — benefits obtained from the regulation of ecosystem processes such as climate regulation, water regulation and natural hazard regulation Cultural services — benefits people obtain through spiritual enrichment, recreation, education and aesthetics Supporting services — services necessary for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans or a direct benefit over a long period of time

The assignment of a given wetland process, component or service as critical is guided by the following considerations:

- It is important for supporting one or more of the Ramsar criteria under which the site was listed; or
- It is an important determinant of the uniqueness or representativeness of the site; or
- It is a component or process of high ecological value; or
- It may be subject to change that will cause potentially significant consequences (e.g. change the ecological character).

It is important to note that, in Australia, the protection of Ramsar Sites is the responsibility of the Federal Government. Management of the Moreton Bay site is the responsibility of the Queensland State Government. It would not be appropriate for individual project proponents to develop their own ecological character description for a Ramsar Site, in particular one with the spatial extents and complexity of the Moreton Bay site.

The draft Moreton Bay ecological character description and RIS are the two key information sources for a description of the ecological character of the Moreton Bay Ramsar Site. While this study is more than 10 years old no significant development or modifications have occurred within Moreton Bay and no notifications of any change to the ecological character have been published. Occasional updates to the RIS also have not indicated any change in ecological character, although it is noted that the Ramsar Site is now considered to meet Ramsar criterion 7 through 9. The absence of any published updates or notification of ecological change should not necessarily be taken to indicate that change has not occurred. Factors such as climate change, sea level rise, ongoing urban encroachment and impacts on migratory species in other parts of the world may all have had an effect on the wetlands character.

An initial review of the critical processes, components and services contributing to the ecological character of the wetland is included as Attachment 1. A graphical depiction of how the critical processes, components and services interact with regard to the project site is provided in Figure 5.

Figure 5: Graphical depiction of how the critical processes, components and services interact in the vicinity of Toondah Harbour

6. PROCESS FOR DETERMINING LOCAL CONTRIBUTIONS AND IMPACTS TO ECOLOGICAL CHARACTER

The process for determining the local representation and contribution of critical processes, components and services to the ecological character of the wetland is based around understanding which are present and how important they are within the context of the wider Ramsar Site. The process involves:

1. Identification of the critical processes, components and services that are represented within the project site and local area.
2. conceptualise interactions between the critical services, components and processes at the project site level as well as how they link into the broader scale processes of the Moreton Bay Ramsar Site.
3. Analysis of the 'importance' of the presence within the context of the Moreton Bay Ramsar Site.

In other words, "what" and "where" are critical processes, components and services located in the local area and "why" are they important to the ecological character of the Ramsar Site?

For the purposes of the method the 'local area' should at least encompass the area within the proposed developments 'zone of influence'. For Toondah Harbour areas of the Ramsar Site extending from Cleveland Point in the north to Point Halloran in the south and east to Peel Island is considered the local area. This will be further reviewed as technical studies progress to ensure all areas within the developments zone of influence are included.

Having identified locally present and contributing critical processes, components and services it is then possible to examine a specific action to determine if and at what scale the action will impact the ecological character of the Ramsar Site. Levels of impact will be based on the value and contribution of the process, component or service affected. Figure 6 provides an outline of the steps and process.

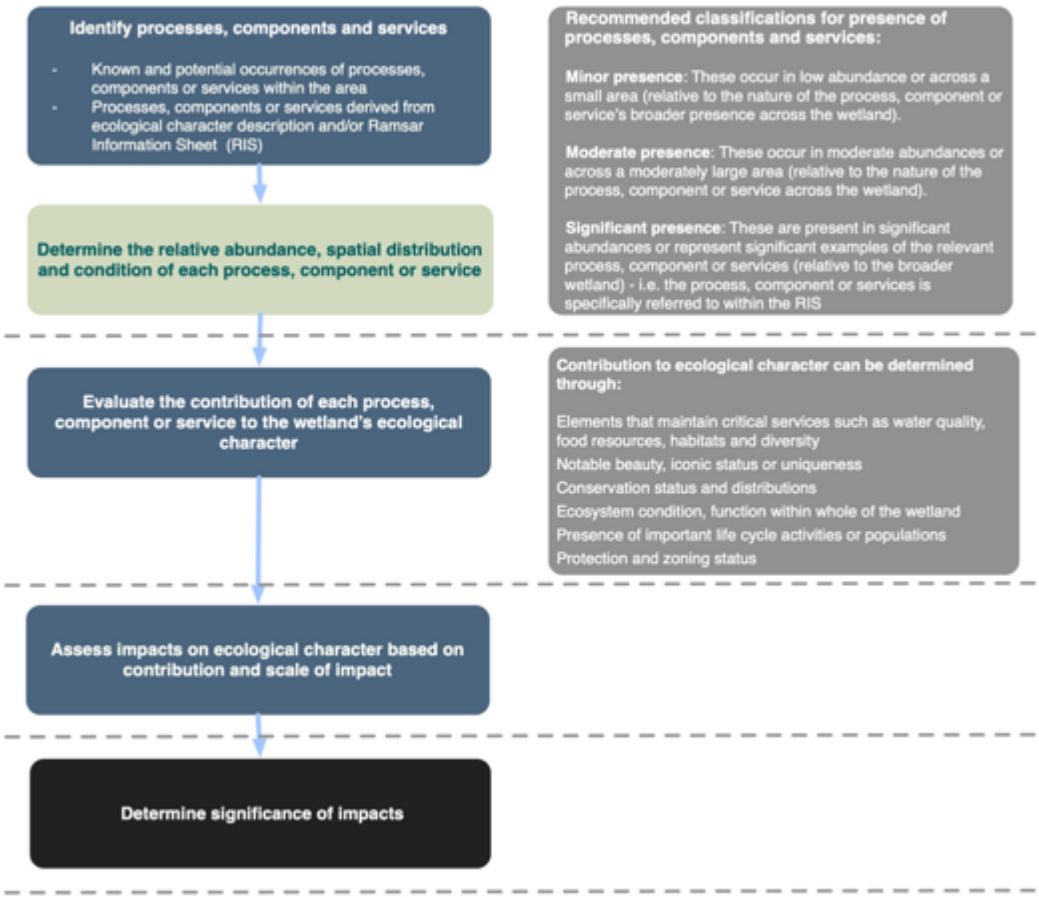

Figure 6: Process for determining local contribution to ecological character

IDENTIFICATION OF CRITICAL PROCESSES, COMPONENTS AND SERVICES IN THE LOCAL AREA

Most processes, components and services are made up of multiple elements, such as various landforms, seascapes and biological entities. A biological component or process may be made up of multiple species habitats, interactions and locations (e.g. a specific migratory bird species may use several locations within the Moreton Bay Ramsar for foraging but travel to a single location to roost at high tide and also utilise as a breeding area).

Identification of the critical processes, components and services that occur within the local area should be based on the best available information.

It may also be necessary to commission specific studies where gaps in information are identified to ensure that all critical components, processes and services are addressed, outlining the respective condition and contribution of those a processes, components and services.

Where site specific studies are commissioned, they should contain the following information at a minimum:

- A description of the methods utilised for the study including the use of any guidelines published by the Federal or State governments.
- Identification of the 'zone of influence' for the study. The zone should be based on the best available information and provide a conservative estimate of the spatial and temporal impacts.
- Description of the existing values at the project site and the zone of influence and its relationship to the critical processes, components and services for the Ramsar site.

The scope and outcomes of the study should facilitate the identification of any representation of critical processes, components and services at the local level.

CONCEPTUAL MODEL OF CRITICAL PROCESSES, COMPONENTS AND SERVICES IN THE LOCAL AREA

Once the local site conditions are understood this information should be used to develop a conceptual model (or series of conceptual models) of how the critical components, processes, and services are represented at the local level. The conceptual model should include:

- the relationships and dependencies between the components, processes and the representation of ecological character in the local area.
- threats to the critical components, processes, and services at the local scale as a result of the project.
- how, and in what ways, any changes to the critical components, processes, and services at the local scale may interact with the critical components, processes, and services for the wider Ramsar site.

An example conceptual model is provided in Figure 7 below.

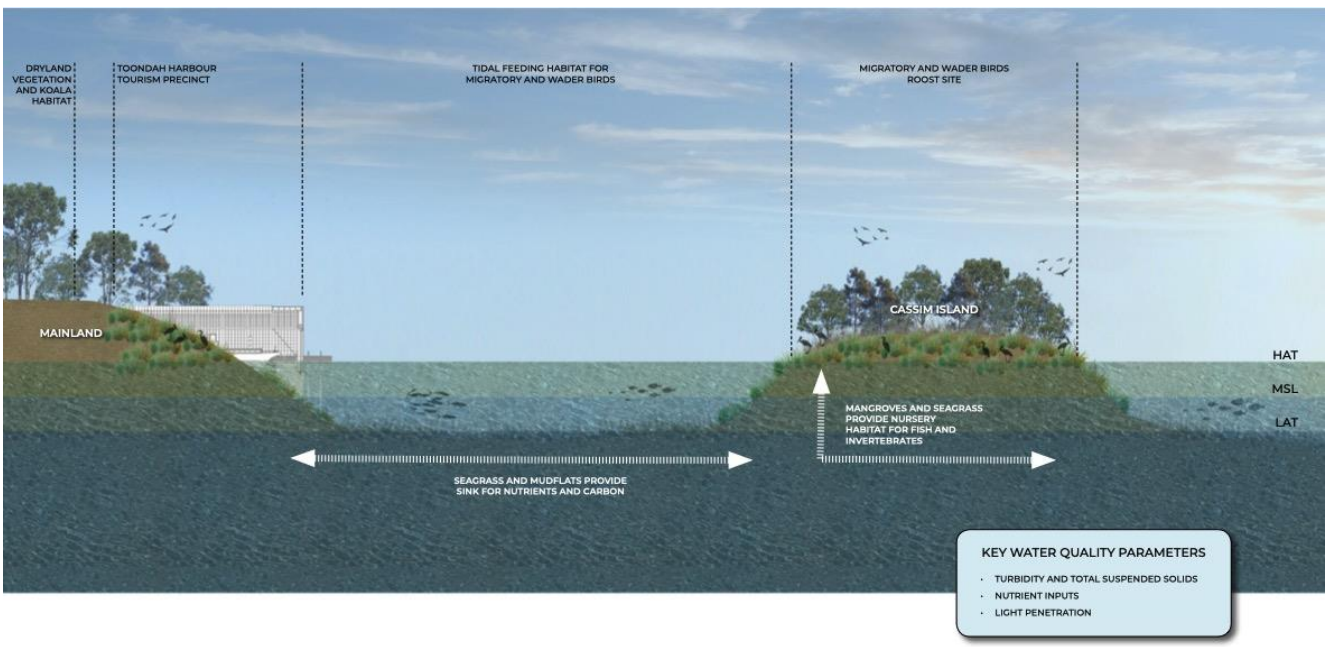

Figure 7: Conceptual model of the components present in the wetland in the vicinity of Toondah Harbour

LOCAL PRESENCE CONTRIBUTION TO ECOLOGICAL CHARACTER

For a critical service or process, the spatial extent may not necessarily influence importance; in these instances, presence can be interpreted more in terms of the role played in maintaining the service or process. For example, a critical service of a Ramsar site may be that it supports an important population of a threatened species. At the local scale assessment should focus on potential habitat present for that species and include targeted surveys for that species using published and accepted survey methods. The extent and use of this habitat by the threatened species should then be reviewed in the context of the whole Ramsar site including the proportion of the habitat type present and number of individuals located in comparison to known population within the Site.

A component may be present in a particular location and may well be of importance due to its locally high value in terms of representation; while in another area it may be a lower value as it does not provide the same ecological function (e.g. recruitment and breeding), representation of value or amenity. Extending the example used above, if the habitat present is used by the threatened species to forage then it may be considered to have less importance than habitat in another location used by that species to roost and breed.

The influences of human appreciation, geography, climatic distribution, geology, oceanography and ecological life cycles all influence where and at what level a particular component, process or service may contribute to ecological character.

The following terms and definitions should be used to classify the contribution of locally occurring critical components, processes or services to the ecological character of the Ramsar Site:

- Not present: No evidence was available to indicate or suggest presence in the local area.
- Minor contribution: occurs in low abundance or across a small area (relative to the nature of its broader presence across the Ramsar Site) and is not necessary for the ongoing function of a critical component, process or service. Noting that a low abundant component that is rare may still be important. Temporary fluctuations or seasonal variation should be considered along with natural events that may affect short-term presence (e.g. storms). Example of minor contribution might include:
  - Small isolated areas of natural ecosystems (coral, vegetation communities etc.) of less than 1% of the known habitat extent in the Ramsar site.
  - Small number of non-breeding species (turtles, dolphins, dugong etc.) that are foraging in the area.
  - Individual occurrences of natural features (rocks, mangroves) that are not unique or notable in some manner.
- Moderate contribution: occurs in moderate abundance or across a moderately large area (relative to its representation across the Ramsar Site) and contributes to the function of a critical component, process or service at the site level. Examples may include:
  - Migratory shorebird aggregations of less than 0.1% of flyway population (considered to be a population of national importance under the Wildlife Conservation Plan for Migratory Shorebirds).
  - Minor nesting or breeding areas sites for common species (e.g. with small numbers of nesting individuals <10).
  - Small areas of natural features, ecosystems and habitats of (e.g. less than 10 ha) that are not unique or notable in some manner.
- Major contribution: present in significant abundances or represent significant examples of the relevant critical component, process or service (relative to its nature across the site) and is essential for the ongoing function of a critical component, process or service. Examples may include:
  - Extensive habitat for threatened species.
  - Undisturbed natural vegetation or features that are unique or notable in some manner.
  - Migratory bird aggregations greater than 0.1% of flyway population.
  - 18 Mile Swamp (North Stradbroke Island).

It is expected an assessment of whether the contribution of the critical components, processes or services at the local level will require input from relevant experts including, for example, marine ecologists, wetland ecologists and coastal processes engineers.

DETERMINATION OF SIGNIFICANT IMPACTS

As outlined above, there are two key principles that guide EPBC Act significant impact assessments for Ramsar Sites:

- The 'ecological character' of the Ramsar Site. Understanding and documenting the ecological character of a Ramsar Site as part of an ecological character description, is central to maintaining and protecting the values of internationally and nationally important wetlands. As part of the Ramsar Convention, Australia is required to manage its Ramsar Sites (including Moreton Bay) to maintain the ecological character of each site.
- The significant impact criteria for Ramsar Sites. EPBC Act Policy Statement 1.1 – Significant impact guidelines (DoE 2013) sets out the criteria for determining the likelihood of an action having a significant impact on the ecological character of a declared Ramsar Site. An action is considered likely to have a significant impact on the ecological character of a Ramsar Site if there is a real chance of the following occurring:
    - Areas of the wetland being destroyed or substantially modified.
    - A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland.
    - The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected.
    - A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health.
    - An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.

Assessments against the above principles should consider the natural variability and limits of acceptable change (LAC) within the wetland ecosystem. These limits will vary based on the elements being altered and the context in which they occur. This will be assessed at the local scale through project specific studies and at the broader Ramsar Site scale through review of publicly available literature and studies. The WBM BMT Ecological Character Description also provides an overview of LACs for the critical components, processes or services for the Moreton Bay Ramsar Site identified through that study. These will be utilised where appropriate. The reliability of all information and data utilised will be assessed (refer section 4).

Using these criteria along with the results of the local contribution assessment a consistent approach to determining activities with the potential to result in a significant impact to the ecological character of the wetland will be used. The process for this assessment is as follows:

- Using the project description, including construction methods and ongoing uses, determine activities with the potential for direct and indirect impacts on existing environmental values.
- Using inputs from relevant experts and impact assessment tools such as coastal processes modelling determine the likely extent of these impacts. This should include assessment of all likely impacts within the 'zone of influence' of the activity.
- Review the impacts against the critical components, processes, and services locally present that are contributing to the ecological character of the Ramsar site using the criteria set out in Table 3.

From the analysis undertaken it should be possible to identify activities with the potential to impact on the local presence of critical processes, components or services that are contributing to ecological character of the Ramsar Site.

Where there is a major contribution (i.e. unique, of notable ecological importance) it is reasonable to assume that the presence and function of that critical process, component or service is part of the ecological character of the whole wetland and any impact has the potential to affect the ecological character of the Ramsar Site and should be avoided if possible.

Where the contribution is moderate or minor and impacts, then the representation locally can be considered to be less critical to maintaining the ecological character of the Ramsar Site. Where this occurs impacts should

be considered in the context of the framework set out in the Ramsar guidelines for avoiding, mitigating and compensating wetland losses.

For those impacts that are likely or almost certain a more detailed risk assessment is recommended to identify the severity and consequence of the impacts.

Table 3: Potential for significant impacts

Criteria	Local contribution of critical processes, components or services to Ecological Character			
	Not Present	**Minor**	**Moderate**	**Major**
Areas of wetland being destroyed or substantially modified	N/A	Unlikely	Possible if changes are permanent	Likely unless change is temporary (less than 1 year)
A substantial and measurable change in the hydrological regime of the wetland	N/A	Unlikely if not measurable or is within natural variability	Possible if change is measurable, permanent and beyond natural variability	Likely resulting in a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland
Habitat or lifecycle of native species being seriously affected	N/A	Unlikely	Possible if permanent Unlikely if temporary or in low season (e.g. outside migratory visitation)	Likely if permanent Unlikely if in low season or non-breeding (e.g. outside migratory visitation)
A substantial and measurable change in the availability or functioning of a critical process, component or service	N/A	Unlikely	Possible if change is measurable, permanent and beyond natural variability	Likely resulting in a substantial change to the quality or extent of the service or a complete loss of service
Permanent or long term substantial and measurable change in the water quality of the wetland	N/A	Unlikely	Possible	Likely
Establishment of invasive species	N/A	Likely*	Likely	Likely

* The establishment of an invasive species is likely to have broad reaching effects and so is likely to be significant in all scenarios.

7. ANALYSIS OF SIGNIFICANCE

The significance of potential impacts on the ecological character of the Ramsar Site will be achieved through a risk assessment. For the purposes of this method the process utilised is derived from Ramsar Convention Handbook 13 - Inventory, assessment, and monitoring. The Appendix to this handbook outlines a number of methods for assessing and managing wetlands, including a framework for a wetland risk assessment. This can be done a number of ways, however, for the purposes of this method two separate approaches are recommended:

1. Apply a standardised risk assessment using likelihood, scale and duration (see below).
2. Document the findings of the assessment applied using Table 3. For each likely or possible impact an analysis against each criteria should be made to outline the severity and nature of the impacts.

This dual approach will provide both a risk and data informed qualitative assessment of impacts that can be used to inform various approval and mitigation planning actions. The dual approach also can work to confirm findings and expose any gaps or differences between the two approaches.

RISK ASSESSMENT

Tables 4 to 7 (based on BMT WBM 2008) can be used to determine the level of risk posed by a particular activity or impact. Activities with high or medium risk might be considered significant and require management measures to reduce the potential for impact. Management measures should utilise site specific data, follow industry standard methods with a proven track record, and/or follow advice from relevant experts. The risk assessment will generally follow the below steps:

- Determination of the initial risk of each potential impact on the critical processes, components and services. That is, the risk without implementation of environmental management measures, based on likelihood and consequence.
- Identification of construction and operational environmental management measures relevant to controlling the initial risk considering any inconsistencies, information, and management gaps. These management measures should be specified in the Draft Environmental Management Plans for the project.
- Determination of the post management risk of each potential impact on the critical processes, components and services.

Specific monitoring programs including threshold criteria will be identified as part of the management measures identified for the project. These will include monitoring associated with construction impacts as well as longer term monitoring programs to confirm impact analysis.

Where impacts cannot be avoided but the assessment identifies that the risk of impact is acceptable, compensation may be required in accordance with the Commonwealth's EPBC Act Environmental Offsets Policy.

Table 4: Scale of Impact

Scale	Definition
Broad Scale	The zone of influence for impacts is beyond the local scale and may include whole-of-Ramsar site, with marked impacts to critical processes, components or services
Local Scale	The zone of influence for impacts is at the local scale (<5km) (potentially across several habitat types) with some impacts to critical processes, components or services
Individual Scale	Impacts will be to an individual processes, components or services at the local scale

Table 5: Duration/Irreversibility of Impact

Duration	Definition
Permanent or Long Term (Irreversible)	Recovery of critical processes, components or services measured in decades or irreversible
Medium Term Impact	Recovery of critical processes, components and services within 5 years
Short Term Impact	Recovery of critical processes, components and services measured in days to months (within a seasonal cycle)

Table 6: Impact Risk Category

Risk	Types
High	Permanent or Long-Term Impact at the Broad Scale
Medium	Permanent or Long-Term Impacts at a Local Scale
	Medium Term Impacts at the Local Scale
	Permanent or Long-Term Impacts at the individual Scale
Low	Medium Term Impact at a Individual scale
	Short Term impact at a Local Scale
Very Low	Medium Term Impact at the Individual Scale
	Short Term Impact at a Local Scale

Table 7: likelihood that impacts will lead to a significant impact to the ecological character of the Ramsar Site

Likelihood that impact to ecological character will occur	High Impact	Medium Impact	Low Impact	Very Low Impact
Likely	4 - High Risk	4 - High Risk	3 - Medium Risk	2 - Low Risk
Possible	4 - High Risk	3 - Medium Risk	2 - Low Risk	1 - Very Low Risk
Not Likely	3 - Medium Risk	2 - Low Risk	1 - Very Low Risk	1 - Very Low Risk

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Attachment 1 – Ecological Character of the Moreton Bay Ramsar Site

1. INTRODUCTION

The 'ecological character' of a wetland is defined as the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time.

As identified in section 5 of the method, two documents have been developed by the State and Federal Governments to describe ecological character of the Moreton Bay Ramsar Site:

- The Ramsar Information Sheet (RIS) completed in June 1999 by the Queensland Government. The most recent update was September 2019; and
- The Ecological Character Description - Moreton Bay Ramsar Site (BMT WBM (2008)).

The ecological character description was overseen by two independent groups established by the Queensland Environmental Protection Agency, the project steering committee and the knowledge management committee who had input on the assessment process. While this study is more than 10 years old no significant development or modifications have occurred within Moreton Bay and no notifications of any change to the ecological character have been published.

Occasional updates to the RIS also have not indicated any change in ecological character, although it is noted that the Ramsar Site is now considered to meet Ramsar criterion 7 through 9.

These two documents have been reviewed to identify the critical processes, components and services for the Moreton Bay Ramsar Site.

2. ECOLOGICAL CHARACTER DESCRIPTION REVIEW

The Ecological Character Description (ECD) study identified all wetland services, processes and components through a detailed review of existing information sources including scientific papers, state and local databases, EIS studies and academic thesis.

Using the categories and list of services/benefits from the National Framework as a guide, it was identified that the Moreton Bay Ramsar site provides a broad spectrum of services/benefits. This included: provisioning services such as provision of food in the form of fisheries and fresh water supply (through groundwater extraction), regulatory services such as erosion protection and climate regulation, cultural services such as recreational and tourism, cultural heritage, education and research and supporting ecosystem services such as biodiversity and the presence of endangered and vulnerable species.

Likewise, given the scope, areal extent and diversity of wetland environments present within the Moreton Bay Ramsar site, all wetland ecosystem processes from the National Framework were seen as occurring within the site, including a broad range of hydrological, climatic, geomorphologic, physico-chemical, biogeochemical and biological processes.

Following the method within the National Framework, the assignment of a given wetland process, component or service as critical was guided by the following considerations:

- The service or underlying component/process is important for supporting one or more of the Ramsar Nomination criteria under which the site was listed; or
- The service or component/process is an important determinant of the uniqueness of the site; or
- The service or component/process may be subject to change in short to medium time frames (<100 years) and/or the change will cause potentially significant consequences (e.g. change the ecological character).

To supplement these criteria additional consideration were given to:

- Suggestions or recommendations regarding critical services, components or processes by Knowledge Management Committee/SEP experts (particularly where such information was documented in scientific literature); and
- For cultural services, reference to Ramsar's 9th Conference, Resolution IX.21 – "Taking into account the cultural values of wetlands" – which identified the following cultural characteristics as relevant in the designation of Ramsar sites:

i. Sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland;

ii. Sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland;

iii. Sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples; and

iv. Sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland.

Following this process, a list of draft critical services/benefits and underpinning components and processes was developed. Ecosystem components (such as habitats, species and populations) and ecosystem processes (such as hydrology) were identified as critical where such features or processes were seen as underpinning one or more nominated critical services.

The Nomination Criteria for the site were used as the primary consideration in selecting the draft critical services/benefits (principally relating to the wetland's ecological values) along with the selection of several cultural services such as site's fisheries values, the significance of the site to indigenous peoples, as well as the education and research and tourism and recreational values of the site.

The draft list of critical services/benefits was presented to the Knowledge Management Committee (KMC) to undertake a validation process of the study team's critical service selections. This process served to confirm the identification of the critical services as well as to identify additional services, components or processes that were overlooked.

The assessment resulted in ten critical services and benefits being identified for the Moreton Bay Ramsar Site that relate back to the key Ramsar Nomination Criteria for the Moreton Bay Ramsar site but also include several cultural and provisioning services that are seen as particularly important or noteworthy in the context of the benefits derived from the site.

In many cases there is a direct relationship between the critical services and wetland habitat types (such as seagrass meadows or mangrove swamps) or noteworthy fauna (endangered and vulnerable flora or fauna). In this way, many of these habitats and species are effective surrogate measures for maintenance of the wetland service and broader ecological character of the wetland.

A number of critical processes were also identified on the basis of their importance in underpinning the critical services and in considering the wetland habitat and noteworthy flora and fauna that make up the critical components.

The ten critical services identified are outlined below.

1. **Moreton Bay Ramsar Site contains a diversity of wetland habitat types that are representative of a major coastal wetland aggregation and in many areas show a high degree of connectivity between habitat types.**

   Across the site there are 22 Ramsar Wetland types represented. Of these:

   - 11 are classified as coastal/marine
   - 10 are classified as inland waters
   - 1 is classified as manmade

   Several habitat types are highly localised (e.g. rare) in the context of the bioregion and within the site itself including non-forested peatlands and permanent freshwater lakes.

2. **Moreton Bay Ramsar Site contains several critical wetland habitat types.**

   BMT WBM (2008) documented that the Moreton Bay Ramsar Site contains marine, estuarine, palustrine, lacustrine and terrestrial biotopes. Several of these wetland habitats are considered, either individually or collectively, to represent particularly outstanding examples of near-natural areas within the biogeographic region.

   While acknowledging that there are numerous examples of such habitat areas within the site, BMT WBM (2008) identified six key wetland representative areas. These are:

   1. Seagrass and shoals in the Eastern Banks area
   2. Intertidal flats and estuarine assemblages in the Pumicestone Passage area
   3. Mangroves and saltmarsh associated with the islands in the Southern Bay
   4. Coral communities of the Eastern Bay
   5. Freshwater wetlands (including wallum and peatlands) of Moreton and North Stradbroke Islands
   6. Ocean beaches and foredunes on Moreton Island.

   These wetland areas were selected on the basis that they:

   - are in natural or near-natural condition (relevant to Ramsar Nomination Criterion 1)
   - contain representative examples of the key habitats within the site
   - contain excellent representative examples of various wetland habitat types within the biogeographic region
   - support many or all of the ten (10) critical wetland services nominated by the ECD
   - contain wetland habitats of recognised high conservation significance.

3. **Moreton Bay Ramsar Site supports an assemblage of vulnerable or endangered marine/aquatic fauna.**

   Of note:

   - Dugongs
   - Green turtles
   - Loggerhead turtles
   - Oxleyan pygmy perch
   - Honey blue-eye (mainland only)

4. **Moreton Bay Ramsar Site supports an assemblage of vulnerable or endangered wetland–dependant terrestrial fauna species**

   Including:

   - Little tern
   - Beach stone-curlew
   - Water mouse
   - Illidge's ant blue butterfly
   - Wallum sedgefrog
   - Australian painted snipe
   - Australasian bittern
   - Eastern curlew

5. **Moreton Bay Ramsar Site supports an assemblage of vulnerable or endangered wetland flora species and endangered and of concern wetland regional ecosystems.**

   Several vulnerable and endangered wetland flora species have been identified within the Ramsar Site. These include:

   - Swamp Daisy
   - Knotweed
   - Lesser Swamp Orchid
   - Yellow Swamp Orchid
   - Swamp Orchid

6. **Moreton Bay Ramsar Site supports significant populations (more than 20,000 in total and over 1% of the population size) of particular populations of shorebirds.**

   Species exceeding the 1% criterion are: Bar-tailed godwit, Whimbrel, Eastern curlew, Terek sandpiper, Grey-tailed tattler, Curlew sandpiper, Pied oystercatcher, Pacific golden plover and Lesser sand plover.

7. **The tidal fish habitats and fish and invertebrate populations of the Moreton Bay Ramsar Site support valuable recreational and commercial fishing activities.**

   Notable species include:

   - Bream, Flathead, Whiting, Luderick, Mullet, Tailor, Mackerel, sharks, baitfish, eels, and Pink snapper fin fish
   - King, Tiger, Endeavour, Banana, Greasyback and School prawns
   - Blue swimmer, Mud, Red spot, Spanner and Coral crabs
   - Callianasid shrimp (yabbies), Squid, Cuttlefish, Rock oysters, bivalves and Beche-de-mer.

8. **Moreton Bay Ramsar Site has important cultural values and significance to indigenous peoples**

   Many traditional owner groups in the region have close association and regularly use the wetland resources within particular areas such as the Bay Islands and Southern Bay region.

9. **Moreton Bay Ramsar Site is an important site for research and education.**

   Several of the key species and habitat types identified above have been subject to long term research and education activities.

10. **The Moreton Bay Ramsar Site provides and supports significant tourism and recreational uses in the Region.**

    With specific importance placed on the marine and estuarine waters; sandy beaches and dunes; and The freshwater lakes. Particularly those sites located on the string of sand islands forming the eastern barrier of the bay.

Critical processes that were identified as contributing to the critical services include Physical Coastal Processes, Hydrology, Groundwater, Energy and Nutrient Dynamics, Biological Processes, Water Quality, Climate, Geomorphology, Sea level rise, Fire Regime and Wind-Driven Processes. Any impacts on these processes have the potential to result in an impact on the critical services provided by the Moreton Bay Ramsar Wetland.

3. RAMSAR INFORMATION SHEET REVIEW

In addition to the information contained in BMT WBM (2008) the Australian and Queensland governments have described the values of the wetland in various information documents, including the Ramsar Information Sheet (DoEE 2019). This information sheet describes the values of the Moreton Bay wetland as:

- One of the largest estuarine bays in Australia and sits in an 'overlap zone' where both tropical and temperate species occur. It supports extensive intertidal areas of seagrass, mangroves and saltmarsh that provide vital habitat for waterbirds, including significant populations of migratory shorebirds.
- A Ramsar Site because of its outstanding coastal wetland values and features. Many of its diverse habitat types retain a near-natural character and are interconnected with other habitats supporting biodiversity.
- Home to five nationally threatened plant species that are wetland dependant, such as the endangered swamp daisy, *Olearia hygrophila*, which is only found on North Stradbroke Island.
- Habitat for humpback whales and dolphins, as well as six of the world's seven species of marine turtles. Other threatened animals, including the grey nurse shark, dugong, wallum sedge frog, water mouse and Oxleyan pygmy perch fish, also live in the Bay or in surrounding waters and wetlands.
- A wetland habitat providing feeding areas, dispersal and migratory pathways, and spawning sites for many fish species. The region supports one of the most productive fisheries in Queensland.
- The perched wetlands on Moreton and North Stradbroke Islands, including lakes and swamps. Perched wetlands are abundant in the coastal Wallum regions of south-eastern Queensland and northern New South Wales, but are scarce in most parts of the world. Perched wetlands form in depressions between dunes where impermeable layers develop in the sand and act like basins holding water higher in the landscape than the water table. They support many unique and interesting animals.
- The site includes natural and near-natural freshwater wetlands and critical habitats such as peat swamps, clay pans, window water-table lakes, perched lakes, freshwater creeks and other groundwater dependent ecosystems.
- Moreton Bay is subject to a large submarine groundwater discharge (SGD) rate estimated to be approximately 18 times greater than the average annual discharge of all the major river inputs into the Bay (Stewart et al. 2015). The SGD has been suggested as a major component of the hydrological and biogeochemical cycles of Moreton Bay and has a major influence on the export of alkalinity and dissolved carbon into the Bay.
- Numerous services to locals and visitors to south east Queensland. Services, these include: tourism and recreational opportunities; fishery products; aesthetic benefits; health and wellbeing; cultural services; storm surge mitigation; climate regulation through carbon sequestration and local temperature moderation and treatment of pollutants (e.g. denitrification processes).
- Mangroves and saltmarsh communities provide important primary production for a range of species, including commercially valuable fish and crab species. The total value of commercial fishery production in the Bay is estimated to be $24-30m (McPhee et al. 2008).
- Moreton Bay's proximity to a major population centre makes it a very popular recreational fishing area. Estimates of the total expenditure by recreational fishers in Moreton Bay range from $156m to $194m per year (Pascoe et al. 2014).
- One of the most important migratory shorebird sites in Australia, supporting both a large number and high diversity. During the summer months some 32 species of migratory shorebirds comprising over 40,000 individuals visit the Bay. This includes significant worldwide populations, including 20% of all eastern curlews and 50% of all grey-tailed tattlers.
- Based on the Hansen *et al.* 2016 revised East Asian-Australasian Flyway population estimates, the site provides habitat for >1% of the estimated East Asian-Australasian Flyway population of the following species:
    - bar-tailed godwit (*Limosa lapponica*)
    - curlew sandpiper (*Calidris ferruginea*)
    - eastern curlew (*Numenius madagascariensis*)
    - grey-tailed tattler (*Heteroscelus brevipes*)
    - red-necked stint (*Calidris ruficollis*)
    - Australian pied oystercatcher (*Haematopus longirostris*)
    - whimbrel (*Numenius phaeopus*)
    - sharp-tailed sandpiper (*Calidris acuminata*)
    - lesser sand plover (*Charadrius mongolus*)
    - double-banded plover (*Charadrius bicinctus*).

Attachment 2

Data Reliability Review

Reliability of Information from Key Sources

Source	Description	Confidence in Accuracy
Mangrove and associated communities of Moreton Bay, Queensland, Australia**:** Change in extent 1955-1997-2012	Prepared by the Queensland herbarium for State Government in 2016. Included review of broad scale mapping of mangrove and saltmarsh communities as well as more detailed studies. Older studies may be less accurate due to mapping limitations.	Moderate
Draft Ecological Character Description – Moreton Bay Ramsar Site	Prepared for the Queensland Environmental Protection Agency by BMT WBM in 2008. Included a number of external review and oversight committees and utilised best available information and datasets at the time.	Moderate
Moreton Bay Quandamooka & Catchment: Past, present, and future	A book published by the Moreton Bay Foundation in 2019. A number of papers from the book were utilised in the assessment, including: ▪ Migratory shorebirds of Moreton Bay ▪ Ecology of the marine mammals of Moreton Bay ▪ Seagrasses of Moreton Bay: Diversity, ecology and resilience ▪ Marine turtles in Moreton Bay All studies included contributions from leading researchers and were peer reviewed.	High
Managing Threats to Migratory Shorebirds in Moreton Bay	Published in 2019 by University of Queensland for Healthy Land and Water. Included specific data collection for the study as well as review of several peer reviewed sources.	High
Distribution and conservation of delphinids in Moreton Bay	Published in 1998 by University of Queensland for a book on Moreton Bay and Catchment. Included peer reviewed information using contemporary datasets at that time.	Moderate
Dramatic increase in mud distribution across a large sub-tropical embayment, Moreton Bay, Australia	Published in the Marine Pollution Bulletin in 2017 which is a peer reviewed international scientific journal	High

Source	Description	Confidence in Accuracy
Environmental History and Ecology of Moreton Bay	Published in 2017 by CSIRO Publishing. Author Daryl McPhee has utilised a number of information sources in the book, many of which pre-date 2015. Most sources are peer reviewed studies and data	Moderate
Tracking the rapid loss of tidal wetlands in the Yellow Sea	Published in 2014 in the Frontiers in Ecology and the Environment, a peer reviewed scientific journal. Assessment included remote sensing techniques considered to be best practice at the time the study was undertaken	Moderate
Moreton Bay Ramsar Information Sheet	Published by the Queensland Government in 2019 based on Qld spatial data and mapping as well as a number of peer reviewed source material	High
Simultaneous declines in summer survival of three shorebird species signals a flyway at risk	Published in the Journal of Applied Ecology in 2016 based on a review of data from 2006 - 2013	Moderate
Benthic inventory of reefal areas of inshore Moreton Bay, Queensland, Australia, Brisbane	Published in 2017 by University of Queensland and Reef Check Australia using filed data collected between 2015 and 2016	High
Integrating outcomes of IUCN red list of ecosystems assessments for connected coastal wetlands	Published in 2020 in the peer reviewed journal Ecological Indicators using recent data from spatial and field surveys	High
Improving the time series of estimates of dugong abundance and distribution by incorporating revised availability bias corrections	Produced by TropWATER in 2015 under the Australian Marine Mammal Centre Grants Program using multiple data sources from between 2001 – 2013. Data sources were generally aerial surveys carried out be experienced ecologists	Moderate
Distribution and abundance of dugong and large marine turtles in Moreton Bay, Hervey Bay and the southern Great Barrier Reef	Produced by TropWATER in 2017 for the Great Barrier Reef Marine Park Authority using multiple data sources dating back to the 1980s. Included a contemporary aerial survey conducted in 2016	High
Rapid population decline in migratory shorebirds relying on Yellow Sea tidal mudflats as stopover sites	Published in 2017 in the peer reviewed journal Nature Communications using 20 years of citizen science data spanning multiple continents. The study was completed by a series of highly experienced authors	High