

7 | Environmental Values



7.0 Environmental values

7.1 Introduction and context

The proposed Gladstone port master planned area is characterised by hot summers with average maximum temperatures above 30°C from December to March, and warm winter days with cool mornings. Rainfall is highest between December and February and relatively little rain falls between April and September at Gladstone. Winds are relatively strong and typically from the south east in the mornings and east to northeast in the afternoons⁸.

The desired outcomes for the environment to be achieved in the proposed Gladstone port master planned area for these values are directly related to the objectives of the Commonwealth, State and local legislative requirements which protect these values. These requirements are summarised in Table 6 and it is noted that desired outcomes for the environment for developments would require scrutiny on a case-by-case basis whilst also considering cumulative impacts of such developments to help facilitate broad-scale protection of environmental values within the proposed Gladstone port master planned area and surrounding areas.

Table 6 Environmental Values and Corresponding Protective Legislation, Policy and Planning Initiatives

Legislation and Planning Instruments	Categories of Environmental Value
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Matters of National Environmental Significance such as World, Heritage Properties, threatened species and ecological communities, migratory species and wetlands of international importance
<i>Nature Conservation Act 1992</i> (NC Act)	Endangered and Vulnerable Species
	Near Threatened and Special Least Concern Species
	National Parks
	Other conservation areas
<i>Vegetation Management Act 1999</i> (VM Act) / <i>Sustainable Planning Act 2009</i> (SPA)	Essential Habitat
	Remnant Vegetation / Regional Ecosystems (REs)
<i>Great Barrier Reef Marine Park Act 1995</i> (GBRMP Act)	Great Barrier Reef World Heritage Area (GBRWHA), Great Barrier Reef Marine Park (GBRMP)
	Dugong Protection Areas
Strategy for the Conservation and Management of Queensland's Wetlands 1999	Wetlands
Reef Water Quality Protection Plan (Reef Plan)	Great Barrier Reef
<i>Fisheries Act 1994</i>	Declared Fish Habitat Areas
	Marine Plants

⁸ Australian Bureau of Meteorology 2015, <http://www.bom.gov.au/>

Legislation and Planning Instruments	Categories of Environmental Value
<i>Queensland Environmental Offset Act 2014</i>	Matters of National, State and Local Environmental Significance
State Planning Policy July 2014	Environment and Heritage (Biodiversity, Coastal Environment, Cultural Heritage, Water Quality)
Environmental Protection (Water) Policy 2009	Water Quality
Environmental Protection (Air) Policy 2008	Air Quality

This section identifies the terrestrial and marine environmental values present within the proposed Gladstone port master planned area with significant regard given to:

- World Heritage attributes of Outstanding Universal Value (OUV)
- Matters of National Environmental Significance (MNES)
- Matters of State Environmental Significance (MSES)
- other notable environmental features.

7.2 Outstanding Universal Value of the Great Barrier Reef World Heritage Area

An environmental value of significance within the proposed Gladstone port master planned area is the Great Barrier Reef World Heritage Area. The environment values relate to the expression of a number of attributes and maintenance of integrity that contributes to the Outstanding Universal Value of the Great Barrier Reef (GBR) at the Port of Gladstone and its surrounding area.

This section provides:

- a brief description of the Great Barrier Reef World Heritage Area (GBRWHA)
- background to the concept of Outstanding Universal Value, including descriptions of World Heritage listing criteria, integrity, protection and management measures and Statement of Outstanding Universal Value
- identification of Outstanding Universal Value key attributes represented at Gladstone.

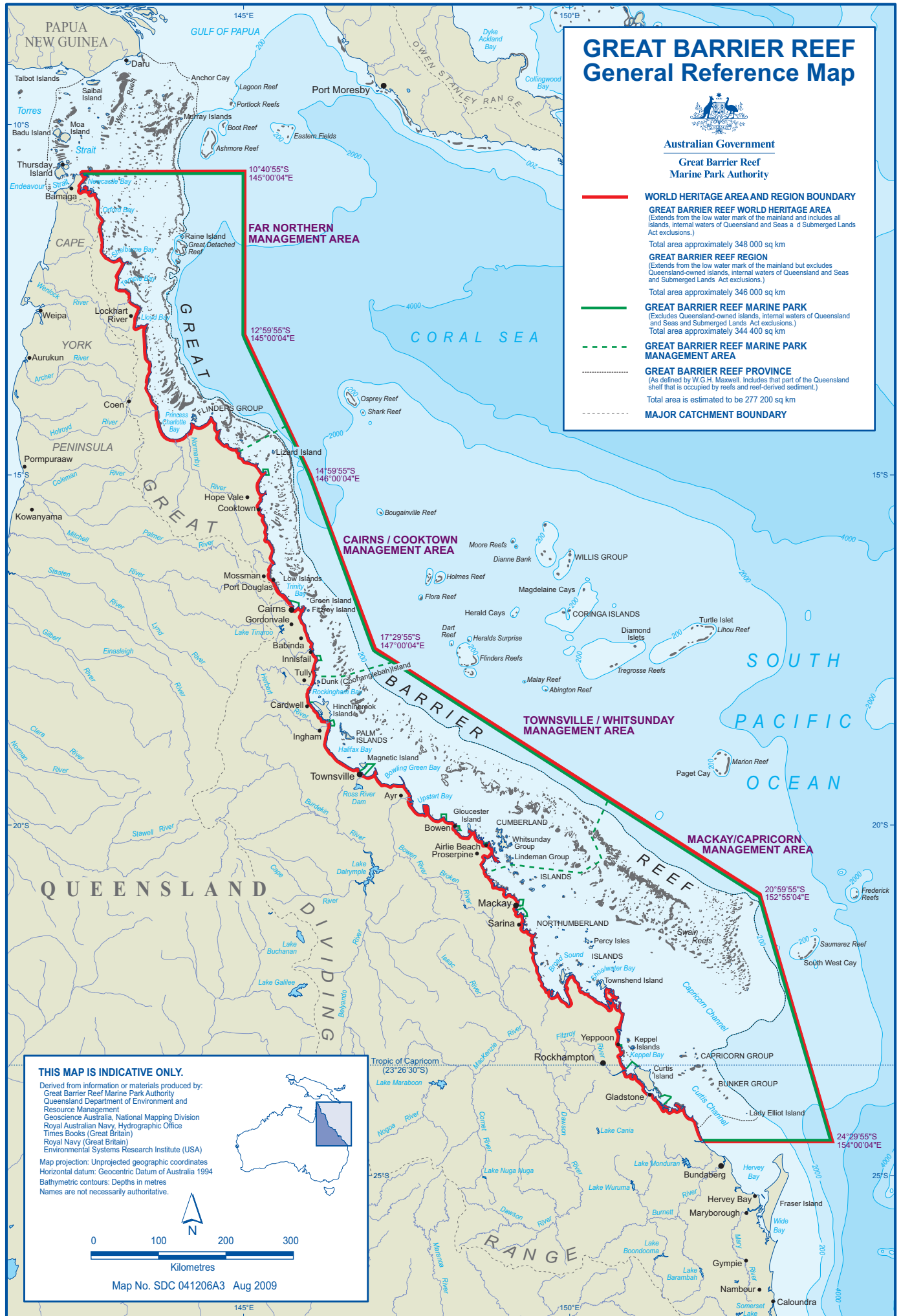
7.2.1 Great Barrier Reef World Heritage Area

The Great Barrier Reef was inscribed on the World Heritage List in recognition of its Outstanding Universal Value in 1981. It covers an area of 348,000 km² and includes:

- along the coast of Queensland for 2,000 km from the top of Cape York to just north of Fraser Island
- all islands within the outer boundary (about 1,050 islands)
- all waters seaward of low water mark (including internal waters of Queensland and port waters)
- 11 trading ports.

The GBRWHA includes the Great Barrier Reef Marine Park (refer to Figure 12).

Figure 12: Great Barrier Reef Boundaries



GREAT BARRIER REEF General Reference Map



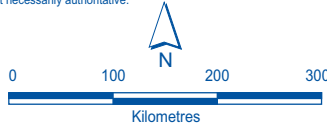
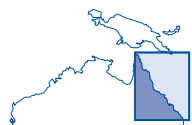
Australian Government
Great Barrier Reef
Marine Park Authority

- **WORLD HERITAGE AREA AND REGION BOUNDARY**
GREAT BARRIER REEF WORLD HERITAGE AREA
(Extends from the low water mark of the mainland and includes all islands, internal waters of Queensland and Seas and Submerged Lands Act exclusions.)
 Total area approximately 348 000 sq km
- **GREAT BARRIER REEF REGION**
(Extends from the low water mark of the mainland but excludes Queensland-owned islands, internal waters of Queensland and Seas and Submerged Lands Act exclusions.)
 Total area approximately 346 000 sq km
- - - - - **GREAT BARRIER REEF MARINE PARK MANAGEMENT AREA**
(Excludes Queensland-owned islands, internal waters of Queensland and Seas and Submerged Lands Act exclusions.)
 Total area approximately 344 400 sq km
- - - - - **GREAT BARRIER REEF PROVINCE**
(As defined by W.G.H. Maxwell. Includes that part of the Queensland shelf that is occupied by reefs and reef-derived sediment.)
 Total area is estimated to be 277 200 sq km
- - - - - **MAJOR CATCHMENT BOUNDARY**

THIS MAP IS INDICATIVE ONLY.

Derived from information or materials produced by:
 Great Barrier Reef Marine Park Authority
 Queensland Department of Environment and
 Resource Management
 Geoscience Australia, National Mapping Division
 Royal Australian Navy, Hydrographic Office
 Times Books (Great Britain)
 Royal Navy (Great Britain)
 Environmental Systems Research Institute (USA)

Map projection: Unprojected geographic coordinates
 Horizontal datum: Geocentric Datum of Australia 1994
 Bathymetric contours: Depths in metres
 Names are not necessarily authoritative.



Map No. SDC 041206A3 Aug 2009

7.2.2 Concept of Outstanding Universal Value

Outstanding Universal Value is the fundamental concept of the World Heritage Convention and underpins the listing of properties on the World Heritage List. To be considered of Outstanding Universal Value a property needs to:

- meet one or more of ten criteria set out in the convention
- meet the conditions of integrity
- if a cultural heritage property, meet the conditions of authenticity
- have an adequate system of protection and management to safeguard its future⁹.

7.2.3 Criteria for assessing Outstanding Universal Value

For a property to be listed under the Convention, it must meet one or more of the following criteria:

- Criterion (i) – represent a masterpiece of human creative genius
- Criterion (ii) – exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design
- Criterion (iii) – bear a unique or at least exceptional testimony to a cultural tradition or to a civilisation which is living or which has disappeared or to a cultural tradition or to a civilisation which is living or which has disappeared
- Criterion (iv) – be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates a significant stage or stages in human history
- Criterion (v) – be an outstanding example of a traditional human settlement, land use or sea use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change
- Criterion (vi) – be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance
- Criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance
- Criterion (viii) – be outstanding examples representing major stages of earth's history, including the record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features
- Criterion (ix) – be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal; and marine ecosystems and communities of plants and animals
- Criterion (x) contain the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

⁹ UNESCO (2013). Operational Guidelines for the Implementation of the World Heritage Convention.

The GBR was inscribed under four of natural criteria identified above. These are:

- superlative natural beauty (Criterion vii)
- outstanding geological, geomorphic or physiographic features (Criterion viii)
- outstanding examples of ecological and biological processes (Criterion ix)
- the most important and significant natural habitats for biological diversity (Criterion x).

The GBR was the first coral reef ecosystem in the world to be made a World Heritage area¹⁰. The GBR is a place of great significance to its Traditional Owners, who continue to maintain a unique and continuing connection the Reef and adjacent coastal areas.

7.2.4 Statement of Outstanding Universal Value

A retrospective statement of the Outstanding Universal Value of the GBR was approved by the World Heritage Committee in 2012¹¹. The statement highlights the values of the GBR under each criterion as summarised briefly below:

Superlative natural beauty

The GBR provides above and below water some of the most spectacular scenery on earth. It is one of the few living structures visible from space, is an unparalleled aerial panoramic seascape of reef, islands, coral cays, mangrove forests and rugged vegetated mountains of Hinchinbrook Island. Beneath the ocean surface are spectacular coral assemblages and thousands of species of reef fish. Annual coral spawning, migrating whales, nesting turtles and significant spawning of many fish add to the superlative natural phenomena.

Outstanding geological, geomorphic or physiographic features

The GBR has evolved over millennia. The area has been exposed and flooded by at least four glacial and interglacial cycles, and in the last 15,000 years reefs have grown on the continental shelf. It is the world's largest coral reef ecosystem, with inshore fringing, mid-shelf and exposed outer reefs. The GBR has been moulded by changing climates and sea levels and through wind and water erosion over long time periods.

Outstanding example of ecological and biological processes

The unique biological diversity of the GBR reflects its maturity and includes evidence of the evolution of hard corals and some fauna. The reef currently supports over 400 species of coral, 4,000 species of molluscs, over 1,500 fish species, a great diversity of sponges, anemones, marine worms, crustaceans, as well as 240 bird species astride 2,500 individual reefs and 900 islands.

The most important and significant natural habitats for biological diversity

The GBR is one of the richest and most complex natural ecosystems on earth. Its size and diversity supports tens of thousands of marine and terrestrial species, many of which have global significance. The reef is a major feeding ground for the world's largest population of dugong, is a significant area for humpback whale calving, and supports thirty species of

¹⁰ Commonwealth of Australia. 2014. Great Barrier Reef Region Strategic Assessment – Strategic Assessment Report.

¹¹ Australian Government 2015. Reef 2050 Long-Term Sustainability Plan.

whales and dolphins, and six of the world's seven species of turtle, including the world's largest green turtle breeding site at Raine Island.

7.2.5 World heritage attributes relevant to the proposed Gladstone port master planned area

An environmental value of significance within the proposed Gladstone port master planned area is the GBRWHA. The values relate to the expression of a number of attributes and maintenance of integrity that are expressed in the terrestrial and marine environments of Gladstone and its surrounds.

The GBRWHA area includes waters seaward of the low water mark, including those around Gladstone Port, and about 1,050 islands. Figure 12 shows the proposed Gladstone port master planned area boundary in relation to the World Heritage Area and the Great Barrier Reef Marine Park, which excludes some coastal areas. Port Curtis and surrounds primarily lies within the WHA, but is situated outside the State and Commonwealth Marine Parks. The GBRMP boundary is the eastern side of Facing Island and Curtis Island and extends offshore to the limit of Australian territorial waters.

Attributes of the OUV of the GBRWHA are present within the proposed Gladstone port master planned area. Curtis Island is the largest island in the GBRWHA. Curtis Island has relatively extensive low-lying lands, no mountain range, lower rainfall and is located at the southern limit of coral reefs. The shallow sedimentary seabed and sheltered waters of the Port Curtis Basin with linked mudflat, mangrove, sandy beaches and intact vegetation shoreline areas are core physical attributes.

Water quality and the extent, condition and associated communities of seabed habitat for seagrasses and intertidal and subtidal habitat of mangroves are critical marine habitat matters within and beyond the proposed Gladstone port master planned area. The area sustains a broad range of plant and animal biological diversity of the GBRWHA. This includes mangrove communities, seagrass meadows, invertebrates, mud crabs, fish, dugong and turtles. Sheltered waters are habitat for many marine mammals and saltmarshes and wetlands are habitat for resident and migratory shorebirds and seabirds.

Some work has previously been carried out under several EIS projects to understand the relevant OUV attributes of the Great Barrier Reef World Heritage Area at Gladstone. Further guidance on how to understand OUV of the GBR WHA has been provided in:

- EPBC Act referral guidelines for the Outstanding Universal Value of the Great Barrier Reef World Heritage Area (DoE 2014)
- Great Barrier Reef Outlook Report 2014 (GBRMPA 2014)
- Independent Review of the Port of Gladstone. Report on Findings. July 2013 (Commonwealth of Australia 2013).

These documents provide examples of key attributes that contribute to OUV for the WHA. DOE indicate that attributes are not expressed equally over the whole of the property and that attributes can change over time as new information is found.

Table 7 provides an overview of the key attributes relevant to each listing criterion and if they are applicable to the proposed Gladstone port master planned area and surrounds.

Table 7 OUV attributes expressed in the proposed Gladstone port master planned area and surrounds¹²

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

7.3 Methodology

Assumptions

This report has relied on the following searches of publically available ecological databases and mapping systems, accessed in September 2015. It has been supplemented by a limited literature search and it is acknowledged that there is other information on the environmental values available in the public domain which has not been reviewed for this report. It is

¹² Department of Environment and Heritage Protection. 2013. *Independent Review of the Port of Gladstone*. July 2013. DOE, Canberra.

assumed that further environmental information will be sought as the Gladstone port master planning process progresses.

- Commonwealth Department of the Environment (DOE) Protected Matters Search Tool and SPRAT profiles for threatened species and threatened ecological communities
- Queensland Department of Environment and Heritage Protection (DEHP) Wildlife Online
- Atlas of Living Australia (flora and fauna known records)
- Queensland Department of Natural Resources and Mines (DNRM) Vegetation Management Mapping and Regional Ecosystems Description Database
- DEHP Protected Plants Flora Survey Trigger Area Mapping
- DEHP Environmentally Sensitive Areas Mapping
- DEHP Referable Wetlands Mapping
- Queensland Department of Agriculture and Fisheries (DAF) Declared Fish Habitat Area Mapping, and
- DILGP SPP interactive mapping system.

A number of publically available Environmental Impact Statement (EIS) studies associated with major projects in the greater Gladstone region were also reviewed to identify environmental values and constraints pertaining to the proposed Gladstone port master planned area (Table 8).

Table 8 EIS studies undertaken within the greater Gladstone area

Date	Project	Scope and Method of Study	URL
2006 / 2007	Wiggins Island Coal Export Terminal	EIS / SEIS	http://www.wicet.com.au/irm/content/environment.aspx?RID=329
2007/2008	GPN or GNP Gladstone Nickel Project	EIS / SEIS	http://www.dilgp.qld.gov.au/assessments-and-approvals/gladstone-pacific-nickel-refinery.html
2008	Moura Link –Aldoga Rail Project	EIS	Not available
2009	QCLNG Curtis LNG Project	EIS	http://www.qgc.com.au/environment/environmental-impact-management/qclng-environmental-impact-statement-(eis).aspx
2010	APLNG Australia Pacific LNG Project	EIS	http://www.aplng.com.au/environment/our-environmental-impact-statement

Date	Project	Scope and Method of Study	URL
2010	Western Basin Dredging and Disposal Project	EIS	http://www.westernbasinportdevelopment.com.au/eis_documentation
2012	Queensland Curtis LNG Project	EIS / SEIS	http://www.qgc.com.au/environment/environmental-impact-management/qclng-environmental-impact-statement-(eis).aspx
2012	Santos Gladstone LNG Project	EIS / SEIS	http://www.santoslng.com/resource-library/glng-supplementary-eis/introduction.aspx
2013	Gladstone Steel Plant Project	EIS	http://www.statedevelopment.qld.gov.au/resources/project/gladstone-steel-making-facility/gladstone-steel-making-executive-summary.pdf
2013	Arrow LNG Plant	EIS / SEIS	http://www.dilgp.qld.gov.au/assessments-and-approvals/arrow-lng-plant.html

7.4 Landform and biota

7.4.1 Flora

7.4.1.1 Threatened Flora

Description and Context

Eighteen threatened flora species have been identified within the proposed Gladstone port master planned area with a likelihood of occurrence of either 'known' or 'possible' including:

- Yarwun Whitewood (*Atalaya collina*) - small tree to 5 m tall
- Broad-leaved Bertya (*Bertya opposens*) – slender shrub to 5 m tall
- Three-leaved Bosistoa (*Bosistoa transversa*) – medium-size tree to 22 m tall
- Miniature Moss-orchid (*Bulbophyllum globuliforme*) – tiny epiphytic orchid to 1.5 cm tall
- Wedge-leaved Tuckeroo (*Cupaniopsis shirleyana*) – small tree to 10 m tall
- Large-fruited Zamia Palm (*Cycas megacarpa*) – trunked cycad to 5 m tall
- Marlborough Blue Zamia Palm (*C. ophiolitica*) – trunked cycad to 4 m tall
- Dansiea (*Dansiea elliptica*) – large tree to 35 m tall
- Bristly Bluegrass (*Dichanthium setosum*) – densely tufted grass to 70 cm tall
- Germainia Grass (*Germainia capitata*) – tufted grass to 60 cm tall
- Scarlet Fuchsia (*Graptophyllum excelsum*) – dense shrub to 3 m tall
- Byfield Spider Flower (*Grevillea venusta*) – dense shrub to 5 m tall
- Grease Nut (*Hernandia bivalvis*) – small tree to 12 m tall
- Smooth-barked Bonewood (*Macropteranthes leiocaulis*) – tree to 25 m tall

- Mount Larcom Monkey-rope (*Parsonsia larcomensis*) – semi-woody creeper to 5 m long
- Quassia (*Samadera bidwillii*) – small shrub or tree to 6 m tall
- Coastal Xylosma (*Xylosma ovata*) – shrub to 2 m tall, and
- Mount Larcom Zieria (*Zieria actites*) – dense shrub to 1 m tall.

It is noted that this list does not include those species that are identified as ‘unlikely’ to occur within the proposed Gladstone port master planned area (as identified in Table 9). The conservation status of these species at the Commonwealth (EPBC Act) and State (NC Act) level are provided in Table 9 along with their habitat preferences, known distributional range and the likelihood of their occurrence within the master planned area.

The areas at high risk of containing these threatened or near threatened flora species in the proposed Gladstone port master planned area are reflected in the regulated vegetation mapping category for MSES in Figure 13. There is a potential for all of these species to occur within the area within and outside of their current known extent.

A key gap in relation to these species is site-specific survey information within the proposed Gladstone port master planned area in areas of potential habitat.

Potential Threats, Pressures and Impacts

Direct threats to threatened flora species in the proposed Gladstone port master planned area include:

- clearing and associated fragmentation

Indirect threats are also present in the area including:

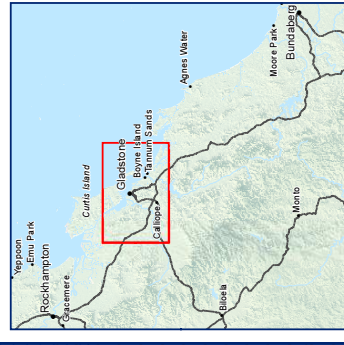
- weed invasion and disturbance
- fire or altered fire regimes
- pests
- grazing by domestic stock and agricultural practices
- timber harvesting
- damage to host trees from roadworks
- illegal harvesting
- inappropriate collection practices
- modification of water flows and soil erosion
- drought
- loss of insect pollinators, and
- low abundance leading to inbreeding and loss of genetic variation.

Figure 13

Matters of State Environmental Significance

Legend

- Cities
- Urban centres
- Local centres
- Localities
- Railway
- Highways
- Secondary Roads
- Property boundaries
- Port limits
- ⋯⋯⋯ area boundary
- ⋯⋯⋯ Proposed Gladstone port master planned area boundary
- ▨ Great Barrier Reef Marine Park
- ▨ MSES - Regulated vegetation (intersecting a watercourse)
- ▨ MSES Drainage
- ▨ MSES - High Ecological Significance wetlands
- ▨ MSES - Wildlife habitat
- ▨ MSES - Regulated vegetation
- ▨ MSES - Protected area



10 November 2015



0 0.5 1 2 3 4 5
Kilometres

Coordinate System: GCS GDA 1984
Datum: GDA 1984
Units: Degree

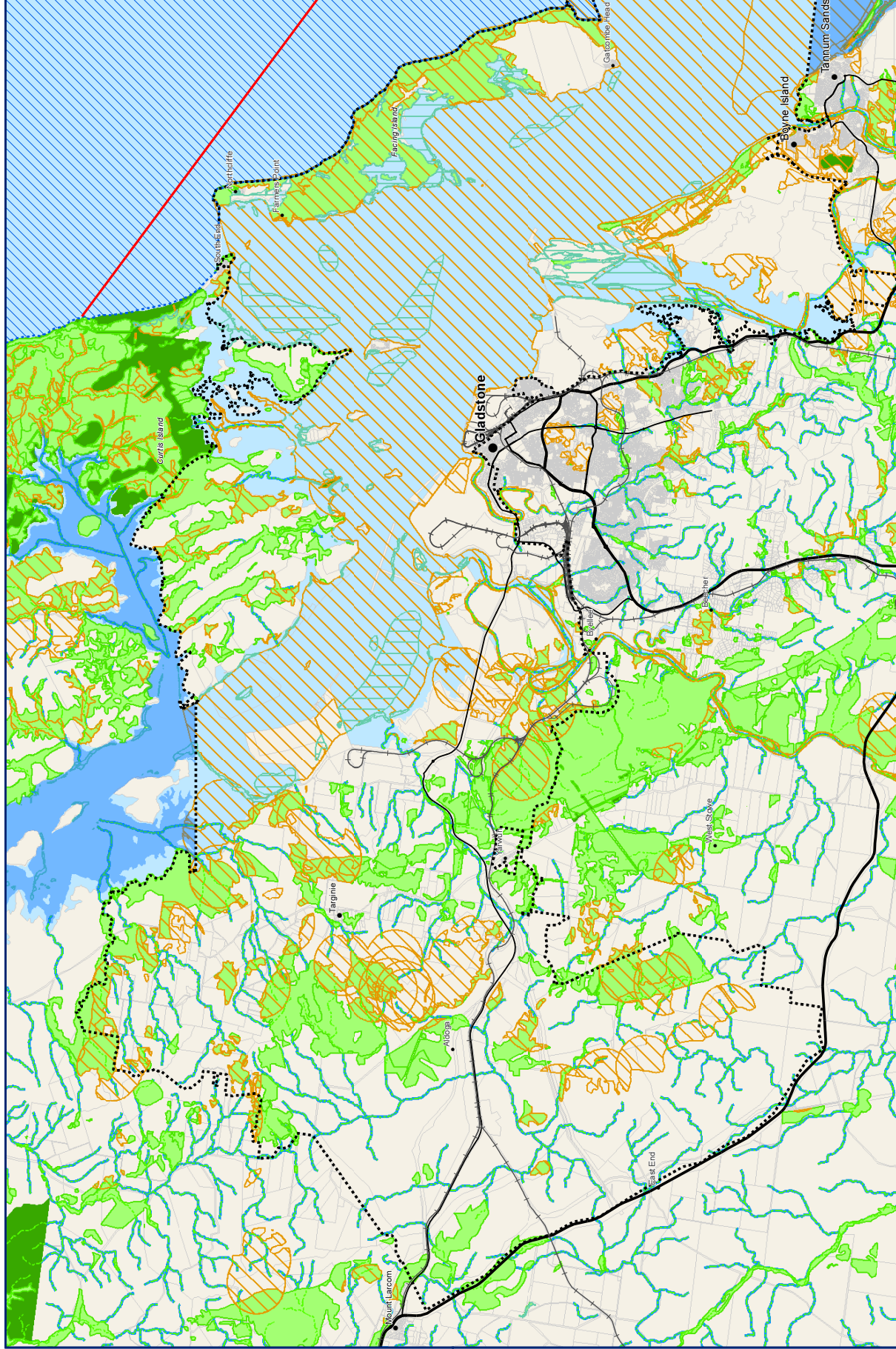


Table 9 Likelihood of occurrence of listed flora species within the proposed Gladstone port master planned area

*Conservation Status: CTH = Commonwealth (listed under the EPBC Act), QLD = Queensland (listed under the NC Act), EX = Extinct, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, NL = Not Listed.

Botanical Name Common Name Family Name	Status *		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
<i>Acacia</i> sp. Castletower (N.Gibson TOI345) Mount Castletower Wattle Mimosaceae	NL	VU	Little known species restricted to Mount Castletower south of Gladstone in CE QLD ¹⁴ .	Unlikely. Highly restricted species known only from the type locality at Mount Castletower south of the area.
<i>Acacia storyi</i> Story's Wattle Mimosaceae	NL	NT	Open eucalypt forests with a shrub or wattle dominated understorey in sandy and shallow skeletal soils over sandstone in C QLD, from Blackdown Tablelands to the coast ¹⁴ .	Unlikely. Highly restricted species known only from the type locality on the Blackdown Tablelands in C QLD. Known record on Curtis Island north of Graham Creek is suspected to be incorrect ¹⁵ .
<i>Apatophyllum olsenii</i> Olsen's Apatophyllum Celastraceae	VU	EN	Open forests and tall shrublands in association with Queensland Peppermint (<i>Eucalyptus exserta</i>), Brush Box (<i>Lophostemon confertus</i>) and Forest Grasstree (<i>Xanthorrhoea johnsonii</i>) on granitic ridges and granite boulder outcrops in the Many Peaks Range region of C QLD ¹⁶ . This species is known from two locations south of the area.	Unlikely. Highly restricted species known only from the Many Peaks range south of the area.
<i>Atalaya collina</i> Yarwun Whitewood Sapindaceae	EN	EN	Dry rainforest and semi-evergreen vine thicket communities in dark clay soils and on hillsides in the Yarwun – Miriam Vale region of C and SE QLD ¹⁷ .	Known. Suitable habitat present in the proposed Gladstone port master planned area and populations known to the West

¹³ Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 24th September 2015.

¹⁴ Maslin, B.R. (coordinator). 2001. *WATTLE: Acacias of Australia. CD-ROM, Version 1.0*. Australian Biological Resources Study, Canberra, and Department of Conservation and Land Management, Perth.

¹⁵ Queensland Herbarium. 2015. pers. com.

¹⁶ McGillivray, D.T. 1971. *Apatophyllum*: An interesting new Australian genus in the Family Celastraceae. *Kew Bulletin*. 25(3): 401-6.

¹⁷ Threatened Species Scientific Committee. 2009a. *Commonwealth Conservation Advice on Atalaya collina*. DEWHA, Canberra.

Botanical Name Common Name Family Name	Status*		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
<i>Bertya opponens</i> Broad-leaved Bertya Euphorbiaceae	VU	LC	Broad habitat range including mixed shrublands, Lancewood (<i>Acacia shirleyi</i>) woodlands, mallee, <i>Eucalyptus - Acacia</i> open forests with shrubby understorey, <i>Eucalyptus - Calltris</i> open woodlands and semi-evergreen vine thickets, in shallow red soils in coastal regions of eastern Australia ¹⁸ .	Stowe – Gravel Creek area of the proposed Gladstone port master planned area. This species is also known to the Boyne Valley area south of the area. Possible. Suitable habitat present within the study area and species is known to several areas in the vicinity of the proposed Gladstone port master planned area including Mount Muchison and Mount Castletower.
<i>Bosistoa transversa</i> Three-leaved Bosistoa Rutaceae	VU	LC	Lowland subtropical rainforests of subtropical coastal regions to 300 m altitude ¹⁹ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and several populations present in the Targinie – Mount Larcom area.
<i>Bulbophyllum globuliforme</i> Miniature Moss-orchid Orchidaceae	VU	NT	Epiphyte on the scaly bark of the branches and upper trunk of mature Hoop Pine (<i>Araucaria cunninghamii</i>) trees of subtropical coastal ranges in SE QLD and NE NSW at 500 - 800 m altitude ²⁰ .	Possible. This species is known from several locations along the eastern coastline of Queensland and New South Wales. It is known from the Kroombit Tops area south-west of the area and preferred host trees are known to occur within the area.
<i>Cupaniopsis shirleyana</i>	VU	VU	Dry rainforests and scrubby urbanised areas on moderate to very	Known. Suitable habitat is present within

¹⁸ Halford, D.A. and Henderson, R.J.F. 2002. Studies in Euphorbiaceae A.L.Juss. sens. lat. 3. A revision of *Bertya* Planch. (Ricinocarpeae Mull.Arg., Bertyinae Mull.Arg.). *Austrobaileya* 6(2): 221 – 223.

¹⁹ Department of Environment, Water, Heritage and Arts (DEWHA). 2008. *Bosistoa transversa* in *Species Profile and Threats Database*. Department of the Environment and Water Resources, Canberra. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=16091 viewed 24/09/2015.

²⁰ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

Botanical Name Common Name Family Name	Status*		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
Wedge-leaved Tuckeroo Sapindaceae			steep slopes, scree slope gullies and rocky stream channels at 60 – 550 m altitude in SE QLD, from Brisbane to Curtis Island ²¹ .	the proposed Gladstone port master planned area and this species is known from several locations in Queensland including on the southern end of Curtis Island and Aldoga area.
<i>Cycas megacarpa</i> Large-fruited Zamia Palm Cycadaceae	EN	EN	Woodlands and open woodlands dominated by Lemon-scented Spotted Gum (<i>Corymbia citriodora</i>), Narrow-leaved Red Ironbark (<i>Eucalyptus crebra</i>), Gum-topped Bloodwood (<i>C. eynthropioides</i>), Silver-leaved Ironbark (<i>E. melanophloia</i>) and Brush Box, on rocky substrates derived from acid volcanics, ironstone and mudstone and rarely alluvium and at 40 – 680 m altitude in the Bouldercombe-Woolooga of SE QLD ²² .	Known. Suitable habitat present within the proposed Gladstone port master planned area and this species is known several populations within and in the vicinity of the port master planned area including the Targinie – Mount Larcom area.
<i>Cycas ophiolitica</i> Marlborough Blue Zamia Palm Cycadaceae	EN	EN	Woodlands and open woodlands dominated by Ghost Gum (<i>Corymbia dallachiana</i>), Gum-topped Bloodwood, Serpentine Bloodwood (<i>C. xanthope</i>) and Broad-leaved Red Ironbark (<i>Eucalyptus fibrosa</i>) on serpentine substrates; Ghost Gum, Gum-topped Bloodwood and Narrow-leaved Red Ironbark on mudstone; and Pink Bloodwood (<i>C. intermedia</i>), Narrow-leaved Red Ironbark and Queensland Blue Gum (<i>E. tereticornis</i>) on alluvial loams and at 80 – 400 m altitude in the Marlborough – Rockhampton area of C QLD ²³ .	Possible. Suitable habitat present with the proposed Gladstone port master planned area and the known extent of this species lies to the north of the area.

²¹ Threatened Species Scientific Committee. 2009b. *Commonwealth Conservation Advice on Cupaniopsis shirleyana*. DEWHA, Canberra.

²² Queensland Herbarium. 2007. *National Multi-species Recovery Plan for the Cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia lomandroides, Macrozamia pauli-guilelmi and Macrozamia platyrrhachis*. DEWHA, Canberra.

²³ Queensland Herbarium. 2007. *National Multi-species Recovery Plan for the Cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia lomandroides, Macrozamia pauli-guilelmi and Macrozamia platyrrhachis*. DEWHA, Canberra.

Botanical Name Common Name Family Name	Status*		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
<i>Dansiea elliptica</i> Dansiea Combretaceae	NL	NT	Coastal nophyll vine forests and semi-evergreen vine thickets in sandy soils at low altitudes (30 - 150 m) in SE QLD and rainforests and rainforest margins at 100 - 500 m altitude in NE QLD ²⁴ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and this species known from a number of locations within and in the vicinity of the master planned area including the West Stowe – Targinie area.
<i>Dichanthium setosum</i> Bristly Bluegrass Poaceae	VU	VU	Moderately disturbed areas including cleared woodlands, grassy roadside remnants, grazed lands and highly disturbed pastures, in heavy basaltic soils and stony red-brown hard-setting loams with clay subsoil in S QLD and N NSW ²⁵ .	Possible. Suitable habitat is present in the proposed Gladstone port master planned area and this species is known south of the master planned area in the vicinity of Lake Awoonga.
<i>Germainia capitata</i> Germainia Grass Poaceae	VU	VU	Eucalypt and paperbark woodlands in sandy soils and often seasonally inundated areas, in the Gladstone-Bundaberg region of CE QLD and Torres Strait Islands in N QLD ²⁶ .	Unlikely. Highly restricted species with disjoint populations in the Agnes Waters area south of the proposed Gladstone port master planned area and the Torres Strait.
<i>Graptophyllum excelsum</i> Scarlet Fuchsia Acanthaceae	NL	NT	Semi-evergreen vine thickets in soil pockets among rocks and in rock crevices on quite steep, rough, rocky, eroded hillsides. Found in tropical and subtropical coastal regions of CE and NE QLD, from Cape York to Port Curtis, in soils derived from limestone, sandstone and igneous rock ²⁷ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and species is known from within the proposed Gladstone port master planned area (Targinie area) and surrounding area.

²⁴ Harden, G., McDonald, B. and Williams, J. 2006. *Rainforest Trees and Shrubs: A field guide to their identification*. Gwen Harden Publishing, Nambucca Heads.

²⁵ Threatened Species Scientific Committee. 2008a. *Commonwealth Conservation Advice on *Dichanthium setosum**. DEWHA, Canberra.

²⁶ Threatened Species Scientific Committee. 2008b. *Approved Conservation Advice for *Germainia capitata**. DEWHA, Canberra.

²⁷ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

Botanical Name Common Name Family Name	Status*		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
<i>Grevillea venusta</i> Byfield Spider Flower Proteaceae	VU	VU	Mixed sclerophyll forests and woodlands and rainforests of the Port Curtis area in C QLD in a range of soil types from deep sands to shallow granitic sands and along creekbanks or ridges and often at the base of mountains ²⁸ .	Possible. Suitable habitat present within the proposed Gladstone port master planned area and this species is known to the south of the proposed Gladstone port master planned area at Mount Castletower and to the north at Shoalwater Bay.
<i>Hernandia bivalvis</i> Grease Nut Hernandiaceae	NL	NT	Rainforests, vine thickets and microphyll vine forests to 620 m altitude on coastal ranges on rock pavements and outcrops in shallow soils in SE QLD ²⁹ .	Known. Suitable habitat present within the area and this species is known from the Targinie area.
<i>Macropteranthes leiocaulis</i> Smooth-barked Bonewood Combretaceae	NL	NT	Deciduous vine thickets, semi-evergreen vine thickets and araucarian microphyll vine forests and occasionally forest and woodland habitats in red eucrozems (red, strongly structured clay soils) or sandstone talus in E QLD ³⁰ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and this species is known from the Targinie area.
<i>Parsonia larcomensis</i> Mount Larcum Monkey-rope Apocynaceae	VU	VU	Open heathlands and shrublands at or near the summits of mountain peaks on cliffs or among outcrops of acid volcanic rocks and serpentinite and in shallow, loamy soils in association with Narrow-leaved Red Ironbark, <i>Xanthorrhoea</i> spp. and Serpentinite Rice Flower (<i>Pimelea leptospermoides</i>) at 350 – 750 m altitude in the Rockhampton - Mt Perry region of C QLD ³¹ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and this species is known from the Targinie area.

²⁸ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

²⁹ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

³⁰ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

³¹ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

Botanical Name Common Name Family Name	Status*		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
<i>Parsonia kroombitensis</i> Kroombit Tops Monkey Rope Apocynaceae	NL	VU	Low shrubby eucalypt woodlands and open shrublands and lithophytic ferns, at the edges of deep valleys and among outcrops of acidic volcanic rocks of CE QLD ³² .	Unlikely. Species is highly restricted to Kroombit Tops with one outlier recorded near Lake Awoonga.
<i>Phaius australis</i> Lesser Swamp-orchid Orchidaceae	EN	EN	Ecotones of swamps and forests including swampy sclerophyll forests dominated by paperbarks, swamp forests with sclerophyll emergents or fringing open forests and paperbark swamp forests associated with rainforest species and occasionally wallum, seagelands, rainforests and closed forests. Occurs in densely shaded areas in permanently damp, sandy soils (and at higher altitudes farther north) in coastal regions of SE QLD and NE NSW ³³ .	Unlikely. Broad distributional range however, preferred habitat not present within the area.
<i>Samadera bidwillii</i> Quassia Simaroubaceae	VU	VU	Lowland rainforests or rainforest margins and occasionally open forests, woodlands and mangroves in lithosols, skeletal soils, loamy sands, sands, silts and sands with clay subsoils at 1 - 617 m altitude in coastal regions ³⁴ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and this species is known from the Targinie area.
<i>Sophora fraseri</i> Brush Sophora Fabaceae	VU	VU	Margins and large gaps of wet sclerophyll forests, rainforests, dry open forests, araucarian notophyll vine forests, araucarian microphyll vine forests and thickets, semi-evergreen vine thickets and riverine vine scrub in shallow soils in hilly terrain at 60 – 660 m altitude in subtropical coastal regions of S QLD and N NSW ³⁵ .	Unlikely. This species is largely restricted to SE QLD and NE NSW with northernmost extent recorded at Boyne Valley, approximately 40 km south of the area.
<i>Xylosma ovata</i>	NL	NT	Littoral rainforests in CE QLD ³⁶ .	Possible. Small areas of suitable habitat

³² Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

³³ Threatened Species Scientific Committee. 2008c. *Commonwealth Conservation Advice on Phaius australis*. DEWHA, Canberra.

³⁴ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

³⁵ Department of Natural Resources. 1999. *Species Management Profiles: Flora and Fauna Information System 2*. DNR, Brisbane.

³⁶ Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 27th October 2015.

Botanical Name Common Name Family Name	Status*		Preferred Habitat	Likelihood of Occurrence ¹³
	CTH	QLD		
Coastal Xylosma Flacourtiaceae				are present within the proposed Gladstone port master planned area and this species is known from areas north and south of the area.
<i>Zieria acities</i> Mount Larcom Zieria Rutaceae	NL	EN	Open woodlands and shrublands, in crevices and clefts on exposed outcrops and cliff lines on the Targinie Quartz Monzonite at 630 m altitude and in association with Mount Larcom Monkey Rope, on an isolated peak of Mount Larcom, WNW of Gladstone in C QLD ³⁷ .	Known. Suitable habitat present within proposed Gladstone port master planned area and species known to the Targinie area.

³⁷ Threatened Species Scientific Committee. 2008d. *Commonwealth Conservation Advice on Zieria sp. Brolga Park (A.R. Bean 1002)*. DEWHA, Canberra.

7.4.1.2 Threatened Ecological Communities

Description and Context

Five threatened ecological communities as defined under the EPBC Act were identified as potential significant environmental values within the proposed Gladstone port master planned area, based on current state vegetation mapping.

Table 10 provides a list of threatened ecological communities potentially occurring within the proposed Gladstone port master planned area including their conservation status and corresponding regional ecosystems (REs) currently mapped on the DNRM vegetation management mapping system (Figure 14).

Table 10 Threatened Ecological Communities Potentially Occurring within the proposed Gladstone port master planned area

Threatened Ecological Community	Status*	REs Identified as Potentially Containing TEC	REs Currently Mapped within the Area	Total Area Mapped (ha)
Littoral Rainforests and Coastal Vine Thickets of Eastern Australia ³⁸	CE	3.2.1a, 3.2.1b, 3.2.12, 3.2.13, 3.2.28, 3.2.29, 3.2.31, 3.2.11, 3.12.20, 7.2.1a-l, 7.2.2.a-h, 7.2.5a, 7.2.6b, 7.11.3b, 7.12.11d, 8.2.2 and 12.2.2 (TSSC, 2008e).	12.2.2	529.0
Lowland Rainforests of Subtropical Australia ³⁹	CE	12.3.1, 12.5.13, 12.8.3, 12.8.4, 12.8.13, 12.11.1, 12.11.10, 12.12.1, 12.12.16 (TSSC, 2011b).	12.3.1	53.3
Brigalow (<i>Acacia harpophylla</i> dominant and codominant) ⁴⁰	EN	11.3.11, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.5.16, 11.9.1, 11.9.5, 11.9.6, 11.11.14, 11.12.21, 12.8.23, 12.9-10.6, 12.12.26 (TSSC, 2013a).	11.11.14	7.7
Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ⁴¹	EN	11.3.11, 11.4.1, 11.5.15, 11.8.13, 11.9.4, 11.11.18, 11.2.3, 11.8.3, 11.8.6, 11.9.8 (TSSC, 2001).	11.11.18, 11.3.11, 11.8.3	1768.1
Subtropical and Temperate Coastal Saltmarsh ⁴²	VU	12.1.2 (TSSC, 2013b).	12.1.2	3454.2

³⁸ Threatened Species Scientific Committee. 2008d. *Commonwealth Listing Advice on Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*. TSSC, Canberra.

³⁹ Threatened Species Scientific Committee. 2011b. *Commonwealth Listing Advice on Lowland Rainforest of Subtropical Australia*. TSSC, Canberra.

⁴⁰ Threatened Species Scientific Committee. 2013a. *Commonwealth Conservation Advice for Brigalow Ecological Community*. TSSC, Canberra.

⁴¹ Threatened Species Scientific Committee. 2001. *Commonwealth Listing Advice on Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions*. TSSC, Canberra.

⁴² Threatened Species Scientific Committee. 2013b. *Commonwealth Conservation Advice for Subtropical and Temperate Coastal Saltmarsh*. TSSC, Canberra.

*Status (CTH under the EPBC Act): CE = Critically Endangered, EN = Endangered, VU = Vulnerable. **based on current regulated vegetation mapping of regional ecosystems.

Potential Threats, Pressures and Impacts

Direct threats to threatened ecological communities in the proposed Gladstone port master planned area include:

- clearing and associated fragmentation / edge effects.

Indirect threats are also present in the master planned area including:

- invasive species
- inappropriate fire regimes
- disturbance from pest animals
- inappropriate grazing regimes and agricultural practices
- changes to hydrological regimes and tidal restriction
- mangrove encroachment
- inappropriate vector control practices
- pollution and litter
- eutrophication
- acid sulphate soils
- tourism and recreational disturbance
- pathogens
- climate change.

7.4.1.3 Listed Regional Ecosystems

Description and Context

The Regional Ecosystem Description Database lists the biodiversity status (BD Status) and the vegetation management class (VM class) of each regional ecosystem. The biodiversity status is based on an assessment of the condition of remnant vegetation in addition to the criteria used to determine the class under the *Vegetation Management Act 1999* (the Act). The VM class is listed in the Vegetation Management Regulation under the Act.

Regional Ecosystems (REs) are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. They are used to describe and categorise vegetation under the Queensland *Vegetation Management Act 1999* (VM Act) and are mapped by DNRM.

Regulated vegetation includes:

- Regulated vegetation under the VMA that is mapped as 'endangered' or 'of concern' or least concern regional ecosystems
- Essential habitat area for wildlife declared as endangered or vulnerable under the NCA
- Regional ecosystems that intersect with watercourses on vegetation management watercourse mapping or with wetlands on the vegetation management wetland map.

The proposed Gladstone port master planned area is mapped as containing 65 REs including six listed as endangered, 17 listed as of concern and 42 listed as least concern

under the VM Act and constitute significant environmental values within the proposed master planned area.

The names and conservation listing status of these REs are given in Table 11 and the extent of endangered and of concern REs is illustrated in Figure 14. Least concern REs are mapped in Figure 15.

A key gap in relation to these communities is site-specific survey information within the proposed Gladstone port master planned area to confirm their presence and condition.

Table 11 Regional Ecosystems Mapped within the proposed Gladstone port master planned area

*Status: VM Class = Vegetation Management Class as listed under the VM Act, Biodiversity = Biodiversity Status under the provisions of the Queensland VM Act 1999, EN = Endangered, OC = Of Concern, LC = Least Concern, NC = No Concern at Present.

RE Code	Community Description	Status*	
		VM Act	Biodiversity Status
11.1.1	Salt Couch (<i>Sporobolus virginicus</i>) grassland on marine clay plains	LC	NC
11.1.2a	Bare mud flats on Quaternary estuarine deposits with very isolated individual stunted mangroves	LC	NC
11.1.4a	<i>Rhizophora</i> open forest on Quaternary estuarine deposits	LC	NC
11.1.4c	Yellow Mangrove (<i>Ceriops tagal</i>) +/- Grey Mangrove (<i>Avicennia marina</i>) open forest on Quaternary estuarine deposits	LC	NC
11.1.4d	Mangrove closed forest on landward edge of tidal flats and upper tidal reaches of creeks	LC	NC
11.3.4	Queensland Blue Gum (<i>E. tereticornis</i>) and / or <i>Eucalyptus</i> spp. woodland on alluvial plains	OC	OC
11.3.11	Semi-evergreen vine thicket on alluvial plains	EN	EN
11.3.25	Queensland Blue Gum or River Red Gum (<i>E. camaldulensis</i>) woodland fringing drainage lines	LC	OC
11.3.26	Gum-topped Box (<i>E. moluccana</i>) or Grey Box (<i>E. microcarpa</i>) woodland to open forest on margins of alluvial plains	LC	NC
11.3.29	Narrow-leaved Ironbark, Queensland Peppermint, <i>Melaleuca</i> spp. woodland on alluvial plains	LC	NC
11.5.2	Narrow-leaved Ironbark, <i>Corymbia</i> spp. with Gum-topped Box on lower slopes of Cainozoic sand plains and / or remnant surfaces	LC	NC
11.5.8a	Poplar Gum (<i>E. platyphylla</i>), Pink Bloodwood, Swamp Box (<i>Lophostemon suaveolens</i>) +/- Queensland Blue Gum woodland on Cainozoic sand plains and / or remnant surfaces	LC	NC
11.5.9d	Lemon-scented Spotted Gum and / or Narrow-leaved Ironbark woodland on Cainozoic sand plains and / or remnant surfaces	LC	NC
11.7.6	Lemon-scented Spotted Gum and / or Narrow-leaved Ironbark woodland on Cainozoic lateritic duricrust	LC	NC
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks	OC	OC
11.8.4	Silver-leaved Ironbark open woodland on Cainozoic igneous rocks	LC	NC

RE Code	Community Description	Status*	
		VM Act	Biodiversity Status
11.11.3	Lemon-scented Spotted Gum, Narrow-leaved Ironbark, Yellow Stringybark (<i>E. acmenoides</i>) open forest on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.3c	Gum-topped Box woodland on lower slopes	LC	NC
11.11.4	Narrow-leaved Ironbark woodland on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.4a	Queensland Blue Gum woodland on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.4b	Brown Bloodwood (<i>Corymbia trachyphloia</i>) or Yellow Stringybark, Narrow-leaved Ironbark woodland +/- Black Wattle (<i>Acacia leiocalyx</i>) on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.4c	Gum-topped Box woodland on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.5	Microphyll vine forest +/- Hoop Pine on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.5a	Vine thicket, usually no Hoop Pine emergents, on old sedimentary rocks with varying degrees of metamorphism and folding	LC	NC
11.11.14	Brigalow open forest on deformed and metamorphosed sediments and interbedded volcanics	EN	EN
11.11.15	Narrow-leaved Ironbark woodland on deformed and metamorphosed sediments and interbedded volcanics	LC	NC
11.11.15a	Narrow-leaved Ironbark, Queensland Peppermint woodland on deformed and metamorphosed sediments and interbedded volcanics	LC	NC
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding	EN	EN
11.12.1	Narrow-leaved Ironbark woodland on igneous rocks	LC	NC
11.12.3	Narrow-leaved Ironbark, Queensland Blue Gum, Smooth-barked Apple (<i>Angophora leiocarpa</i>) woodland on igneous rocks especially granite	LC	OC
11.12.4	Semi-evergreen vine thicket and microphyll vine forest on igneous rocks	LC	NC
11.12.6	Lemon-scented Spotted Gum open forest on igneous rocks	LC	NC
11.12.14	<i>Lophostemon</i> spp. woodland on igneous rocks	OC	OC
11.12.15	Forest Sheoak (<i>Allocasuarina torulosa</i>), Weeping Cabbage Palm (<i>Livistona decora</i>) woodland on igneous rocks	OC	OC
11.12.18	Montane shrubland on igneous rocks	OC	OC
12.1.1	Swamp Sheoak (<i>Casuarina glauca</i>) woodland on margins of marine clay plains	OC	EN
12.1.2	Saltpan vegetation including grassland, hermland and sedgeland on marine clay plains	LC	NC

RE Code	Community Description	Status*	
		VM Act	Biodiversity Status
12.1.3	Mangrove shrubland to low closed forest on marine clay plains and estuaries	LC	NC
12.2.2	Microphyll / notophyll vine forest on beach ridges	OC	EN
12.2.11	Moreton Bay Ash (<i>C. tessellaris</i>) +/- Queensland Blue Gum, Pink Bloodwood and Weeping Cabbage Palm woodland on beach ridges in northern half of bioregion	LC	NC
12.2.14	Foredune complex	LC	NC
12.2.15	Red-fruit Sawsedge (<i>Gahnia sieberiana</i>), Spreading Roperush (<i>Empodisma minus</i>), <i>Gleichenia</i> spp. closed sedgeland in coastal swamps	LC	NC
12.2.16	Sand blows largely devoid of vegetation	OC	OC
12.3.1	Gallery rainforest (notophyll vine forest) on alluvial plains	EN	EN
12.3.3	Queensland Blue Gum woodland on Quaternary alluvium	EN	EN
12.3.3d	Gum-topped Box woodland on Quaternary alluvium	EN	EN
12.3.5	Broad-leaved Paperbark (<i>Melaleuca quinquenervia</i>) open forest on coastal alluvium	LC	OC
12.3.6	Broad-leaved Paperbark +/- Queensland Blue Gum, Swamp Box open forest on coastal alluvial plains	LC	NC
12.3.7	Queensland Blue Gum, River Sheoak (<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>) +/- <i>Melaleuca</i> spp. fringing woodland	LC	NC
12.3.11	Queensland Blue Gum +/- Grey Ironbark (<i>E. siderophloia</i>), Pink Bloodwood open forest on alluvial plains usually near coast	OC	OC
12.3.12	Broad-leaved White Mahogany (<i>E. latisinensis</i>) or Queensland Peppermint, Broad-leaved Tea-tree (<i>M. viridiflora</i> var. <i>viridiflora</i>) woodland on alluvial plains	LC	OC
12.5.1	Open forest complex with Lemon-scented Spotted Gum on subcoastal remnant Tertiary surfaces	LC	NC
12.5.4	Broad-leaved White Mahogany +/- Pink Bloodwood, Brown Bloodwood, Smooth-barked Apple, Queensland Peppermint woodland on complex of remnant Tertiary surfaces and Cainozoic and Mesozoic sediments	LC	NC
12.11.4	Semi-evergreen vine thicket on metamorphics +/- interbedded volcanics	OC	OC
12.11.6	Lemon-scented Spotted Gum, Narrow-leaved Ironbark woodland on metamorphics +/- interbedded volcanics	LC	NC
12.11.7	Narrow-leaved Ironbark woodland on metamorphics +/- interbedded volcanics	LC	NC
12.11.12	Araucarian complex microphyll vine forest on metamorphics +/- interbedded volcanics	OC	OC
12.11.14	Narrow-leaved Ironbark, Queensland Blue Gum, Pink Bloodwood woodland on metamorphics +/- interbedded volcanics	OC	OC

RE Code	Community Description	Status*	
		VM Act	Biodiversity Status
12.11.17	Yellow Stringybark or White Mahogany (<i>E. portuensis</i>) open forest on metamorphics +/- interbedded volcanics	OC	OC
12.11.18	Gum-topped Box woodland on metamorphics +/- interbedded volcanics	LC	NC
12.11.19	Broad-leaved Red Ironbark woodland on metamorphics +/- interbedded volcanics	OC	OC
12.11.20	Pink Bloodwood, Swamp Box woodland on metamorphics +/- interbedded volcanics	OC	OC
12.11.21	Buloke (<i>Allocasuarina leuhmannii</i>), Fibrebark (<i>Melaleuca nervosa</i>) woodland on metamorphics +/- interbedded volcanics	OC	OC
12.12.5	Lemon-scented Spotted Gum, Narrow-leaved Ironbark woodland on Mesozoic to Proterozoic igneous rocks	LC	NC
12.12.19	Vegetation complex of rocky headlands on Mesozoic to Proterozoic igneous rocks	OC	OC

Under the Queensland *Vegetation Management Act 1999* (VM Act), a permit may be required to clear endangered, of concern or least concern vegetation (Figure 14) unless the clearing is for an exempt activity.

Potential Threats, Pressures and Impacts

Direct threats to regional ecosystems in the proposed Gladstone port master planned area include:

- clearing and associated fragmentation / edge effects.

Indirect threats are also present in the master planned area including:

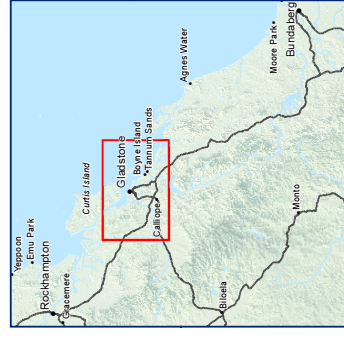
- invasive species
- inappropriate fire regimes
- changes to groundwater
- changes to hydrological regimes and tidal restriction
- tourism and recreational disturbance
- disturbance from pest animals
- inappropriate grazing regimes and agricultural practices
- mangrove encroachment
- inappropriate vector control practices
- pollution and litter
- eutrophication
- acid sulphate soils
- pathogens
- climate change.

Figure 14

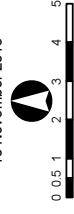
Regulated vegetation

Legend

- Cities
- Urban centres
- Local centres
- Localities
- Railway
- Highways
- Secondary Roads
- Property boundaries
- Port limits
- Proposed Gladstone port master planned area boundary
- Great Barrier Reef Marine Park
- Great Barrier Reef Coast Marine Park
- Essential Habitat
- Regional Ecosystems v8.0
 - Endangered (Dominant)
 - Endangered (Sub Dominant)
 - Of Concern (Dominant)
 - Of Concern (Sub Dominant)



10 November 2015



Coordinate System: GCS GDA 1984
Datum: GDA 1984
Units: Degree

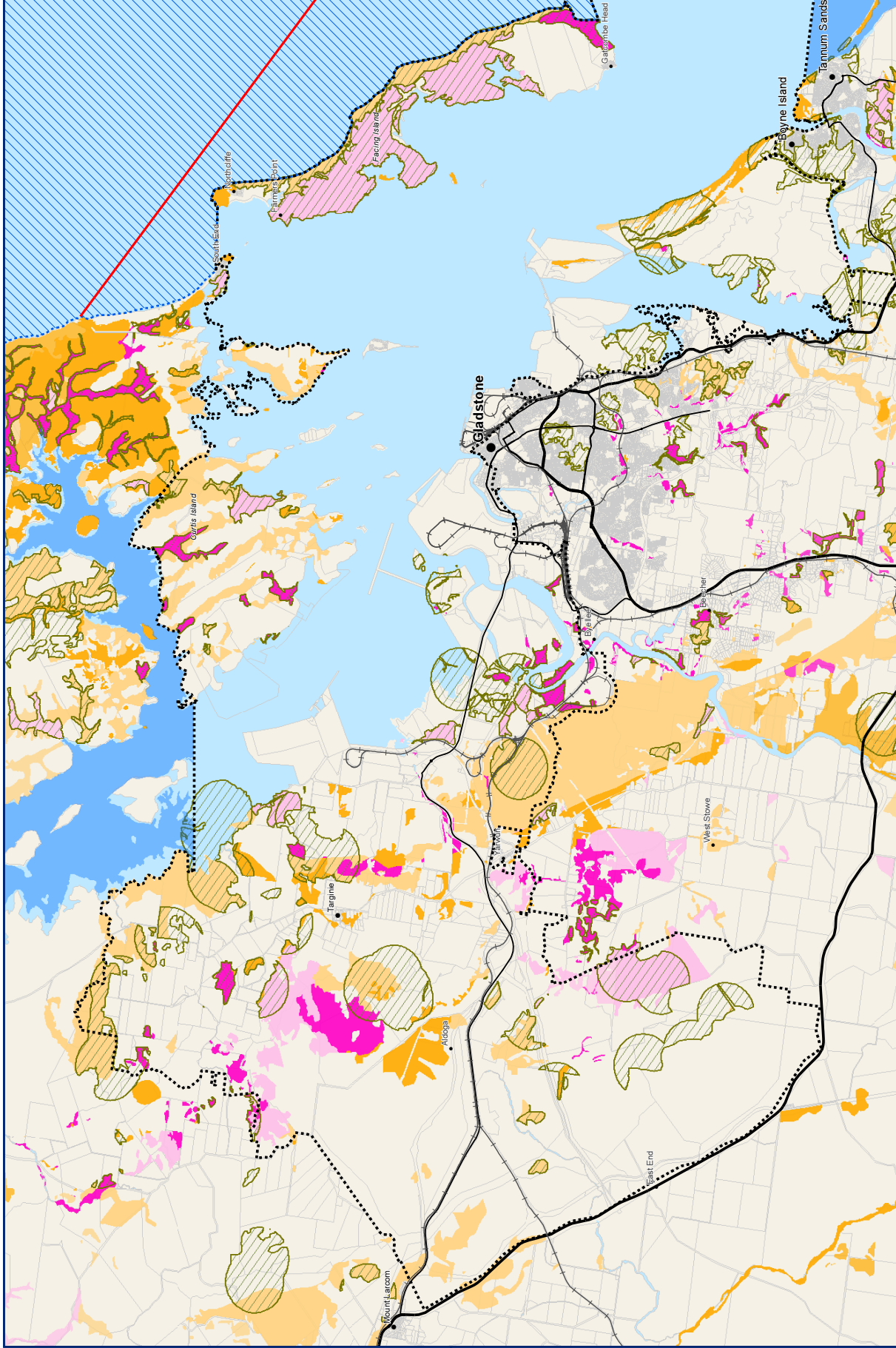
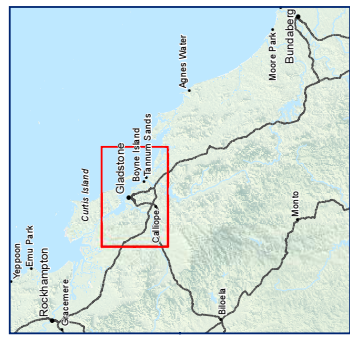
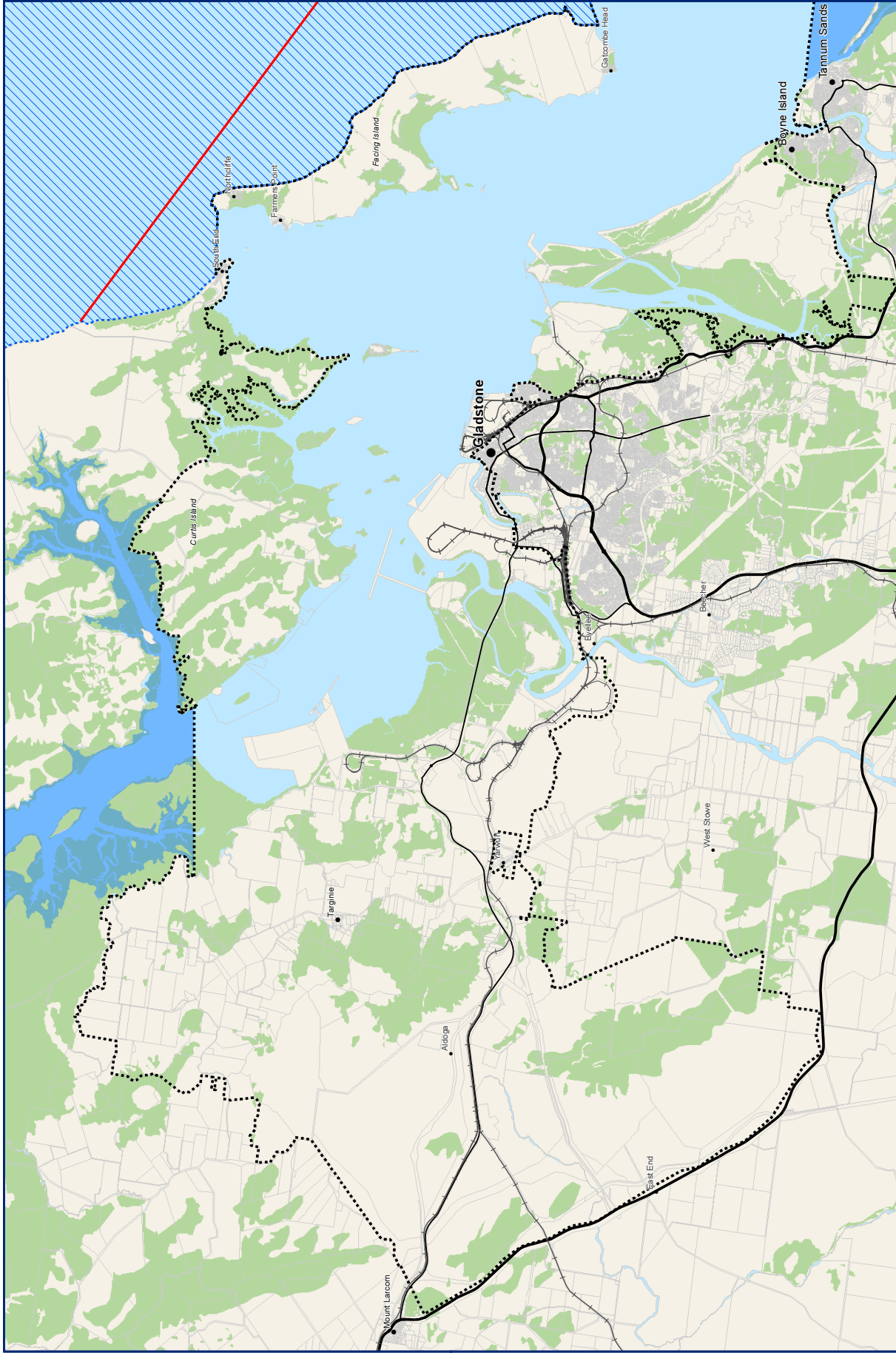


Figure 15

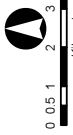
Least Concern vegetation

Legend

- Cities
- Urban centres
- Local centres
- Localities
- Railway
- Highways
- Secondary Roads
- Property boundaries
- Port limits
- ⋯ Proposed Gladstone port master planned area boundary
- ⋯ Great Barrier Reef Marine Park
- ⋯ Great Barrier Reef Coast Marine Park
- Regional Ecosystems v8.0
- Least concern



10 November 2015



0 0.5 1 2 3 4 5
 Kilometres
 Coordinate System: GCS GDA 1984
 Datum: GDA 1984
 Units: Degree

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7.4.1.4 Invasive Species

Table 12 summarises the invasive weed species identified as potentially occurring with the proposed Gladstone port master planned area. Thirty two Weeds of National Significance (WoNS) have been identified by the Australian government based on an assessment process that prioritised these weeds based on their invasiveness, potential for spread and environmental, social and economic impact⁴³.

There are three classes of declared weeds under the *Land Protection (Pest and Stock Route Management) Act 2002*. Class 1 declared weeds are not commonly present in Queensland and if found in Queensland are subject to eradication. Class 2 declared weeds are established in Queensland and must be controlled by landowners on their property. Class 3 declared weeds are established in Queensland and must be controlled by landowners whose property is adjacent to an environmentally significant area⁴⁴.

Table 12 Likelihood of occurrence of significant weeds in the proposed Gladstone port master planned area

Botanical Name	Common Name	WoNS (Cth)	Declared (QLD)
<i>Alternanthera philoxeroides</i>	Alligator Weed	Yes	Class 1
<i>Anredera cordifolia</i>	Madeira Vine	Yes	Class 3
<i>Asparagus aethiopicus</i>	Asparagus Fern	Yes	Class 3
<i>Asparagus aethiopicus</i> cv. Sprengeri	Basket asparagus Fern	No	Class 3
<i>Asparagus africanus</i>	Climbing Asparagus	Yes	Class 3
<i>Asparagus plumosus</i> , <i>Protasparagus plumosuss</i>	Climbing Asparagus-Fern	Yes	Class 3
<i>Baccharis halimifolia</i>	Groundsel Bush	Yes	Class 2
<i>Bryophyllum delagoense</i>	Mother-of-Millions	No	Class 2
<i>Bryophyllum x houghtonii</i>	Hybrid Mother of Millions	No	Class 2
<i>Cabomba caroliniana</i>	Cabomba	Yes	Class 2
<i>Cascabela thevetia</i>	Yellow	No	Class 3

⁴³ Australian Government 2014. *Weeds of National Significance*, <http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>.

⁴⁴ Queensland Government 2015. *Business and industry portal - Weed control laws*, <https://www.business.qld.gov.au/industry/agriculture/land-management/health-pests-weeds-diseases/weeds-and-diseases/controlling-weeds-property/weed-control-laws>.

Botanical Name	Common Name	WoNS (Cth)	Declared (QLD)
	oleander		
<i>Celtis sinensis</i>	Chinese elm	No	Class 3
<i>Chrysanthemoides monilifera</i>	Bitou Bush	Yes	Class 1
<i>Cryptostegia grandiflora</i>	Rubber Vine	Yes	Class 2
<i>Dolichandra unguis-cati</i>	Cats Claw	Yes	Class 3
<i>Eichhornia crassipes</i>	Water Hyacinth	Yes	Class 2
<i>Hymenachne amplexicaulis</i>	Hymenachne	Yes	Class 2
<i>Hymenachne amplexicaulis</i> cv. Olive	Olive Hymenachne	No	Class 2
<i>Jatropha gossypifolia</i>	Bellyache Bush	Yes	Class 2
<i>Lantana camara</i>	Lantana	Yes	Class 2
<i>Lantana montevidensis</i>	Creeping Lantana	No	Class 2
<i>Opuntia</i> spp.	Prickly Pears	Yes	Class 1
<i>Parkinsonia aculeata</i>	Parkinsonia	Yes	Class 2
<i>Parthenium hysterophorus</i>	Parthenium Weed	Yes	Class 2
<i>Prosopis</i> spp.	Mesquite	Yes	Class 1
<i>Protasparagus densiflorus</i>	Asparagus Fern	Yes	Class 3
<i>Rubus fruticosus aggregata</i>	Blackberry	Yes	Class 3
<i>Salix</i> spp.	Willows	Yes	Class 1
<i>Salvinia molesta</i>	Salvinia	Yes	Class 2
<i>Schinus terebinthifolius</i>	Broadleaf Paper Tree	No	Class 3
<i>Spathodea campanulata</i> subsp. <i>nilotica</i>	Bidgood	No	Class 2
<i>Sphagneticola trilobata</i>	Creeping Ox-eye	No	Class 3
<i>Sporobolus africanus</i>	Parramatta grass	No	Class 2
<i>Sporobolus fertilis</i>	Giant Parramatta grass	No	Class 2
<i>Sporobolus jacquemontii</i>	American	No	Class 2

Botanical Name	Common Name	WoNS (Cth)	Declared (QLD)
	Ratstail Grass		
<i>Sporobolus natalensis</i> , <i>Sporobolus pyramidalis</i>	Giant Ratstail Grass	No	Class 2
<i>Tecoma stans</i> var. <i>stans</i>	Yellow Tecoma	No	Class 3
<i>Vachellia nilotica</i>	Prickly Acacia	Yes	Class 2

7.4.2 Fauna

7.4.2.1 Threatened Terrestrial Birds

Description and Context

Fifteen conservation significant terrestrial bird species, listed under the provisions of the EPBC Act and/or NC Act, were identified from the desktop assessment as potentially occurring within the proposed Gladstone port master planned area (Table 13).

Refinement of the potential occurrence of each species, based on the likelihood of occurrence assessment, identified seven conservation significant terrestrial bird species that are known to occur within the proposed Gladstone port master planned area. In addition, six other species are considered to have a possible likelihood of occurrence within the proposed Gladstone port master planned area based on their known range and the presence of suitable habitat within the study. The remaining two species are considered unlikely to occur within the proposed Gladstone port master planned area.

The proposed Gladstone port master planned area supports suitable habitat for the species with a number of these previously recorded in the area. A key gap in relation to these species is site-specific survey information within the proposed Gladstone port master planned area in areas of potential habitat.

Potential Threats, Pressures and Impacts

Potential threats (direct and indirect) to conservation significant terrestrial bird species in the proposed Gladstone port master planned area have been identified.

Potential direct threats to these species include:

- the loss of suitable foraging and nesting habitat from vegetation clearing
- the mortality and/or injury of fauna resulting from vehicles and machine interactions.

Potential indirect threats to these species include:

- fragmentation of habitat and habitat degradation from increased edge effects
- exacerbation of weeds and pest animals
- noise, light and vehicle movements disturbing breeding periods
- alterations to freshwater hydrology and surface water quality

- fire and altered fire regimes.

Table 13 Likelihood of occurrence of listed bird species within the proposed Gladstone port master planned area

*Conservation Status: CTH = Commonwealth (listed under the EPBC Act), QLD = Queensland (listed under the NC Act), EX = Extinct, CE = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, SL = Special Least Concern, NL = Not Listed

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁴⁵
	CTH	QLD		
<i>Botaurus poiciloptilus</i> Australasian Bittern	EN	LC	The Australasian Bittern occurs in terrestrial wetlands and, rarely, estuarine habitats, mainly in the temperate southeast and southwest. It favours wetlands with tall dense vegetation ⁴⁶ .	Possible. Suitable habitat areas including estuarine habitats are present within the proposed Gladstone port master planned area. As such this species is considered a possible occurrence.
<i>Calidris ferruginea</i> Curlew Sandpiper	CE	SL	Species utilises the intertidal zone for foraging and roosting purposes. Habitat types within the intertidal zone include mudflats, mangrove communities, rocky shores, saltflats and salt marshes and sandy beaches ⁴⁷ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area near Yarwun and Southend, Curtis Island ⁴⁸ .
<i>Calyptorhynchus lathamii erebus</i> Glossy Black-cockatoo (northern)	NL	VU	The Glossy Black-cockatoo is reliant on casuarina seeds and requires habitats that include these trees. Inhabits forest and woodland with abundant casuarina trees ⁴⁹ .	Possible. Suitable habitat areas are present within the proposed Gladstone port master planned area. As such this species is considered a possible occurrence.

⁴⁵ Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 24th September 2015.

⁴⁶ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁴⁷ URS. 2009. *GLNG EIS Marine Ecology Technical Report*. Report prepared for Santos Ltd.

⁴⁸ ALA. 2015. *Species profile occurrence search results*. Atlas of Living Australia.

⁴⁹ Morcombe. 2004. *Field guide to Australian Birds*. Steve Parish Publishing, Archerfield, Australia.

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁴⁵
	CTH	QLD		
<i>Cyclopsitta diophthalma coxeni</i> Coxen's Fig-Parrot	EN	EN	Core habitat is rainforest but ventures out short distances to into woodland.	Unlikely. Core habitat unlikely to be present in large areas and therefore species unlikely to be present.
<i>Epthianura crocea macgregori</i> Yellow Chat (Dawson)	VU	EN	Occurs within coastal grassy swamps and lagoon margins in vegetation of reeds and saltbush.	Possible. Suitable habitat areas are present within the proposed Gladstone port master planned area. As such this species is considered a possible occurrence.
<i>Erythrotrichis radiatus</i> Red Goshawk	VU	EN	The Red Goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia ⁵⁰ . The red goshawk requires woodland habitat for nesting and foraging purposes. Nest trees are invariably within 1 km of permanent water (river, swamp, pool).	Unlikely. Core habitat unlikely to be present in large areas and therefore species unlikely to be present.
<i>Esacus magnirostris</i> Beach Stone-curlew	NL	VU	The Beach Stone-curlew is confined to marine tidal habitat such as mudflats, mangroves and sandy, stony or rocky shores ⁵¹ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area near Targinie and Southend, Curtis Island.
<i>Falco hypoleucos</i> Grey Falcon	NL	VU	The Grey Falcon occurs within shrubland, grassland and wooded watercourses of arid and semi-arid regions ⁵² .	Possible. Suitable habitat areas are present within the proposed Gladstone port master planned area. As such this species is considered a possible occurrence.

⁵⁰ Department of the Environment (2015). *Species Profile and Threats Database*, Department of the Environment, Canberra.

⁵¹ Morcombe, M. 2004. *Field Guide to Australian Birds*. Steve Parish Publishing. Archerfield, Australia

⁵² Morcombe, M. 2004. *Field Guide to Australian Birds*. Steve Parish Publishing. Archerfield, Australia

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁴⁵
	CTH	QLD		
<i>Geophaps scripta scripta</i> Squatter Pigeon (southern subspecies)	VU	VU	The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open eucalypt forests. The species also inhabits sown grasslands with scattered remnant trees, disturbed areas (such as roads, railways, settlements and stockyards), scrubland, Acacia regrowth and is commonly found in heavily-grazed areas north of the Tropic of Capricorn. However, it is noted that this species is considered more common in ungrazed land ⁵³ .	Known. This species was recorded within the proposed Gladstone port master planned area.
<i>Neochmia ruficauda ruficauda</i> Star Finch	EN	EN	Inhabits tall grass besides swamps and rivers, and grassy eucalypt open woodlands near watercourses ⁵⁴ .	Possible. Suitable habitat areas are present within the proposed Gladstone port master planned area. As such this species is considered a possible occurrence.
<i>Ninox strenua</i> Powerful Owl	NL	VU	The Powerful Owl is found in open forests and woodlands, as well as along sheltered gullies in wet forests with dense understoreys, especially along watercourses ⁵⁵ .	Known. This species was recorded within the proposed Gladstone port master planned area.
<i>Numenius madagascariensis</i> Eastern Curlew	CE	VU	The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass ⁵⁶ .	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area in suitable habitat near Curtis Island and Barney Point (ALA, 2015).
<i>Poephila cincta cincta</i>	EN	EN	The Black-throated Finch (southern) occurs mainly in grassy, open	Known. Suitable habitat present within

⁵³ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁵⁴ Morcombe, M. 2004. *Field Guide to Australian Birds*. Steve Parish Publishing. Archerfield, Australia

⁵⁵ Morcombe, M. 2004. *Field Guide to Australian Birds*. Steve Parish Publishing. Archerfield, Australia

⁵⁶ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁴⁵
	CTH	QLD		
Black-throated Finch (southern)			woodlands and forests, typically dominated by Eucalyptus, Corymbia and Melaleuca, and occasionally in tussock grasslands or other habitats (for example freshwater wetlands), often along or near watercourses, or in the vicinity of water. Eucalypts commonly associated with this species include Narrow-leaved Ironbark, River Red Gum and Silver-leaved Ironbark ⁵⁷ .	the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area along the margins of South Trees Inlet east of Glen Eden.
<i>Rostratula australis</i> Australian Painted Snipe	VU	VU	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans.	Possible. Suitable habitat areas are present within the proposed Gladstone port master planned area. As such this species is considered a possible occurrence.
<i>Turnix melanogaster</i> Black-breasted Button-quail	VU	VU	The black-breasted button-quail is restricted to rainforests and forests, mostly in areas with 770-1,200 mm rainfall per annum. They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, Araucarian microphyll vine forest and Araucarian notophyll vine forest.	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area along the margins of South Trees Inlet east of Glen Eden.

⁵⁷ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

7.4.2.2 Migratory Species

Description and Context

The desktop assessment identified 56 migratory bird species listed under the provisions of the EPBC Act were identified as potentially occurring within the proposed Gladstone port master planned area. This includes 15 migratory marine birds, 10 migratory terrestrial birds and 31 migratory wetland birds. Refinement of the potential occurrence of each species based on the likelihood of occurrence assessment identified 45 migratory species that are known to occur within the proposed Gladstone port master planned area (refer Table 14).

In addition, seven additional migratory species are considered to have a possible likelihood of occurrence within the proposed Gladstone port master planned area based on their known range and the presence of suitable habitat within the study. The remaining four migratory species are considered to have an unlikely likelihood of occurrence.

Shorebird surveys have been undertaken annually since 2011 along the Curtis Coast⁵⁸. A total of 13,752 migratory shorebirds consisting of 21 species were recorded during the survey in 2015 which found increases in Red-necked Stints, Great Knots, Bar-tailed Godwits, Greater Sand Plover and Whimbrels and decreases in numbers of Lesser Sand Plovers, Terek Sandpipers Eastern Curlew and Grey Tattlers over the 144 roost sites surveyed. Two rarely recorded species, Latham's Snipe and Little Curlew were also seen during this survey.

Counts of Eastern Curlew, now considered critically endangered, Terek Sandpiper and Grey-tailed Tattler, indicate that the Curtis Coast population may be considered a site of national significance for these species as they support 0.1 per cent of the population threshold⁵⁹.

During the 2015 survey around 100 Curlew Sandpiper were recorded on the Port Curtis coast⁶⁰.

The proposed Gladstone port master planned area supports suitable habitat for the species with a number of these previously recorded in the area. A key gap in relation to these species is site-specific survey information within the proposed Gladstone port master planned area in areas of potential habitat.

Potential Threats, Pressures and Impacts

Potential threats (direct and indirect) to migratory bird species in the proposed Gladstone port master planned area have been identified.

Potential direct threats to these species include:

- loss and disturbance of shorebird roost sites
- the loss of suitable foraging and nesting habitat from vegetation clearing

⁵⁸ Wildlife Unlimited. 2015. Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey – 2015.

⁵⁹ DEWHA. 2009. Significant impact guidelines for 36 migratory shorebirds – Background paper to EPBC Act policy statement 3.21. Commonwealth of Australia.

⁶⁰ Wildlife Unlimited. 2015. Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey – 2015.

- the mortality and/or injury of fauna resulting from vehicles and machine interactions
- disruption of migratory shorebird foraging and roosting areas

Potential indirect threats to these species include:

- fragmentation of habitat and habitat degradation from increased edge effects
- exacerbation of weeds and pest animals
- noise, light and vehicle movements disturbing breeding periods and foraging
- alterations to freshwater hydrology and surface water quality
- fire and altered fire regimes.

Table 14 Likelihood of occurrence of migratory species within the proposed Gladstone port master planned area

*Conservation Status: CTH = Commonwealth (listed under the EPBC Act), QLD = Queensland (listed under the NC Act), Mi = Migratory, SL = Special Least Concern.

Scientific Name Common Name	Status*		Likelihood of occurrence ⁶¹
	CTH	QLD	
<i>Acrocephalus australis</i> Australian Reed-warbler	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Auckland Inlet and Boyne River, Tannum Sands.
<i>Actitis hypoleucos</i> Common sandpiper	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Yarwun, Tannum Sands and Auckland Inlet.
<i>Anous stolidus</i> Common noddy	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area near Tannum Sands.
<i>Apus pacificus</i> Fork-tailed swift	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Tannum Sands.
<i>Ardea alba modesta</i> Eastern Great Egret	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Mt Larcom.
<i>Ardea ibis</i> Cattle Egret	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Targinie and Boyne Island.
<i>Arenaria interpres</i> Ruddy Turnstone	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Southend, Curtis Island.
<i>Ardenna pacifica</i> Wedge-tailed shearwater	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area over waters east of Tannum Sands.
<i>Ardenna tenuirostris</i> Short-tailed shearwater	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area over waters near of Facing Island.

⁶¹ Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 24th September 2015.

Scientific Name Common Name	Status*		Likelihood of occurrence ⁶¹
	CTH	QLD	
<i>Calidris alba</i> Sanderling	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Yarwun.
<i>Calidris acuminata</i> Sharp-tailed Sandpiper	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area in Port Curtis.
<i>Calidris canutus</i> Red Knot	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Yarwun.
<i>Calidris ruficollis</i> Red-necked Stint	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Yarwun, Port Curtis and Southend, Curtis Island.
<i>Calidris subminuta</i> Long-toed Stint	Mi	SL	Possible. No records for the species are found within the area. However suitable habitat is present within the area, and thus is a possible occurrence.
<i>Calidris tenuirostris</i> Great Knot	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Southend, Curtis Island .
<i>Charadrius bicinctus</i> Double-banded Plover	Mi	SL	Possible. No records for the species are found within the area. However suitable habitat is present within the area, and thus is a possible occurrence.
<i>Charadrius leschenaultii</i> Greater Sand Plover	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Southend, Curtis Island.
<i>Charadrius mongolus</i> Lesser Sand Plover	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Southend, Curtis Island and Boyne Island.
<i>Charadrius veredus</i> Oriental Plover	Mi	SL	Unlikely. No records within the proposed Gladstone port master planned area or region. Species has a preference toward semi-arid regions such as claypans and gibberstone plains. Marine areas such as tidal mudflats are used less frequently.
<i>Coracina tenuirostris</i> Cicadabird	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Clinton and Tannum Sands.
<i>Cuculus optatus</i> Oriental Cuckoo	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Clinton and Tannum Sands.
<i>Fregata ariel</i> Lesser frigatebird	Mi	SL	Possible. Records exist for the species on offshore islands and oceanic waters adjacent to the proposed Gladstone port master planned area.
<i>Fregata minor</i> Great frigatebird	Mi	SL	Possible. Records exist for the species on offshore islands and oceanic waters near Heron Reef. Species could be a visitor to the area.
<i>Gallinago hardwickii</i> Latham's Snipe	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Yarwun and Clinton.

Scientific Name Common Name	Status*		Likelihood of occurrence ⁶¹
	CTH	QLD	
<i>Gallinago megala</i> Swinhoe's Snipe	Mi	SL	Unlikely. No records within the area. National records indicate that this species occurs across northern Australia.
<i>Gallinago stenura</i> Pin-tailed Snipe	Mi	SL	Unlikely. No records within the area. National records indicate that this species occurs across northern Australia.
<i>Gelochelidon nilotica</i> Gull-billed tern	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area within Port Curtis.
<i>Hirundapus caudacutus</i> White-throated Needletail	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Mt Larcom.
<i>Hydroprogne caspia</i> Caspian tern	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area throughout Port Curtis.
<i>Limicola falcinellus</i> Broad-billed Sandpiper	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Auckland Inlet and Clinton.
<i>Limosa lapponica</i> Bar-tailed Godwit	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Southend, Curtis Island and throughout Port Curtis.
<i>Limosa limosa</i> Black-tailed Godwit	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Clinton.
<i>Merops ornatus</i> Rainbow Bee-eater	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the study near Mt Larcom, Yarwun, Clinton, Camp Island and Targinie.
<i>Monarcha melanopsis</i> Black-faced Monarch	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Curtis Island.
<i>Myiagra cyanoleuca</i> Satin Flycatcher	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Yarwun and Curtis Island.
<i>Oceanites oceanicus</i> Wilson's storm-petrel	Mi	SL	Possible. Records exist for the species on offshore islands and oceanic waters near Heron Reef. Record exists within Gladstone from 130. As such, species considered a potential visitor to the area.
<i>Onychoprion anaethetus</i> Bridled tern	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area near Kirkwood.
<i>Plegadis falcinellus</i> Glossy Ibis	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Barney Point.

Scientific Name Common Name	Status*		Likelihood of occurrence ⁶¹
	CTH	QLD	
<i>Pluvialis fulva</i> Pacific Golden Plover	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Clinton.
<i>Pluvialis squatarola</i> Grey Plover	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area south of Yarwun.
<i>Rhipidura rufifrons</i> Rufous Fantail	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Camp Island.
<i>Stercorarius maccormicki</i> South Polar skua	Mi	SL	Unlikely. Offshore species with records south east of Brisbane. Unlikely occurrence within area.
<i>Sterna albifrons</i> Little tern	Mi	SL	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the area near Yarwun, and waters south of Quoin Island and Southend.
<i>Sterna dougallii</i> Roseate tern	Mi	SL	Possible. Known nesting habitat east of the proposed Gladstone port master planned area on Wilson Island. Possible visitor to area.
<i>Sterna hirundo</i> Common Tern	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Parsons Point.
<i>Sterna sumatrana</i> Black-naped Tern	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area south of Quoin Island.
<i>Sula leucogaster</i> Brown Booby	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area in waters south of Quoin Island.
<i>Symposiachrus trivirgatus</i> Spectacled Monarch	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Canoe Point.
<i>Numenius minutus</i> Little Curlew	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Clinton.
<i>Numenius phaeopus</i> Whimbrel	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area in suitable habitat near Curtis Island, Barney Point and Tannum Sands.
<i>Pandion cristatus</i> Eastern Osprey	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Curtis Island, Wiggins Island, Barney Point and Tannum Sands.
<i>Tringa brevipes</i> Grey-tailed Tattler	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Targinie, Southend and Canoe Point.
<i>Tringa incana</i> Wandering Tattler	Mi	SL	Possible. No records for the species are found within the area. However suitable habitat is present within the area, and thus is a possible occurrence.

Scientific Name Common Name	Status*		Likelihood of occurrence ⁶¹
	CTH	QLD	
<i>Tringa nebularia</i> Common Greenshank	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Southend and Hay Island.
<i>Tringa stagnatilis</i> Marsh Sandpiper	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Hay Island.
<i>Xenus cinereus</i> Terek Sandpiper	Mi	SL	Known. Suitable habitat present within the area and species has been recorded from within the area near Passage Islands.

7.4.2.3 Other Listed Threatened Fauna

Description and Context

Eleven conservation significant fauna species listed under the provisions of the EPBC Act and/or NC Act were identified from the desktop assessment as potentially occurring within the proposed Gladstone port master planned area (Table 16).

Refinement of the potential occurrence of each species based on the likelihood of occurrence assessment identified one species that is known to occur within the proposed Gladstone port master planned area (Table 15). In addition, ten other fauna species are considered to have a possible likelihood of occurrence within the proposed Gladstone port master planned area based on their known range and the presence of suitable habitat within the area.

The proposed Gladstone port master planned area supports suitable habitat for these species with a number of these previously recorded in the area. A key gap in relation to these species is site-specific survey information within the proposed Gladstone port master planned area in areas of potential habitat.

Table 15 Likelihood of occurrence of other listed fauna species within the proposed Gladstone port master planned area

*Conservation Status: CTH = Commonwealth (listed under the EPBC Act), QLD = Queensland (listed under the NC Act), EX = Extinct, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, SL = Special Least Concern, NL = Not Listed.

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁶²
	CTH	QLD		
Mammals				
<i>Taphozous australis</i> Coastal Sheath-tail Bat	NL	NT	This species prefers to roost in sea caves and rocky clefts although it is also known to roost in boulder piles ⁶³ .	Possible. Suitable habitat areas are present within the area. As such this species is considered a possible occurrence.
<i>Xeromys myoides</i> Water Mouse	VU	VU	In south-east Queensland, Water Mouse habitat includes mangrove communities and adjacent sedgeland, grasslands and freshwater wetlands ⁶⁴ .	Possible. Suitable habitat areas are present within the area. As such this species is considered a possible occurrence.
<i>Ornithorhynchus anatinus</i> Platypus	NL	SL	Inhabits freshwater streams, lakes, shallow reservoirs and farm dams. Prefers areas with steep, vegetated banks in which to burrow ⁶⁵ .	Possible. Suitable habitat areas are present within the area. As such this species is considered a possible occurrence.
<i>Phascolarctos cinereus</i> Koala	VU	VU	Koalas occur within open woodland habitat comprising a range of Eucalypt species.	Known. Suitable habitat areas are present within the area, including essential habitat mapping.
<i>Tachyglossus aculeatus</i> Short-beaked Echidna	NL	SL	Species occurs in a variety of terrestrial habitats including desert, rainforest, open forest and farmland ⁶⁶ .	Known. Suitable habitat present within the GSDA and species has been

⁶² Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 27th October 2015.

⁶³ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁶⁴ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁶⁵ Menkhorst, P. and Knight, F. 2004. *A Field Guide to the Mammals of Australia*. Oxford University Press, Australia.

⁶⁶ Menkhorst, P. and Knight, F. 2004. *A Field Guide to the Mammals of Australia*. Oxford University Press, Australia.

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁶²
	CTH	QLD		
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat	VU	VU	Roosting habitat for this species includes overhangs, caves, mine shafts and abandoned fairy martin nests which this species depends ⁶⁷ .	recorded from within the GSDA east of Mount Larcom. Possible. Suitable habitat areas are present within the GSDA. As such this species is considered a possible occurrence.
<i>Dasyurus hallucatus</i> Northern Quoll	EN	LC	The Northern Quoll occurs within rocky areas and eucalypt forests which support hollow logs, rock crevices, caves and hollow trees ⁶⁸ .	Possible. Suitable habitat areas are present within the GSDA. As such this species is considered a possible occurrence.
<i>Nyctophilus corbeni</i> Corben's Long-eared Bat	VU	VU	Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands.	Possible. Suitable habitat areas are present within the GSDA. As such this species is considered a possible occurrence.
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox	VU	LC	The Grey-headed Flying-fox requires foraging resources and roosting sites. It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. The Grey-headed Flying-fox roosts in aggregations of various sizes on exposed branches. Roost sites are typically located near water, such as lakes, rivers or the coast ⁶⁹ .	Possible. Suitable habitat areas are present within the GSDA. As such this species is considered a possible occurrence.

⁶⁷ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁶⁸ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁶⁹ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

Scientific Name Common Name	Status*		Preferred habitat	Likelihood of occurrence ⁶²
	CTH	QLD		
Reptiles				
<i>Egernia rugosa</i> Yakka Skink	VU	VU	The Yakka Skink occurs within woodland habitat including the species: Brigalow (<i>Acacia harpophylla</i>), Mulga (<i>A. aneura</i>), Bendee (<i>A. catenulata</i>), Lancewood (<i>A. shirleyi</i>), Belah (<i>Casuarina cristata</i>), Poplar Box (<i>Eucalyptus populnea</i>), Ironbark (<i>Eucalyptus</i> spp.) and White Cypress Pine (<i>Callitris glaucophylla</i>). Microhabitat for this species includes cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows ⁷⁰ .	Possible. Suitable habitat areas are present within the GSDA. As such this species is considered a possible occurrence.
<i>Furina dunmali</i> Dunmall's Snake	VU	VU	Dunmall's Snake has been found in a range of habitats including various Spotted Gum (<i>Corymbia citriodora</i>), Ironbark (<i>Eucalyptus crebra</i>) and <i>E. melanophloia</i> , White Cypress Pine (<i>Callitris glaucophylla</i>) and Bullock open forest and woodland associations on sandstone derived soils. Little is known about the microhabitat requirements of this species ⁷¹ .	Possible. Suitable habitat areas are present within the GSDA. As such this species is considered a possible occurrence.

⁷⁰ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

⁷¹ Department of the Environment. 2015. *Species Profile and Threats Database*. Department of the Environment, Canberra.

7.4.3 Pests

Table 16 outlines the potential faunal pest species that could occur within the proposed Gladstone port master planned area.

Table 16 Possible animal pest species in the proposed Gladstone port master planned area⁷²

Scientific Name	Common Name	Known to be present
Invertebrates		
<i>Solenopsis invicta</i>	Fire Ant	Yes, Curtis Island, Yarwun ⁷³
Birds		
<i>Acridotheres tristis</i>	Indian Myna	No
<i>Anas platyrhynchos</i>	Mallard	No
<i>Columba livia</i>	Rock Pigeon	Yes
<i>Lonchura punctulata</i>	Nutmeg Mannikin	No
<i>Passer domesticus</i>	House Sparrow	Yes
<i>Streptopelia chinensis</i>	Spotted Turtle-Dove	No
<i>Sturnus vulgaris</i>	Common Starling	No
Frogs		
<i>Rhinella marina</i>	Cane Toad	Yes
Mammals		
<i>Bos taurus</i>	Domestic Cattle	Yes
<i>Canis lupus familiaris</i>	Domestic Dog	Yes
<i>Capra hircus</i>	Goat	No
<i>Equus caballus</i>	Horse	No
<i>Felis catus</i>	Domestic Cat	Yes
<i>Lepus europeus</i>	Brown Hare	Yes

⁷² DAF 2015. *Photo guide to pest animals*. Source: <https://www.daf.qld.gov.au/plants/weeds-pest-animals-ants/pest-animals/a-z-listing-of-pest-animals/photo-guide-to-pest-animals>.

⁷³ DAF 2015. Fire ant restricted area map and declaration notice within Gladstone. Source: https://www.daf.qld.gov.au/_data/assets/pdf_file/0015/147030/RIFA-gladstone-restricted-area.pdf.

Scientific Name	Common Name	Known to be present
<i>Mus musculus</i>	House Mouse	Yes
<i>Oryctolagus cuniculus</i>	European Rabbit	Yes
<i>Rattus rattus</i>	Black Rat	Yes
<i>Sus scrofa</i>	Pig	Yes
<i>Vulpes vulpes</i>	Red Fox	Yes
Fish		
<i>Gambusia holbrooki</i>	Mosquito fish	Yes
<i>Poecilia reticulata</i>	Guppy	Yes

It is noted that there are many environmental management programs in place in the Gladstone area, which may be active within the proposed Gladstone port master planned area. These groups and some of their activities are identified below.

- Fitzroy Basin Association, (Grazing Best Management Practice Programs, support feral animal and weed control programs, rubbish removal in waterways and beaches, tree and shrub planting, installation of cattle watering points (away from waterways)⁷⁴
- Conservation Volunteers Australia (with CQ University, quarterly surveys of marine debris)⁷⁵
- Capricorn Coast Landcare Group (land and creek rehabilitation, seed collection and plant propagation, water quality monitoring, weed buster workshops)
- Port Curtis Harbour Watch (school and community based program monitoring marine and estuarine water and substrate in Gladstone Harbour and surrounds)
- Society for Growing Australian Plants Queensland, Gladstone Branch (support the Tondoon Botanic Gardens Herbarium, advice for bush tucker school gardens, community tree planting)
- Green Army (environmental conservation, community engagement, participation and experience, skills, training and accreditation in a range of conservation management areas).

Potential Threats, Pressures and Impacts

Potential threats (direct and indirect) to conservation significant fauna species in the proposed Gladstone port master planned area have been identified.

⁷⁴ Fitzroy Basin Association. 2015. Annual Report 2014-2015. Source: <http://www.fba.org.au/wordpress/wp-content/uploads/2015/10/Fitzroy-Basin-Association-Inc-Annual-Report-2014-15.pdf>

⁷⁵ Since 2011 quarterly surveys of marine debris have collected 20,999 items, commonly plastic fragments and rope. CQU, 2015, *Ocean Rubbish is Harming Our Marine Animals*. Source: <https://www.cqu.edu.au/cquinews/stories/general-category/2015/ocean-rubbish-is-harming-our-marine-animals>

Direct threats to these species in the master planned area include:

- habitat loss
- loss of fauna movement corridors (local and regional)
- fauna mortality through collision with vehicles.

Indirect threats vary as these species have a wide range of behaviours and habitats, and include:

- fragmentation and edge effects
- fire or altered fire regimes
- pests, in particular cane toads that are ingested by northern quolls
- exacerbation of weeds
- artificial lighting, in particular lighting that disturbs foraging or roosting for bats
- disturbance from people and vehicle activity.

7.4.4 Physiography and Topography

Much of the proposed Gladstone port master planned area is a low coastal plain. Mount Larcom Range forms a prominent mountain feature, trending south to south-easterly, borders the coastal plain. Calliope and Boyne rivers flow north-north easterly through deep gorges in this coast-range barrier. Gladstone Harbour, bounded by the mainland and on the north and east by the outer continental islands of Curtis and Facing islands, contains a complex array of inlets, channels, shoals, tidal marshes, river and stream mouths, small islands and shorelines.

Figure 16 shows the prevailing topography within the proposed Gladstone port master planned area using 50m contour intervals. The land areas immediately adjacent to the port and Calliope River are predominantly flat whilst the undeveloped areas surrounding Mount Larcom and to the south east of Yarwun are characterised by undulating topography.

7.4.4.1 Description and context

The following soil types are present in the terrestrial component of the proposed Gladstone port master planned area⁷⁶:

- Hydrosols, commonly associated with acid sulphate soils, are located within the intertidal and supratidal flats
- Vertosols and sodosols are located within the alluvial systems such as swamps, channels and flat
- Rudosols, tenosols, chromosols and some sodosols associated with the higher sloping areas.

Mapping of soil types show that the yellow duplex soil category dominates the proposed Gladstone port master planned area, with non-cracking clays fringing Port Curtis⁷⁷. Soils on Curtis Island are generally shallow acid yellow –mottled duplex soils⁷⁸.

⁷⁶ Australia Pacific LNG. 2010. *Australia Pacific LNG Project: Environmental Impact Statement*. APLNG, Queensland.

Acid sulfate soils of the coastal land and tidal flat areas within the proposed Gladstone port master plan area are mapped by DNRM⁷⁹. The tidal flats are composed of fine sediment indicative of a low energy deposition of a marine dominated rather than fluvial depositional regime. Acid sulfate soils in the tidal lands or tidal zones are classified as hydrosols, with sulfidic and histic-sulfidic hydrosols typically occurring in the intertidal (mangrove) mudflats. Sulfuric hydrosols are mainly associated with saltpans (supratidal flats) or extratidal (slightly elevated marine couch) flats). Soils of the beach ridge sands are either Rudosols or Tenosols⁸⁰.

Sediments and sedimentology of the Gladstone Harbour was first described by Conaghan in 1966⁸¹. Conaghan broadly described the harbour's regional physiography and geology as a drowned river valley, with the harbour containing deep tidal channels and linear sandbanks flanked on both sides with zones of tidal flats and mangrove swamp. Textural variation of the bottom sediments were considered by Conaghan as controlled by differences in hydrography, where coarse sediments characterise the deeper channels influenced by swift tidal currents on ebb and flood tides. Finer sediment winnowed by currents are deposited on shoals, with tidal concentration of muddy sediment towards the peripheral shoals, muds deposited in sheltered areas not subject to strong currents and waves. Four broad sediment facies were found to occur; sandy, muddy, intermediate and carbonate associated with fringing coral-algal reefs. In deeper channel areas, modern marine sands are underlain with fluvial sediments probably deposited during later Pleistocene glacial periods. More recent work on Port Curtis estuary sediments state that they consist of primarily silts and clays within the shallow intertidal banks, while fine and coarse sand dominate in the more energetic deeper regions of the estuary. The estuary maintains a highly turbid character as the large tides cause significant resuspension of fine sediment and large deposits of silt from the hinterland occur in times of flood.⁸² Surface sediment median grain size (um) is mapped for the surface sediments of the inner Gladstone Harbour and used in a three dimensional sediment transport and fates model (Plate 1).

⁷⁷ Gladstone Area Water Board. 2008. Gladstone-Fitzroy Pipeline Project Environmental Impact Statement. Chapter 5. Soils and Contaminated Land (Figure 5.2).

⁷⁸ Department of Environment. 1994. Curtis Coast Study Resource Report.

⁷⁹ Queensland Government Natural Resources, Mines and Energy. 2004. Acid Sulfate Soils Tannum Sands-Gladstone, Scale 1:50,000.

⁸⁰ Ross, D.J. 2004. Acid Sulfate Soils Tannum Sands- Gladstone Area Central Queensland Coast. Department of Natural Resources & Mines.

⁸¹ Conaghan, P.J. 1966. Sediments and Sedimentary Processes in Gladstone Harbour, Queensland. University of Queensland Press.

⁸² Dunn, Ryan, Zigic, Sasha, Burling, Murray and Hsin Hui Lin. 2015. Hydrodynamic and Sediment Modelling within a Macro Tidal Estuary: Port Curtis Estuary, Australia. *Journal of Marine Science and Engineering*, 3 pp720-744.

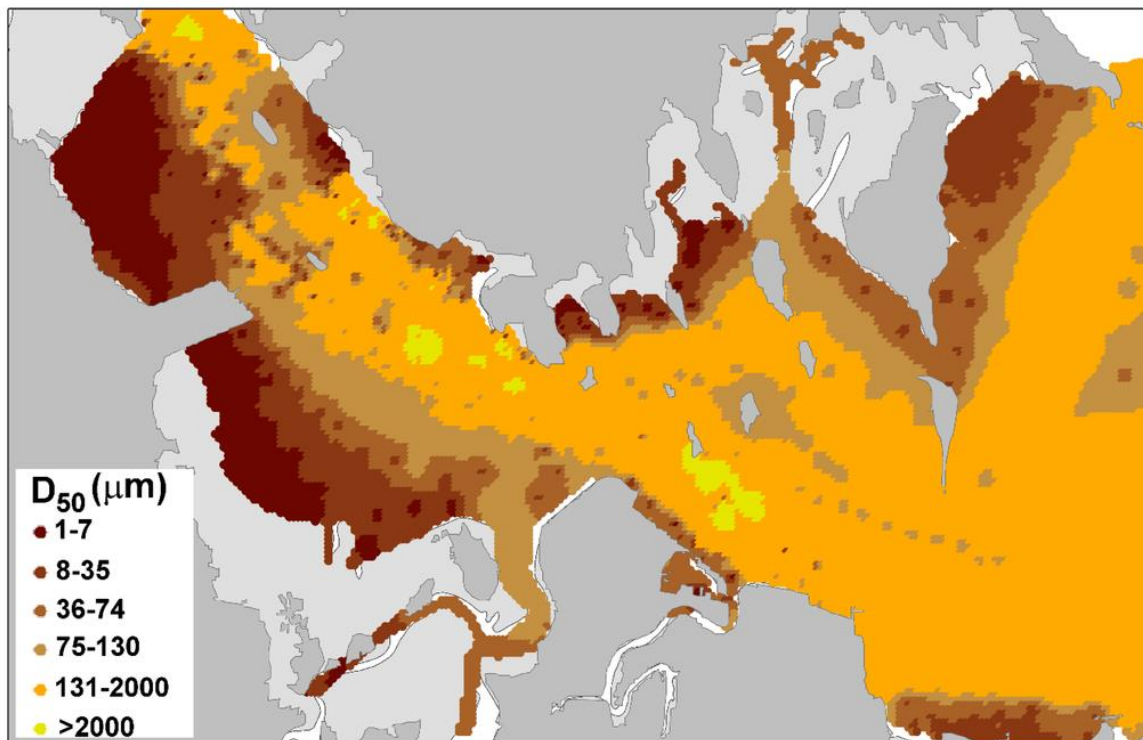


Plate 1 Surface sediment median grain size (D_{50}) map of Port Curtis Estuary⁷⁵

Marine sediment quality has been extensively examined in Port Curtis and as at 2012, 462 sample sites investigated⁸³. DEHP's 2012 reporting was undertaken after speculation that sediment bound toxicants released during dredging was related to fish health issues at Port Curtis. Findings of sediment sampling indicate that there are no conspicuous 'above guideline'⁸⁴ concentrations of elements and compounds suggestive of point sources of sediment contaminants. Specific findings from the DEHP study were that:

- No metal exceeded the ISQG guideline except for mercury taken at the mouth of the Boyne River, although all follow up sampling found less than ISQG guidelines levels at this site.
- The metalloid arsenic exceeded the ISQG low value at four sites (out of 31 sites in Port Curtis) and it is likely that arsenic and barium are present in the sediments of Port Curtis.
- Sulfur, sulphides and sulfates (naturally occurring components of marine sediments) occur at the expected range, suggesting that they are not of concern.
- Fluoride measurements (a common constituent of rock and marine sediments) are relatively low.
- No pesticides were detected in the Port Curtis sediments.

⁸³ Department of Environment and Heritage Protection. 2012. Update on the Quality of Sediment from Port Curtis and Tributaries. Water Science Technical Report Volume 2012 Number 6. State of Queensland.

⁸⁴ Australian Interim Sediment Quality Guidelines (ISQGs) 2000

- Dioxins were detected within the typical range of Australian sediments adjacent to urban and industrial environments. Arclors (commercial mixtures of PCBs which are being progressively withdrawn from sale) were not detected however.
- Tributyltin (TBT) (now banned but persists in the environment) was detected in a small number of samples but did not exceed ISQG values.
- Petroleum hydrocarbons are at low relative levels and less than NEMP ecological investigation levels in soils. Further no BTEX was detected and PAH levels did not exceed ISQG values.

A key gap in relation to soil quality on land is site-specific information within the proposed Gladstone port master planned area in undeveloped areas.

7.4.4.2 Potential threats, pressures and impacts

Direct threats to soil and marine sediment quality within the proposed Gladstone port master planned area include:

- vegetation clearing and other land use practises leading to destabilisation, sediment runoff, loss of top soil, dust creation or compaction
- construction activities leading to contamination of soil by hazardous substances.

Indirect threats to soil and marine sediment quality within the proposed Gladstone port master planned area include:

- alterations to groundwater leading to activation of potential acid sulphate soils
- increased sedimentation leading to smothering of marine communities and burial of coral, mangrove and seagrass; decreases in available sunlight and subsequent limiting of production of algae and macrophytes, increased water temperature; damage to fish (irrigation or scour of gills) or damage to fish habitat by reduction of available oxygen; reduce the success of visual predators; release of toxic organic chemicals which have been absorbed into sediment into the marine environment⁸⁵
- alterations to biogeochemical process in marine sediments such as nutrient recycling, carbon re-mineralisation and carbon burial and subsequent changes in community structure⁸⁶
- changes to marine sediment pH, ambient carbonate systems and oxygen concentrations which can affect metal mobilisation⁸⁷
- changes to nutrient status from soil management activities
- soil pollution from industrial & agricultural activities, waste disposal, and accidental oil spills.

⁸⁵ UNEP. The Caribbean Environment Program. Sedimentation and Erosion Program.

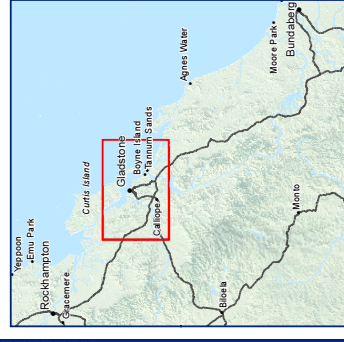
⁸⁶ Taylor, P., Lichschlag, A., Toberman, M, Sayer, M, Reynolds, A., Sato, T and H Stahl. 2015. Impact and recovery of pH in marine sediments subject to a temporary carbon dioxide leak. International Journal of Greenhouse Gas Control. Vol 38. 93-101

⁸⁷ Australian Interim Sediment Quality Guidelines (ISQGs)

Figure 16

Topography

- Legend**
- Cities
 - Urban centres
 - Local centres
 - Localities
 - Railway
 - Highways
 - Secondary Roads
 - Local Connector Roads
 - Property boundaries
 - Port limits
 - Proposed Gladstone port master planned area boundary
 - Great Barrier Reef Marine Park
 - Great Barrier Reef Coast Marine Park
 - 50m contour intervals

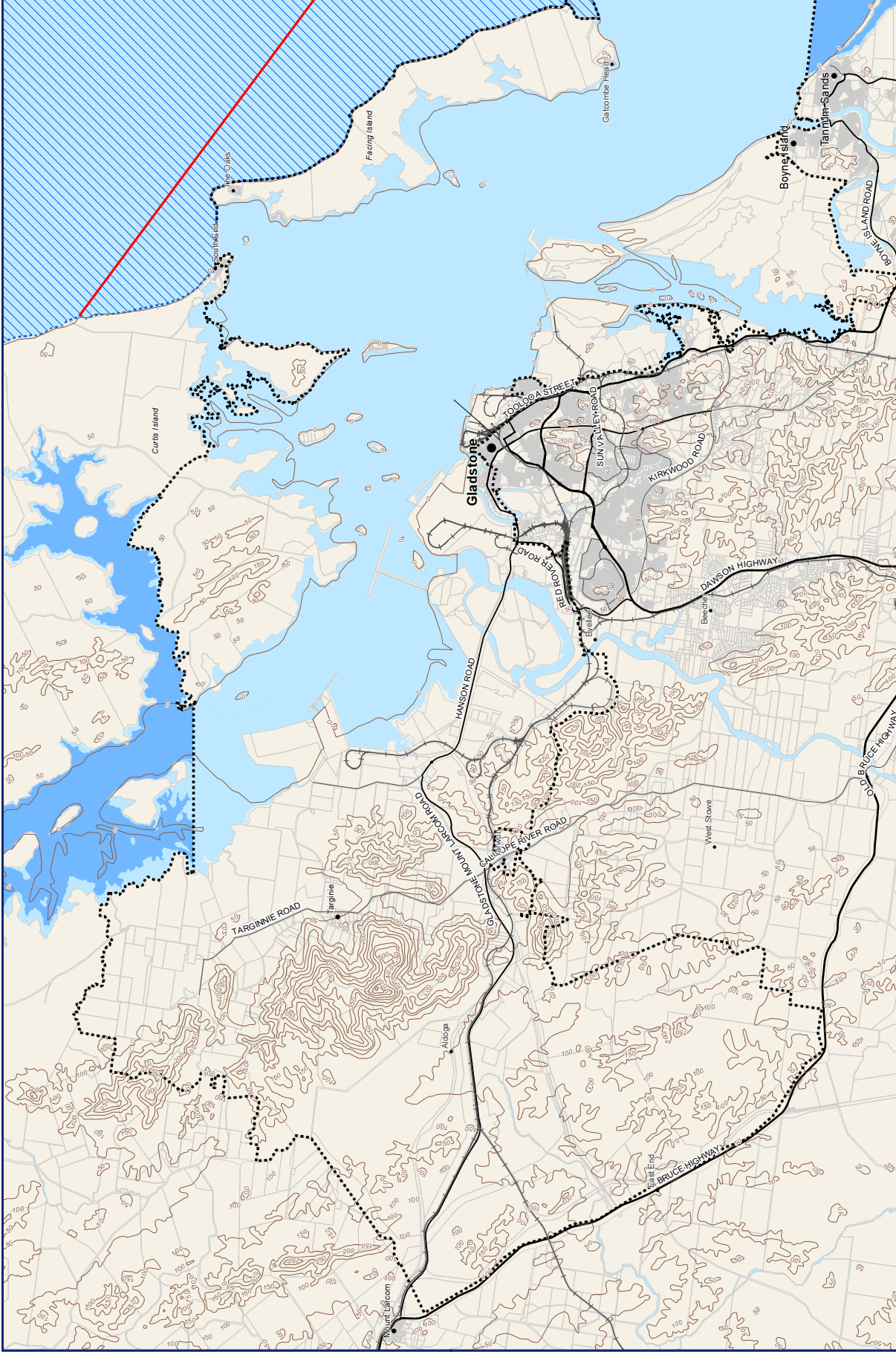


10 November 2015



0 0.5 1 2 3 4 5
Kilometres

Coordinate System: GCS GDA 1984
Datum: GDA 1984
Units: Degree



7.5 Water Ecosystem (Marine and Estuarine)

The proposed Gladstone port master planned area is dominated by the Gladstone Harbour and port operational area. A number of reclaimed areas and berths are present along coastal areas of the mainland and channel side of Curtis Island.

For the purposes of this section, the marine water ecosystem refers to waters within and adjacent to the proposed Gladstone port master planned area. A range of species and habitats have been identified as significant environmental values of the marine water ecosystems of the proposed Gladstone port master planned area and are described in the sections below.

7.5.1 Flora

7.5.1.1 Description and Context

Mangroves

A number of mangrove species are present within the proposed Gladstone port master planned area and of which, some are considered at or near their known geographical distribution⁸⁸. Mangroves provide structurally complex habitat for juvenile fish and invertebrates.

Broad scale mapping of mangrove habitat within Port Curtis was undertaken in 2004 and to Colosseum Island in 2009, finding seventeen different types of mangrove communities⁸⁹. Generally Rhizophora communities are found to the seaward edge, backed with a narrow mixed band of Avicenna / Ceriops. Landward of these communities, extensive salt pans tended to occur with samphires and saline grass communities. Along watercourses with freshwater the mangrove species of Aegiceras and Xylocarpus are often found⁹⁰. Port Curtis contains an unusual mix of mangrove species as the region marks an overlap between the southernmost reaches of tropical mangrove species and also supports a diverse array of sub-tropical species⁹¹. The Port Curtis area also marks the southern distribution of Cedar mangrove (*Xylocarpus moluccensis*), Holly mangrove (*Acanthus ilicifolius*) and Rib fruited orange mangrove (*Bruguiera exaristata*)⁹². Twelve species of mangrove are known to occur in the Calliope River^{93&94}.

Mangroves also form remnant vegetation as discussed in Section 7.4 (Landform and Biota). Five regional ecosystems containing mangroves as identified in Table 17 are mapped in the

⁸⁸ Australia Pacific LNG. 2010. *Australia Pacific LNG Project – Environmental Impact Statement*. APLNG, Queensland.

⁸⁹ Danaher, K.F.M., Rasheed, M.A., and R. Thomas 2005. The intertidal wetlands of Port Curtis. Queensland Department of Primary Industries and Fisheries, 55

⁹⁰ Port Curtis Integrated Monitoring Program. 2011. Port Curtis Ecosystem Health Report 2008-2010, Gladstone.

⁹¹ Small, M. 1997. Fish communities of a subtropical mangrove forest, with comparison to adjacent mudflats and seagrass beds. Central Queensland University, Rockhampton Qld

⁹² Danaher, K.F.M., Rasheed, M.A., and R. Thomas 2005. The intertidal wetlands of Port Curtis. Queensland Department of Primary Industries and Fisheries, 55

⁹³ McKinnon, S, Lupton, C, Long, P. 1995. A fisheries Resource Assessment of the Calliope River System in Central Queensland 1994. Department of Primary Industries, Qld

⁹⁴ Queensland Parks and Wildlife Service. 2014. Fisheries Resources of Calliope River, Gladstone Central Queensland. State of Queensland

proposed Gladstone port master planned area as least concern regional ecosystems in Figure 15 and shown as wetlands in Figure 17.

Table 17 Regional Ecosystems containing mangroves within the proposed Gladstone port master planned area

RE	Description of vegetation communities ⁹⁵
11.1.2a	Estuarine wetlands (e.g. mangroves). Bare mud flats on Quaternary estuarine deposits, with very isolated individual stunted mangroves such as <i>Avicennia marina</i> and/or <i>Ceriops tagal</i> . May have obvious salt crusts on the soil surface.
11.1.4a	Estuarine wetlands (e.g. mangroves). <i>Rhizophora</i> spp. open forest on Quaternary estuarine deposits. This may include <i>Rhizophora stylosa</i> or <i>R. apiculata</i> as dominants, with occasional <i>Avicennia marina</i> as emergents, and subdominant <i>Bruguiera gymnorhiza</i> and/or <i>Ceriops tagal</i> . In northern areas, occasional <i>Xylocarpus moluccensis</i> may also occur. A shrub layer is usually not present. Occurs on fringing waterways low in intertidal zone, with roots submerged during high tides (Danaher 1995).
11.1.4c	Estuarine wetlands (e.g. mangroves). <i>Ceriops tagal</i> +/- <i>Avicennia marina</i> open forest on Quaternary estuarine deposits. Other mangrove species may be present as occasional individuals including <i>Rhizophora</i> spp., <i>Bruguiera</i> spp., <i>Lumnitzera</i> spp., and <i>Sonneratia</i> spp. A shrub layer is not usually present. Occurs on upstream creek edges, and toward the landward edge of the upper intertidal limit. Only inundated by spring tides (Bruinsma 2000).
11.1.4d	11.1.4d: Estuarine wetlands (e.g. mangroves). Dominated by a range of species from genera such as from <i>Avicennia</i> sp., <i>Ceriops</i> sp., <i>Rhizophora</i> sp. and <i>Bruguiera</i> sp. which form a closed forest. A low shrub layer composed of species such as <i>Acanthus ilicifolius</i> , <i>Acrostichum speciosum</i> , <i>Crinum pedunculatum</i> or juvenile canopy species is often present. Epiphytes on the canopy are common. Occurs on the landward edge of the tidal flats and in the upper tidal reaches of creeks and rivers where there is a high freshwater influence.
12.1.3	Mangrove shrubland to low closed forest. Occurs on Quaternary estuarine deposits. Six vegetation communities are included in this regional ecosystem including: 12.1.3a: <i>Aegiceras corniculatum</i> dominated low closed forest. 12.1.3b: <i>Avicennia marina</i> subsp. <i>australasica</i> dominated shrubland to low closed forest. 12.1.3c: <i>Bruguiera gymnorhiza</i> dominated shrubland to low closed forest. 12.1.3d: <i>Ceriops tagal</i> dominated shrubland to low closed forest. 12.1.3e: <i>Rhizophora stylosa</i> dominated shrubland to low closed forest. 12.1.3f: Estuarine water bodies with groundwater connectivity.

Seagrass

The seagrass beds of the Port Curtis region have been extensively investigated since 1988 and subject to extensive monitoring since 2002⁹⁶. Seagrass condition has been monitored and mapped at seven locations in Port Curtis and Rodd's Bay between from November 2009

⁹⁵ Queensland Herbarium 2014, Regional ecosystem database. Queensland Government.

⁹⁶ Bryant C, Davies, J, Sankey T, Jarvis, J and M Rasheed. 2014. Long Term Seagrass Monitoring in Port Curtis: Quarterly Seagrass Assessments & Permanent Transect Monitoring Progress Report 2009-2013. TropWater, James Cook University.

to December 2013⁹⁷, with further monitoring sites added more recently. Generally, beds and biomass peak late spring and summer and are at their lowest over winter. Seagrass beds within the proposed Gladstone port master planned area are an important food source for dugong and provide nursery habitat for many species of fish, crustacean and other marine invertebrates.

Seagrass species present within Gladstone harbour include:

- *Zostera capricorni*
- *Halophila ovalis*
- *H. decipiens*
- *H. uninervis*
- *H. spinulosa*.

Seagrass beds of the Port Curtis region are dynamic and susceptible to local climate conditions. Seagrass declines may occur as a result of high rainfall events and high inflows of freshwater leading to inputs from sediment, herbicides and reduced salinity. These inflows may also increase nutrient inputs which generally enhance seagrass growth. The most recently available mapping of the Gladstone Port's seagrass distribution is shown in Plate 2.

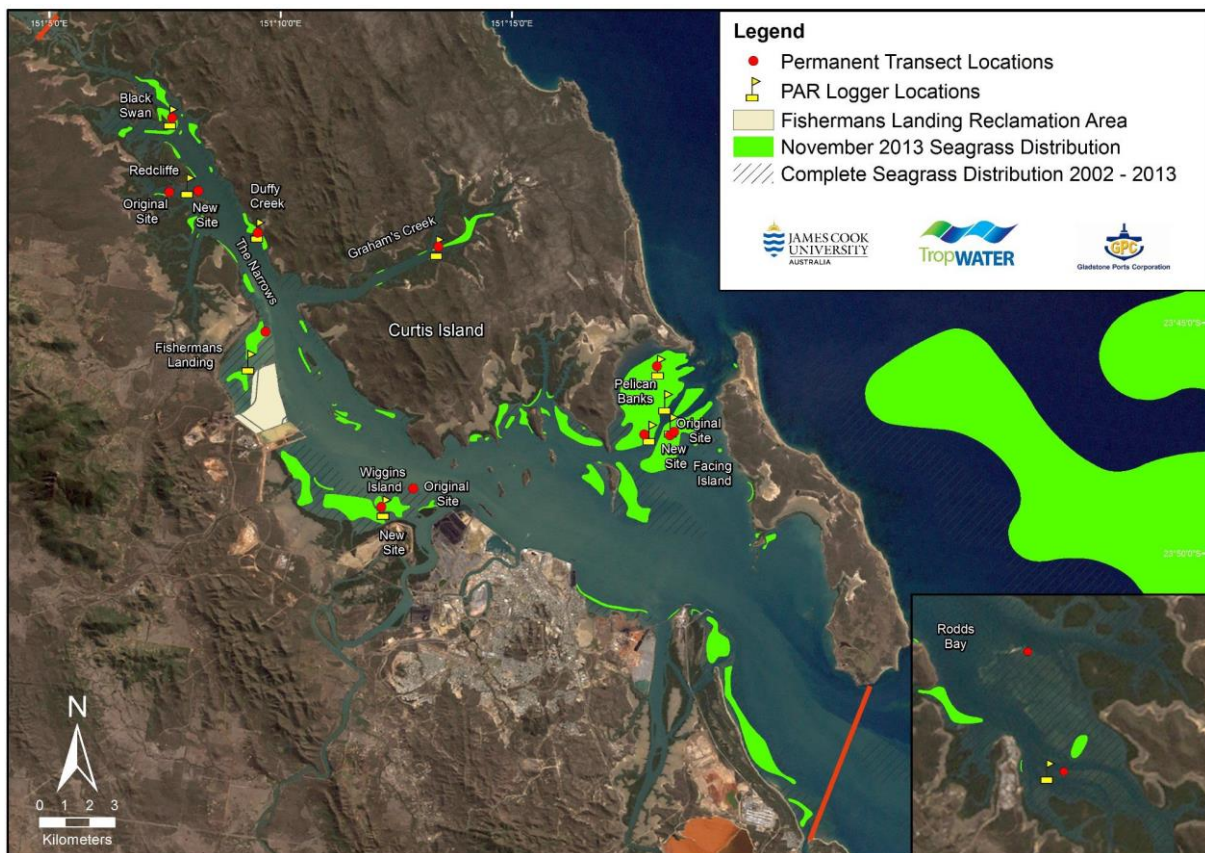


Plate 2 November 2013 Seagrass Distribution (Source Bryant *et al* 2014).

⁹⁷ Bryant, C. V. & Rasheed, M. A. 2013. Gladstone Permanent Transect Seagrass Monitoring – December 2013 Update report, Centre for Tropical Water & Aquatic Ecosystem Research Publication 13/50 James Cook University, Cairns.

Macro algae

PCIMP's Ecological Indicators Monitoring Program examined water macro algae (seaweeds and algae etc.) during 2008-2010 on settlement devices deployed in the Port Curtis area. Findings suggest that large seasonal effects were evident, with greater abundance and higher species diversity during winter⁹⁸. Overall diverse macro algal communities are found throughout the Port Curtis area.

Coral Communities

It is noted that whilst coral is faunal in its composition, it has a number of characteristics comparable to flora and as such has been included within Section 7.5.1. Coral and rocky reef communities occur around Port Curtis and those surveyed appear to be typical of fringing coral reefs on the southern inshore Great Barrier Reef. Around Port Curtis the reefs are composed of coral and other benthic organisms growing on rocks or boulders, as compared with true carbonate reefs⁹⁹. Coral species richness is relatively low compared to areas to the north and also low on inshore reefs compared with mid shelf and outer shelf reefs. Coral cover has been surveyed in the North Passage, the western and southern sides of Facing Island and the sheltered side of Curtis Islands. The location of reefs have been mapped and described by GBRMPA and BMT WBM for the Port of Gladstone Corporation (Figure 2.1 in¹⁰⁰) within the broader Port Curtis area. Known reefs within or on the boundary of the proposed Gladstone port master planned area include those at the following locations:

- North Entrance – Rat Island Reef, North Point, Oaks Reef (Facing Island No 2) and Farmers Reef
- South Channel – reefs around Seal Rocks (Reef No 1), Curtis Rock, East Banks and Gatcombe Head
- Inside Port Curtis – Manning Reef (inside of Facing Island), Bushy Island and Turtle Island.

The BMT WBM study on coral cover and condition found that:

- Most of the reefs surrounding Facing Island are similar in terms of broad community type that is they have moderate hard coral cover, moderate algal cover, low soft coral and other invertebrate cover except for Manning Reef and Farmers Reef
- Manning Reef has high cover of hard coral
- Farmers Reef has high cover of soft coral
- Reef communities at Turtle Island have little coral cover and extensive algal cover.

The Gladstone Harbour Report Card 2015 provides information on coral health around the harbour, through monitoring the health of the reefs and coral habitats between June 2014 and July 2015. Three indicators were assessed to ascertain the overall health of the coral; combined cover of hard and soft coral, macroalgal (algae) cover, and juvenile coral density.

⁹⁸ Port Curtis Integrated Monitoring Program 2011, Port Curtis Ecosystem Health Report 2008 – 2010, <<http://www.pcimp.com.au/PDFs/PCIMP%20Report%202008-2010.pdf>>.

⁹⁹ Sea Research. 2011. The impact of dredge spoil dumping on fringing coral reefs around Facing Island. Report for Gladstone Ports Corporation Limited.

¹⁰⁰ BMT WBM. 2014. Identification of Coral Reef Sites for Restoration and Enhancement in Port Curtis – Phase 1. Figure 2.1.

The overall grade for coral was very poor (E). This result was due to low cover of living corals, low abundance of juvenile corals, and high macroalgal cover at most of the surveyed reefs.

7.5.1.2 Potential Threats, Pressures and Impacts

Marine flora in the proposed Gladstone port master planned area are directly threatened by:

- clearance (particularly for mangroves)
- catchment runoff (generating nutrients or reducing salinity) and point source discharge (particularly for coral)
- capital dredging (for seagrass)
- crown of thorn starfish outbreaks (coral).

Indirect threats to marine flora in the proposed Gladstone port master planned area include:

- changes to hydrological regimes
- changes to water quality (herbicides impact on salt excreting mangroves particularly¹⁰¹)
- increased sediment loads (which can cause gains in mangrove distribution and through turbidity, losses in seagrass and coral)^{96 & 102}
- climate change, particularly extreme rainfall and river discharge events. Cyclonic events cause change in coral cover in a minor way by damaging tips or edges of coral through to severely damaging or removing coral and coral communities. After damage from such severe wind and wave events and underwater turbulence, further changes can occur on reef structures including extensive growth of algae over injured colonies which blanket damaged reef structure (possibly due to increases in available nutrients)¹⁰³.
- flood plumes, caused by intense rainfall can expose large areas to stressful changes in water quality. Seagrass can be ripped up by large waves, and deeper seagrass meadows can be scoured by strong currents. Mangroves and wetlands can be impacted by wind and prolonged inundation¹⁰⁴.

7.5.2 Fauna

Twenty-five conservation significant marine and estuarine fauna species listed under the provisions of the EPBC Act and/or NC Act were identified from the desktop assessment as potentially occurring within the proposed Gladstone port master planned area (Table 18).

Refinement of the potential occurrence of each species based on the likelihood of occurrence assessment identified four species that are known to occur within the proposed Gladstone port master planned area (Table 18). In addition, 17 other species are considered to have a possible likelihood of occurrence within the proposed Gladstone port master planned area based on their known range and the presence of suitable habitat within the study. The

¹⁰¹ Mangrove Watch Australia, a new monitoring program that partners mangrove scientists and community participants. http://www.mangrovetwatch.org.au/index.php?option=com_content&view=category&layout=blog&id=26&Itemid=300161

¹⁰² BMT WBM. 2014. Identification of Coral Reef Sites for Restoration and Enhancement in Port Curtis – Phase 1.

¹⁰³ Great Barrier Reef Marine Park Authority. 2011. Impacts of tropical cyclone Yasi on the Great Barrier Reef. A report on the findings of a rapid ecological impact assessment. Commonwealth of Australia

¹⁰⁴ Great Barrier Reef Marine Park Authority. 2011. Extreme weather and the Great Barrier Reef. Commonwealth of Australia

remaining four conservation significant fauna species are considered unlikely to occur within the proposed Gladstone port master planned area.

All of the Gladstone port area is broadly identified as an area of occupancy for Indo-Pacific humpback (*Sousa sahalensis*) and Australian snubfin dolphin (*Orcaella heinsohni*) by the Great Barrier Reef Marine Park Authority¹⁰⁵. Intensive survey during 2006 and 2008 indicates that the Indo Pacific dolphin tends to occur within the coastal waters of the proposed Gladstone port master planned area and Rodds Harbour, while the Australian snubfin has only been observed in the waters around Keppel Bay and Fitzroy estuary to the north of the master planned area^{106 & 107}. Population estimates indicate that 84 snubfin dolphins live year round mostly in the Fitzroy River estuary, whereas about 200 humpback dolphins live in the Fitzroy River and Port Curtis area. A resident population of Indo-Pacific humpback dolphin occur within Auckland Creek¹⁰³.

Green turtle movement has been tracked around Wiggin Island and Pelican Banks during 2013 using acoustic and satellite tags. Findings indicate average home ranges between from 1.3 to 6.7 km² including seasonal and monthly variations due to movement between both locations and also with seagrass density¹⁰⁸.

Benthic macro-invertebrate communities are found in the deeper water section of the proposed Gladstone port master planned area with differences in communities found inside Facing Island where they are dominated by low density benthic macro-invertebrate communities and the inner port which is dominated with highly diverse and high density communities¹⁰⁹. These differences are likely a result of high tidal currents in the inner port channels.

Table 18 Likelihood of occurrence of listed marine fauna species within the proposed Gladstone port master planned area

*Conservation Status: CTH = Commonwealth (listed under the EPBC Act), QLD = Queensland (listed under the NC Act), EX = Extinct, CE = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, SL = Special Least Concern, NL = Not Listed, Mi = Migratory.

Scientific Name Common Name	Status*		Likelihood of occurrence ¹¹⁰
	CTH	QLD	
Sea Birds			
<i>Diomedea exulans</i> Wandering Albatross	VU	VU	Known. Suitable habitat present within the proposed Gladstone port master planned area and species has been recorded from within the proposed Gladstone port master planned area near Boyne Island.

¹⁰⁵ Great Barrier Reef Marine Park Authority. 2014. Great Barrier Reef Region Strategic Assessment: Strategic Assessment Report, GRMPA Townsville, Figure 7.5 in Chapter 7 Current condition and trend.

¹⁰⁶ Gladstone Port Corporation. No date. Dolphins Fact Sheet. www.gpcl.com.au/Big6

¹⁰⁷ Cagnazzi, D. 2013. Review of Coastal Dolphins in central Queensland, particularly Port Curtis and Port Alma regions. Gladstone Port Corporation

¹⁰⁸ Babcock, R. Baird, M., Pillans, R, Patterson, T, Clementson, L, Haywood, M, Rochester, W, Morello, E, Kelly, N, Ouberkheir K, Fry G, Dunbabin, M Perkins, S, Forecy K, Cooper, S, Adams, M, O'Brien, K, Donovan, A, Kenyon, R, Carlin, G, Wild-Allen, K, Limpus, C. 2015. An integrated study of Gladstone marine system. CSIRO Oceans and Atmosphere.

¹⁰⁹ Rasheed, M.A, Thomas R., Roelofs A.J., Niel, K.M and Kerville, S.P 2003. Port Curtis and Rodds Bay seagrass and benthic macro-invertebrate community baseline survey, November/December 2002. DPI Information Series Q103058, Cairns

¹¹⁰ Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 27th October 2015.

Scientific Name Common Name	Status*		Likelihood of occurrence ¹¹⁰
	CTH	QLD	
<i>Fregetta grallaria grallaria</i> White-bellied Storm-Petrel	VU	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Pachyptila turtur subantarctica</i> Fairy Prion (southern)	VU	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Phoebastria fusca</i> Sooty Albatross	VU	VU	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Pterodroma heraldica</i> Herald Petrel	CE	EN	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Pterodroma neglecta neglecta</i> Kermadec Petrel (western)	VU	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Thalassarche cauta cauta</i> Shy Albatross	VU	VU	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Thalassarche cauta salvini</i> Salvin's Albatross	VU	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Thalassarche cauta steadi</i> White-capped Albatross	VU	VU	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Thalassarche eremita</i> Chatham Albatross	EN	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Thalassarche melanophris</i> Black-browed Albatross	VU	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
<i>Thalassarche melanophris impavida</i> Campbell Albatross	VU	LC	Possible. Species may utilise coastal waters within and adjacent to the proposed Gladstone port master planned area.
Marine Turtles			
<i>Caretta caretta</i> Loggerhead Turtle	EN	EN	Possible. Records exist outside the proposed Gladstone port master planned area near Heron Reef. Species is a possible occurrence within the proposed Gladstone port master planned area.
<i>Chelonia mydas</i> Green Turtle	VU	VU	Known. Suitable habitat present within the proposed Gladstone port master planned area and this species has been recorded from within the proposed Gladstone port master planned area near Hamilton Point, Curtis Island.
<i>Dermochelys coriacea</i> Leatherback Turtle	EN	EN	Possible. Records exist south of Gladstone toward Seventeen Seventy. Species may disperse through the proposed Gladstone port master planned area and is as such a possible occurrence.

Scientific Name Common Name	Status*		Likelihood of occurrence ¹¹⁰
	CTH	QLD	
<i>Eretmochelys imbricata</i> Hawksbill Turtle	VU	VU	Possible. Nearest records exist north of the proposed Gladstone port master planned area near Yeppoon. Species may disperse through the proposed Gladstone port master planned area and is as such a possible occurrence.
<i>Lepidochelys olivacea</i> Olive Ridley Turtle	EN	EN	Possible. No records occur within the proposed Gladstone port master planned area. Distribution of the species suggests species may disperse through the proposed Gladstone port master planned area.
<i>Natator depressus</i> Flatback Turtle	EN	VU	Possible. Records exist immediately adjacent to the proposed Gladstone port master planned area on Curtis Island and east of Facing Island. As such, the flatback turtle is considered a possible occurrence.
Marine Mammals			
<i>Balaenoptera musculus</i> Blue Whale	VU	VU	Unlikely. The distribution and majority of records for the blue whale in Australia occurs primarily in the Southern Ocean ¹¹¹ .
<i>Megaptera novaeangliae</i> Humpback Whale	VU, Mi	VU	Possible. Humpback whales migrate along the continental shelf on the eastern coastline and the proposed Gladstone port master planned area is identified as an area of occupancy ¹¹² .
<i>Dugong dugon</i> Dugong	Mi	VU	Known. Dugongs are known to occur within the proposed Gladstone port master planned area, throughout Gladstone Harbour ¹¹³ .
Sharks			
<i>Carcharodon carcharias</i> Great White Shark	VU	LC	Unlikely. Known to occur in cooler waters found in southern portions of Australia. This species is an unlikely occurrence.
<i>Pristis zijsron</i> Green Sawfish	VU, Mi	LC	Unlikely. Records indicate that the Green Sawfish occurred along the east coast of Queensland and NSW prior to the 1960s, however, after this period there have been no reports of this species south of Cairns. As such, this species is an Unlikely occurrence.
<i>Rhincodon typus</i> Whale shark	VU, Mi	LC	Unlikely. No records for the whale shark occur within the proposed Gladstone port master planned area. The distribution of the species extends along the eastern coast, however, the species is unlikely to occur within the proposed Gladstone port master planned area.

¹¹¹ Menkhorst, P. and Knight, F. 2004. *A Field Guide to the Mammals of Australia*. Oxford University Press, Australia.

¹¹² GBRMPA. 2014. Great Barrier Reef Region Strategic Assessment – Strategic Assessment Report. Great Barrier Reef Marine Park Authority

¹¹³ Soltzick, S., Grech, A., Coles, R., Cagnazzi, D. and Marsh, H. 2013. *Status of the dugong population in the Gladstone area. A Report for Gladstone Ports Corporation Limited for Project CA 120017: Monitoring of Dugongs*, Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER) Publication, James Cook University, Townsville, 37 pp.

Potential Threats, Pressures and Impacts

Potential threats (direct and indirect) to conservation significant marine species in the proposed Gladstone port master planned area have been identified.

Direct threats to marine fauna include:

- mortality as a result of vessel strike
- capital dredging, which may cause fauna mortality
- fishing and netting
- degradation of seabird foraging and nesting grounds.

Indirect threats to the species include:

- alterations to marine hydrology and water quality, including sediment deposition from offshore development and seabed disturbance, and contamination from runoff or activation of acid sulfate soils
- capital dredging, which may cause loss of foraging habitat (e.g. seagrass beds for dugongs)
- disruption to fish breeding life cycles through the loss of habitat, resulting in decreased foraging potential
- disturbance from ship movements
- inappropriate and accidental waste disposal particularly plastic litter, fish nets, lines, rope, bait box packaging bands which kill marine mammals, fish and birds
- noise and vibration, especially from underwater sources including construction and capital dredging
- land based development which degrades stormwater quality and increases stormwater flow, generates sediment discharge, and increased nutrient and pollutant inputs into coastal environments.

Onshore turtle nesting habitat is also threatened by:

- disturbance, including trampling by people or vehicles
- artificial lighting
- pests, including nesting predation by feral species.

7.5.2.1 Fish Habitat Areas

There are no declared fish habitat areas (Schedule 3, Fisheries Regulations) within the proposed Gladstone port master planned area. However the Calliope River is under consideration for declaration as a fish habitat area¹¹⁴.

The Port Curtis coast is known for its high species richness and abundance of fish in marine, coastal, estuarine and freshwater habitats. The estuarine areas, considered to be amongst the most productive natural habitat types in the world, are particularly significant in supporting barramundi and mud crab for much of their lifecycles.

¹¹⁴ Fisheries Resources of Calliope River, Gladstone Central Queensland. 2014. QPWS, Marine Resources, Department of National Parks, Recreation, Sport and Racing

7.5.2.1.1 Recreational and Commercial Fishing

Fishing is a popular recreational activity in the Port Curtis Coast region with extensive mangroves and protected waterways offering mud crabbing and estuary fishing, and the exposed shoreline, rocky headlands and reefs providing a range of ocean species¹¹⁵. Grahams Creek (on the boundary of Gladstone port master planned area) has been noted as a popular recreational location for fishing, crabbing and seasonal prawning¹¹⁶. Recreational fishing continues to grow with a 30 per cent increase in boat registrations between 2000 and 2012 and a 25 per cent rise in fishing effort.

Until recently Gladstone supported one of the largest commercial fishing fleets in Queensland and the area is still heavily used for trawl and crab fishing. Total commercial catch in 2011 was 535.3 tonnes (as retained for sale) with key species fished in Gladstone being barramundi, blue tread fin salmon, grey mackerel, mullet, sharks, banana prawns, and mud crab¹¹⁷. Mud crabs are a key target species for both recreational and commercial crabbers in the Gladstone region¹¹⁸. Commonly caught fish investigated, crustacean and molluscs known from Gladstone Harbour are listed below. Economically important species targeted within and surrounding the Calliope River include mullet, salmon, flathead, whiting, mangrove jack and penaeid prawns. With the Calliope River system, QPWS have compiled a listing of 167 species of fish, crustacean and mollusc species records reflecting the range and availability of habitat, with 91 species in the estuarine reach¹⁰⁹. QPWS have stated that this high species richness is due to that the Calliope River lies on a regional distribution overlap of southern and northern fish species; for example the diamond trevally, sea mullet and the southern herring are at their regional limits in Gladstone waters¹¹⁹. This overlap enables a wider variety of fish to utilise the habitats within the Calliope River.

Table 19 Fish, crustacean and molluscs known from Gladstone Harbour¹²⁰

Common name (* indicates multiple species in category)	Taxonomic Group (Family, genus or species)
Fish species	
Anchovies*	Engraulidae
Australian threadfin*	<i>Polygactylus spp.</i>
Barramundi	<i>Lates calcarifer</i>
Batfish*	Ephippigidae, Drepaneidae
Beach salmon	<i>Leptobrama muelleri</i>

¹¹⁵ Curtis Coast Coastal and Marine Resource Inventory Report. 2012. Gladstone Ports Corporation.

¹¹⁶ Fisherman's Landing Northern Expansion Environmental Impact Statement. 2009. GHD

¹¹⁷ Commercial Catch of Key Species Gladstone 2006-2011. 2012 DAFF.

¹¹⁸ Gladstone fish health survey Mud crab update. 2012. DAFF.

¹¹⁹ CSIRO. 2013. Australian National Fish Collection: Atlas of Living Australia cited in QPWS 1024

¹²⁰ Gladstone Harbour Fish Health Investigation 2011-2012. 2013. DAFF.

Common name (* indicates multiple species in category)	Taxonomic Group (Family, genus or species)
Black jew	<i>Protonibea diacanthus</i>
Blue threadfin	<i>Eleutheronema tetradactylum</i>
Bony bream	<i>Nematalosa erebi</i>
Bream*	<i>Acanthopagrus spp.</i>
Butter bream	<i>Monodactylus argenteus</i>
Catfish	Aridae
Cod / Groupers*	<i>Epinephelus spp.</i>
Flathead*	<i>Platycephalus spp.</i>
Mackerels and Bonito*	Scombridae
Grinner *	Bathysauridae, Synodontidae
Herring *	Clupeidae, Pristigasteridae, Elopidae
Javelin fish *	<i>Pomadasys spp.</i>
King threadfin	<i>Polydactylus macrochir</i>
Milk fish	<i>Chanos chanos</i>
Mullet *	Mugilidae
Ponyfish *	Leiognathidae
Queenfish *	<i>Scomberoides spp.</i>
River jew *	<i>Johnius spp.</i>
Scad *	Carangidae
Scats	Scatophagidae
Sharks and rays	multiple families
Silverbiddies	Gerreidae
Snappers	Lutjanidae
Snubnose dart	<i>Trachinotus blochii</i>
Sole *	Soleidae, Cynoglossidae

Common name (* indicates multiple species in category)	Taxonomic Group (Family, genus or species)
Sweetlips and emperors*	Haemulidae, Lethrinidae
Trevally *	Carangidae
Tripletail	Lobotidae
Whiting *	<i>Sillago spp.</i>
Crustaceans and Molluscs	
Moreton Bay bug *	<i>Thenus spp.</i>
Scallops	Pectinidae
Banana prawns	<i>Fenneropenaeus merguensis</i>
Other prawns *	Penaeidae
Crabs - Not mud crabs *	Portunidae
Mud crabs	<i>Sylla serrata</i>

7.5.2.2 Mudflats and Intertidal Areas

Mudflats are intertidal habitats created by sedimentary deposition in low energy coastal environments, particularly estuaries and often form transitional habitat between subtidal channels and vegetated saltmarshes and mangrove areas. They are often the most extensive part of an estuarine intertidal area. Mudflats play an important role in dissipating wave energy, thereby reducing the risk of erosion. The surface of mudflats plays a significant role in intertidal nutrient chemistry. Typically they are characterised by high biological productivity and support an abundance of organisms particularly microalgae, microbes and invertebrates feeding on detritus and phytoplankton. Mudflats support a diverse benthic (bottom-dwelling) community, including worms, crabs and yabbies. This, in turn, provides food for many fish species. Many internationally significant populations of migratory birds use intertidal habitats to forage and rest (refer to Section 7.4.2.2).

7.5.2.2.1 Introduced Marine Species

Gladstone Port Corporation (GPC) funded a survey of Port Curtis to establish a baseline list of native and introduced species within the Port as identified in Table 20¹²¹. While no pest species were detected, ten introduced species were identified, all of which are widespread in ports throughout Australia and internationally, and not considered a threat to native species.

¹²¹ Lewis, S., Hewitt, C and Melzer A. 2001. Port survey for introduced marine species. Port Curtis. Centre for Environmental Management, Centre for Land and Water Resources Management. Central Queensland University

Table 20 Introduced Marine Species¹²²

Introduced Species	Order/Class	Location
<i>Botrylloides leachi</i>	Ascidian (sea squirts)	Auckland Point; South Trees Wharf
<i>Styela plicata</i>	Ascidian	Wharf pylons throughout Port Curtis
<i>Amathia distans</i>	Bryozoan (moss animals)	Wharf pylons throughout Port Curtis
<i>Bugula neritina</i>	Bryozoan	Gladstone marina, Wharf pylons throughout Port Curtis
<i>Cryptosula pallasiana</i>	Bryozoan	Wharf pylons throughout Port Curtis
<i>Watersipora subtorquata/acuata</i>	Bryozoan	Wharf pylons throughout Port Curtis
<i>Zoobotryon verticillatum</i>	Bryozoan	Gladstone marina; Wharf pylons throughout Port Curtis
<i>Obelia longissima</i>	Hydrozoan (small predatory animal)	Wharf pylons throughout Port Curtis
<i>Paracerceis sculpta</i>	Isopod (crustaceans)	South Trees Wharf
<i>Alexandrium</i> sp.	Dinoflagellate (marine plankton)	Auckland Point; Channel marker S19

7.5.2.3 Dugong Protection Areas

Dugong Protection Areas (DPAs) are Special Management Areas which help with implementation of appropriate management strategies for species conservation within the Marine Park. Three designations make up the Rodds Bay DPA, all of which are directly adjacent to the proposed Gladstone port master planned area. One is situated to the southern border of the Gladstone PPDA, one off the south-eastern corner of Facing Island and one off the north-western corner of Facing Island.

7.5.2.4 Wetlands of International Significance

The proposed Gladstone port master planned area does not lie within or adjacent to any wetland of international significance (i.e. as listed under the Ramsar convention)¹²³.

Gladstone Harbour and intertidal areas of Curtis Island and the mainland including upstream of Calliope River and the South Trees Inlet are mapped as part of the larger Port Curtis wetland complex, which is listed on the Directory of Important Wetlands of Australia¹²⁴.

7.5.2.5 Wetlands of National Importance

Tidal areas of the proposed Gladstone port master planned area are mapped as part of the Port Curtis wetland complex (Figure 17). The Port Curtis wetland complex includes all tidal areas in the vicinity of Gladstone, from Laird and Friend Points, to Gatcombe Head and Canoe Point. It includes the seaward side of Facing Island and Sable Chief Rocks, and southern Curtis Land west of North Point / Connor Bluff.

¹²² Lewis, S., Hewitt, C and Melzer A. 2001. Port survey for introduced marine species. Port Curtis. Centre for Environmental Management, Centre for Land and Water Resources Management. Central Queensland University

¹²³ Department of the Environment. 2015. *Protected Matters Search Tool Report*. DOE, Canberra. Viewed 24th September 2015.

¹²⁴ Department of the Environment. 2015. Directory of Important Wetlands of Australia – Port Curtis Information Sheet. <https://www.environment.gov.au/cgi-bin/wetlands/report.pl> viewed 24th September 2015.

This wetland is recognised as containing important seagrass beds that provide vital habitat for commercially fished crustaceans and being the preferred feeding grounds of several migratory species. A number of mangroves present are also at or near the limit of their geographical distribution and a significant reef community is present on the seaward side of Facing Island.

The Port Curtis wetland is also recognised as providing significant roosting areas of migratory species and major nesting sites for a number of marine turtles.

7.5.2.6 Wetlands of State Significance

Several intertidal areas along the mainland near Fisherman's Landing and south in association with South Trees Inlet are mapped as wetlands of high ecological significance. Facing Island and a number of small, inhabited islands in the channel are also mapped as containing wetlands of high ecological significance (Figure 13).

Potential Threats, Pressures and Impacts

Potential impacts to significant wetlands within the proposed Gladstone port master planned area can only accurately be determined by site specific surveys and an understanding of the type of proposed activity taking place.

Direct threats to wetlands within the proposed Gladstone port master planned area include:

- clearing and reclamation activities.

Indirect threats to wetlands within the proposed Gladstone port master planned area include:

- alterations to hydrological regimes and water quality
- alterations to groundwater and water quality
- dust.

Figure 17

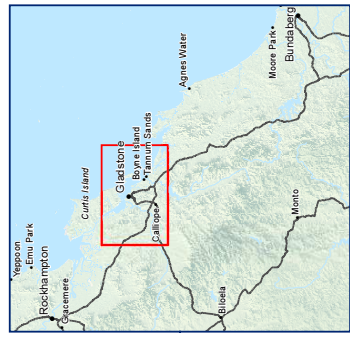
Wetlands

Legend

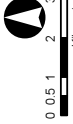
- Cities
- Urban centres
- Local centres
- Localities
- Railway
- Highway
- Secondary Roads
- Great Barrier Reef Marine Park
- Port limits
- Proposed Gladstone port master planned area
- boundary

Wetlands

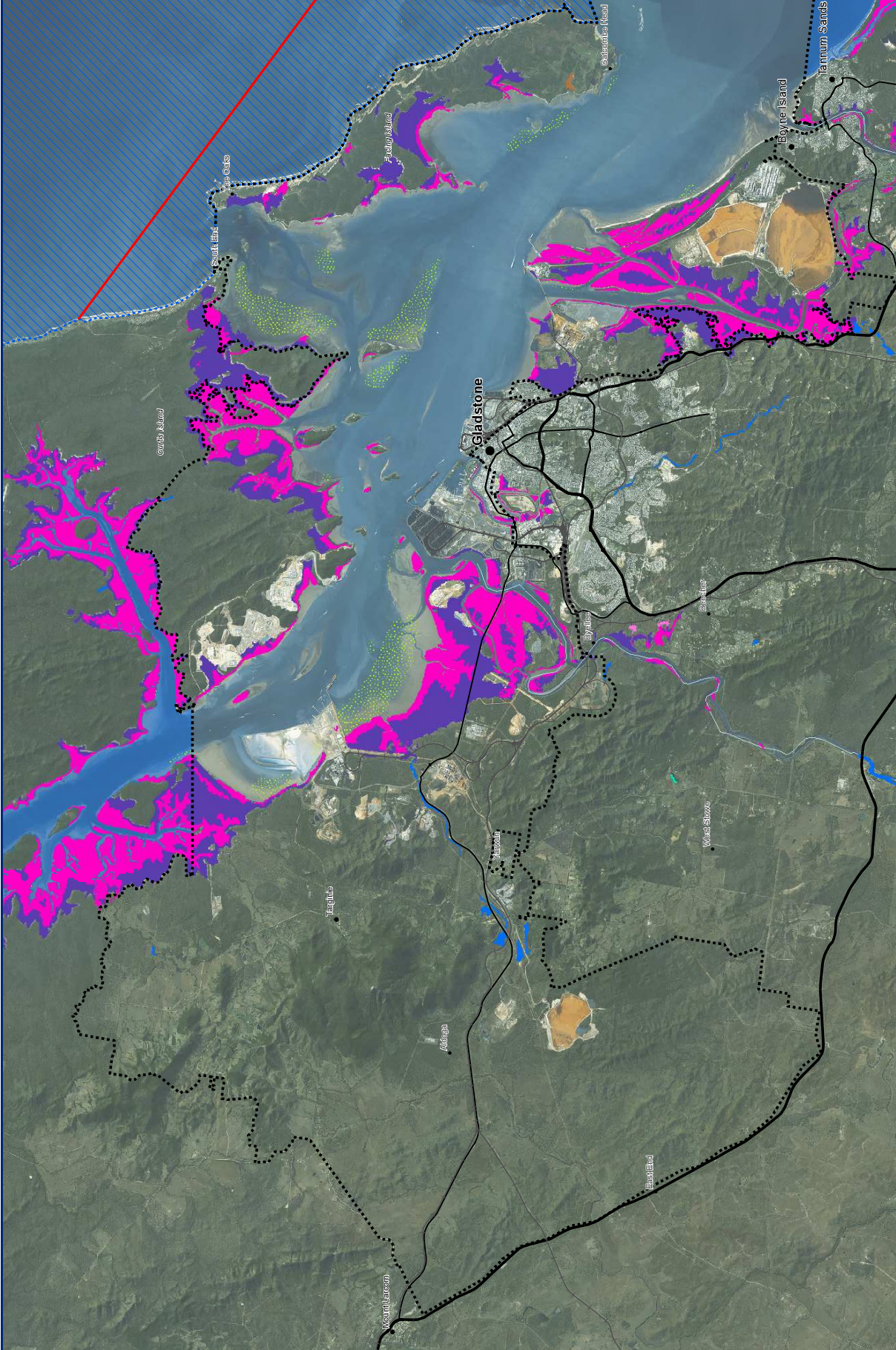
- Coastal/ Sub-coastal floodplain grass, sedge and herb swamps
- Coastal/ Sub-coastal floodplain lakes
- Coastal/ Sub-coastal floodplain tree swamps (Melaleuca and Eucalypt)
- Coastal/ Sub-coastal non-floodplain grass, sedge and herb swamps
- Estuarine - Mangroves and related tree communities
- Estuarine - salt flats and saltmarshes
- Riverine
- Estuarine - water



10 November 2015



Coordinate System: GCS GDA 1984
Datum: GDA 1984
Units: Degree



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7.5.3 Water Quality

Description and Context

Water quality in Port Curtis has been extensively monitored through the Port Curtis Integrated Monitoring Program (PCIMP) and now the Gladstone Healthy Harbour Partnership. The PCIMP was established in 2001 as a consortium of members from 16 bodies representing industry, government (both local and state), research institutions and other stakeholders to develop a cooperative, monitoring program for assessing the ecosystem health of Port Curtis, and to ensure the environmental sustainability of the Port of Gladstone. The Gladstone Healthy Harbour Partnership (GHHP) has built on the PCIMP in a partnership approach, guided and reviewed by an independent science panel. Major partners in the GHHP include Gladstone Ports Corporation and government, industry and the community. The Gladstone Harbour Report Card 2015 reports findings on 13 zones surrounding Gladstone Harbour, measuring the environmental, social, cultural and economic health of the zones between July 2014 and June 2015. A summary of its findings is set out below:

- Environmental health scored a satisfactory rating (C). The environmental indicators fell into three categories:
 - Water and Sediment Quality scored a very good rating (A)
 - Habitats scored a poor rating (D)
 - Connectivity scored a satisfactory rating (C).
- Social health was rated satisfactory (C) based on harbour access, liveability/wellbeing, and harbour usability indicators.
- Economic health was rated as good (B rating) based on economic values, economic stimulus and economic performance.
- Environmental results vary across the harbour zones with the best results in the inner harbour and the worst in Auckland Inlet (A) (see Plate 3). This result may have been influenced by the criteria including only water and sediment quality, as no habitat or connectivity scores were calculated for this zone.
- Grades were likely influenced in 2014 by below average annual rainfall, no major shipping incidents and no major dredging activities¹²⁵.

¹²⁵ Gladstone Healthy Harbour Partnership. Gladstone Harbour Report Card 2015 http://ghhp.org.au/assets/pdf/tech-report/2015%20Report%20Card%20Technical%20Report_FINAL.pdf

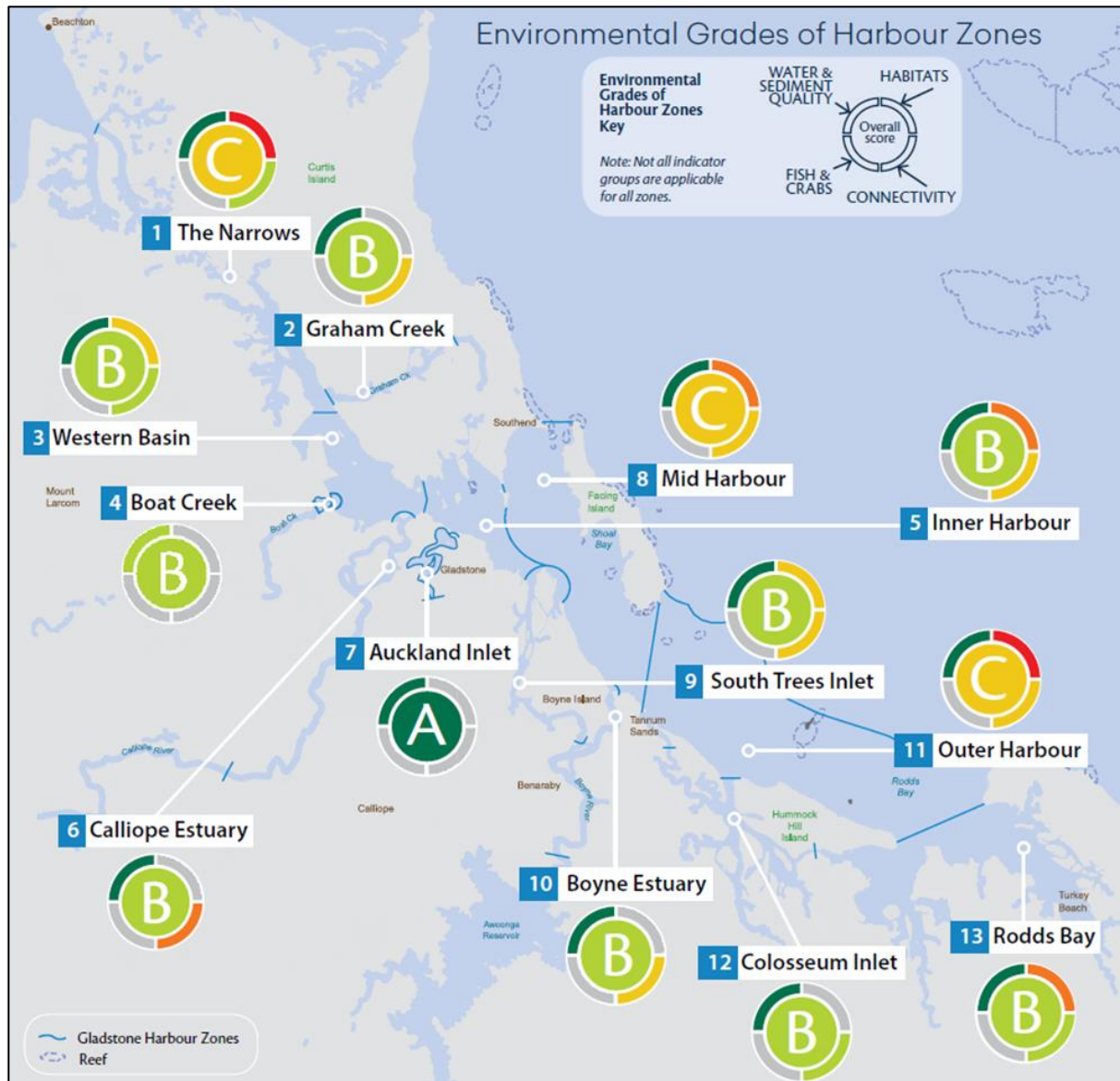


Plate 3 Harbour Zones for Environmental Grading, Healthy Harbour Pilot Report Card 2015

Water quality is regularly monitored by DEHP in the Calliope River. Analysis for the Calliope and Boyne estuaries showed natural variation in water quality due to seasons, flooding, rains and drought. Water quality parameters in the estuaries were consistent with historical levels. Water quality is considered of a high standard in Calliope River with elevated levels of turbidity, phosphorous, copper, manganese and zinc have been detected but all metals are below recommended guidelines¹²⁶.

All metals in sediment samples within the Calliope River are below recommended guidelines and polycyclic aromatic hydrocarbons (PAH's) are of low concentration¹²⁷.

¹²⁶ Department of National Parks, Recreation, Sport and Racing. 2014. *Fisheries Resources of Calliope River Gladstone*. DNPRSR, Brisbane.

¹²⁷ Storey, AW, Anderson, LE, Lynas, J, Melville, F 2007, *Port Curtis Ecosystem Health Report Card, Port Curtis Integrated Monitoring Program (PCIMP)*, Centre for Environmental Management, Central Qld University, 52pp.

Potential Threats, Pressures and Impacts

Potential threats (direct and indirect) to marine water quality include:

- clearing of riparian vegetation
- changes to hydrological regimes and surface water quality
- sediment export
- weed invasion
- alterations to marine hydrological regimes and water quality leading to increased turbidity and mobilisation of sediments
- land based development which degrades stormwater quality and increases stormwater flow, generates sediment discharge, and increased nutrient and pollutant inputs into coastal environments.

7.6 Water Ecosystems (Freshwater)

7.6.1 Freshwater Wetlands

Byellee Wetlands is a locally significant wetland located on the southern bank of the Calliope River, 14 km upstream and is on the boundary of the proposed Gladstone port master planned area. The wetland is approximately 350 ha and is at the interface of saltwater/freshwater influences, comprising of mangroves and saltpan and a freshwater wetland lagoon. Habitat includes riverine blue gum, riparian forest and paperbark tea tree¹²⁸.

7.6.2 Fauna

Description and Context

One conservation significant freshwater fauna species listed under the provisions of the EPBC Act and/or NC Act was identified from the desktop assessment as potentially occurring within the proposed Gladstone port master planned area (Table 21). It is recognised that migratory wetland species identified in Section 7.4.2 may also occur within freshwater ecosystems.

Potential Threats, Pressures and Impacts

Potential threats (direct and indirect) to conservation significant freshwater fauna species in the proposed Gladstone port master planned area have been identified.

Direct threats to freshwater fauna include:

- loss of habitat
- degradation of waterways
- excessive (near total) loss of eggs and hatchlings at the aggregated nesting areas from predation
- nest trampling from cattle.

¹²⁸ Department of National Parks, Recreation, Sport and Racing. 2014. *Fisheries Resources of Calliope River Gladstone*. DNPRSR, Brisbane.

Indirect threats to the species include:

- fragmentation of habitat from the construction of dams and weirs
- alterations to hydrology and water quality
- exacerbation of weeds and pest animals.

Table 21 Likelihood of occurrence of listed freshwater fauna species within the proposed Gladstone port master planned area

Scientific Name Common Name	Status*		Likelihood of occurrence ¹²⁹
	CTH	QLD	
<i>Eseya albagula</i> Southern Snapping Turtle	CE	EN	Possible. No records for the white throated snapping turtle occur within the proposed Gladstone port master planned area. However potential habitat exists within proposed Gladstone port master planned area and overlaps with the species predicted distribution. As such this species is considered a possible occurrence.

*Conservation Status: CTH = Commonwealth (listed under the EPBC Act), QLD = Queensland (listed under the NC Act), CE = Critically Endangered, EN = Endangered.

7.6.3 Watercourses

Description and Context

Surface water quality in the proposed Gladstone port master planned area is an environmental value that influences the habitat value of the marine environment, and the fauna and flora they support. Water quality is integral to the health and persistence of many of the other environmental values occurring within the proposed Gladstone port master planned area.

The proposed Gladstone port master planned area lies mostly within the larger mainland catchment of Calliope River and to a limited extent in the Boyne River catchment as the river anabranch empties to the coast south of Gladstone (refer to Figure 18).

The Calliope River rises in the Calliope Range to the south-west and outside of the proposed Gladstone port master planned area, flowing through the proposed Gladstone port master planned area to the channel near Wiggins Island. The catchment area is approximately 2,255 sq. km in area with main tributaries and Calliope River is connected to the sea by a complex and extensive estuary.

Grazing land has been cleared on slopes and marginal areas resulting in erosion and salinity problems. Approximately 83 percent of the catchment has been cleared, mostly for grazing¹³⁰. Naturally occurring waterholes are present along the Calliope River and the most dominant water use in the catchment is for irrigation purposes, primarily for cattle-feed production¹³¹.

¹²⁹ Atlas of Living Australia. 2015. *Atlas of Living Australia*. <http://www.ala.org.au/> viewed 27th October 2015.

¹³⁰ Gladstone Area Water Board. 2009. *Gladstone – Fitzroy Pipeline Project*. GAWB, Queensland.

¹³¹ Department of Natural Resources and Water. 2007. *Calliope River Basin – Water Resource Plan Consultation Report*. DNRW, Brisbane.

The Boyne River catchment encompasses the portion of the proposed Gladstone port master planned area south of Gladstone. The Boyne River drains from the west including Awoonga Dam, flowing to the sea near Tannum Sands and encompasses a catchment area of 2,590 sq km. The main water use in this catchment is water storage which is then utilised by industry, power generation and port facilities within the proposed Gladstone port master planned area¹³².



Figure 18 Major waterways within the proposed Gladstone Port master planned area¹³³

Major tributaries of the proposed Gladstone port master planned area include:

- tributaries of Graham Creek on Curtis Island (with the main channel of Graham Creek outside the proposed master plan area)
- Mosquito Creek

¹³² Department of Natural Resources and Mines. 2014. *Boyne River Basin Water Resource Plan and Resource Operations Plan – Consultant Report*. DNRM, Brisbane.

¹³³ Department of Infrastructure, Local Government and Planning 2011. *Gladstone*, <http://www.dilgp.qld.gov.au/resources/map/reform/gladstone-map.pdf>

- Sandy Creek
- Larcom Creek
- Boat Creek
- Spring Creek
- Humpy Creek
- The Calliope River, Calliope River Anabranch, and feeder streams
- Auckland Creek and its feeder streams including Police Creek
- South Trees Inlet
- Boyne River (one of the river's anabranches flows into South Trees Inlet).

Waterway barrier works are regulated under the *Fisheries Act 1994* and the *Sustainable Planning Act 2009*, when barriers to fish movement are constructed across waterways. The colour designation of a waterway determines the complexity of the waterway and how important it is for natural fish populations. Further, the colour determines whether waterway barrier works can be conducted under the code for self-assessable development or if a Development Approval must be lodged.

Amber, green and red Queensland Waterways for Waterway Barrier Works exist within the proposed Gladstone port master planned area¹³⁴.

Values associated with water and water quality for the Calliope catchment are identified below¹³⁵:

- unregulated river (no significant barriers or dams)
- irrigation, farm, potable and industrial water source
- important for fish passage
- valued for barramundi fishing
- recreational and aesthetic values
- contains a narrow but nearly continuous riparian corridor and a diverse macro invertebrate and fish assemblage.

The Boyne catchment water and water quality values include:

- irrigation, farm, potable and industrial use water source
- recreational fishing
- recreation and aesthetic values.

Potential Threats, Pressures and Impacts

Potential (direct and indirect) threats to watercourses and freshwater wetlands within the proposed Gladstone port master planned area include:

¹³⁴ DAF classified waterways can be found on the Department of Infrastructure, Local Government and Planning's DA mapping system (<http://www.dilgp.qld.gov.au/about-planning/da-mapping-system.html>).

¹³⁵ Hale, J. and Box P. 2014. Identification and development of a water quality improvement and monitoring program for major catchments supplying Port Curtis.

- increased sediment loads
- barriers to fish movement for migration and life cycle requirements
- alteration to flow regimes and natural flow variation for example by alterations to flood flow, diurnal or daily flow, creation of constant unseasonal high flow and loss of overland flow
- changes in water chemistry (temperature, oxygen and sulphide levels)
- impoundments which trap sediment or cause downstream erosion and stream bed lowering
- loss of riparian vegetation and instream habitat
- introduction of fish and plants
- pollution by human activities (nutrient, heavy metals, pesticides, contaminants).

7.6.4 Groundwater Quality

Description and Context

Groundwater resources in the proposed Gladstone port master planned area is generally classified as fractured or fissured, with extensive aquifers of low to moderate productivity and containing saline groundwater¹³⁶. In the proposed Gladstone port master planned area, less groundwater is used than surface water as a percentage of total water use. There are over 90 registered bores distributed across the proposed Gladstone port master planned area (DNRM and private)¹³⁷. Clusters of bores are located in close proximity to developed areas.

Limited information is available on standing water level fluctuations in the DNRM Groundwater Database from existing bores. Historic groundwater level data for the area (for 2001 – 2009) suggest typical seasonal level fluctuations of 0.4 to 1 m in shallow groundwater (<15 m bgl) within natural strata. Groundwater levels close to the coastline are also likely to fluctuate on a sub-daily and monthly basis in response to tidal movements. Groundwater contains concentrations of dissolved metals (chromium, copper, cobalt, lead, nickel and zinc) and nutrients (ammonia as N) above the ANZECC (2000) guideline values for marine aquatic ecosystems (at the 95 per cent level of protection) at several monitoring locations in the proposed Gladstone port master planned area and groundwater immediately to the west is brackish to saline with a neutral to slightly acidic pH¹³⁸.

A key gap in groundwater quality is site specific information necessary to quantify local water quality and assess relevant impacts of proposed development.

Potential threats, pressures and impacts

Groundwater quality in the aquatic ecosystem is exposed to a range of indirect threats, including:

- alterations to freshwater hydrology and surface water quality

¹³⁶ Harrington N and Cook P. 2014. Groundwater in Australia. National Centre for Groundwater Research and Training, Australia

¹³⁷ Queensland Globe. Inland Waters Information. Searched 25 November 2015.

¹³⁸ GHD. 2009. *Western Basin Dredging and Disposal Project Environmental Impact Statement* GHD, Queensland.

- alterations to groundwater including activation of potential acid sulfate soils.

Issues for groundwater management generally in Australia include⁸³

- over allocation and over use
- impacts of groundwater extraction on surface water systems
- loss of groundwater as a source for ecosystems
- effect of climate change on availability and quality of groundwater resources
- seawater intrusion
- salinisation of groundwater resources and groundwater as an agent for salinisation.

Of these, pressures in the Curtis Coast region are thought to mostly relate to potential for over usage in localised areas for irrigation and stock watering and salt water intrusion.

7.6.5 EPP Water – Environmental Values and Water Quality Objectives

DEHP under the Environmental Protection (Water) Policy 2009 have set environmental values and water quality objectives for Curtis Island, Calliope River and Boyne River Basins¹³⁹ which applies to fresh and estuarine surface waters and groundwaters draining the basins of Curtis Island, Calliope River and Boyne River basins and coastal waters including Gladstone Harbour and the Narrows. Environmental values for water are the qualities for water that make it suitable for supporting aquatic ecosystems and human water uses and require protection from the impacts of habitat alteration, waste releases, contaminated runoff and changed flows. Particular waters have different environmental values and corresponding management intents with associated water quality objectives and are set out for seven broad areas. Given this, they are not summarised in this report.

7.7 Air Quality

7.7.1 Pollutants of Interest

Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulfur dioxide¹⁴⁰. Common sources of air pollution worldwide include household combustion devices, motor vehicles, industrial facilities and forest fires.

Particulate matter (PM) affects people more than any other pollutant, with the major components of PM being sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. Particulate matter is a complex mix of solid and liquid particles or organic and inorganic substances suspended in the air. The most health damaging particles are those with a diameter of 10 microns or less (PM₁₀ and less), which can penetrate and lodge deep inside lungs. World Health Organisation (WHO) Air Quality Guideline 2005 provides guideline values for PM, O₃, NO₂ and SO₂. There has been international discussion on the need to revise the current WHO air quality guidelines for PM₁₀ and PM_{2.5} as there is no

¹³⁹ DEHP. 2014. Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives. Basins 131, 132 and 133, including all waters of Gladstone Harbour, the Narrows, Curtis Island, Calliope and Boyne River basins, and adjacent coastal waters. State of Queensland.

¹⁴⁰¹⁴⁰ World Health Organisation. 2014. Ambient (outdoor) air quality and health. Fact Sheet No 313.

evidence of a safe level of exposure or a threshold below which no adverse health effects occur¹⁴¹. Note there is also a proposed variation to Australia's Ambient Air Quality NEPM for particle standards. The review of the NEPM standards has occurred in the context of significant challenges from climate change and population growth which are predicted to have significant impacts on air quality. Of concern is the likely predicted increase in frequency and severity of bushfires which will significantly increase particle levels in urban and rural areas. Prolonged periods of drought would also increase dust levels. Further population growth places pressure on sustaining air quality improvements due to increased transport demands, domestic emissions and energy use. The review also acknowledges that many pollutants do not have a recognised threshold for adverse health effects¹⁴².

New studies also show toxicological and health effects of SO₂ and over time there may also be new standards set for SO₂.

7.7.2 Legislation—Air quality goals and requirements

The air quality objectives and guidelines values shown in Table 22 and Table 23 are a summary of applicable pollutants of interest air quality goals within Queensland.

Table 22 Proposed Air Quality Goals for the proposed Gladstone port master planned area

Indicator	Air quality objective	Averaging period	Environmental value	Source
CO	9.0 ppm	8 hour	Health and well being	EPP Air
NO ₂	0.12 ppm	1-hour ¹	Health and well being	EPP Air
	0.03 ppm	Annual		
	0.016 ppm	Annual	Health and biodiversity of ecosystems	EPP Air
SO ₂	0.20 ppm	1-hour ¹	Health and well being	EPP Air
	0.08 ppm	24-hour ¹		
	0.02 ppm	Annual		
	0.0075 ppm	Annual	Health and biodiversity of ecosystems (for forests and natural vegetation)	EPP Air
	0.011 ppm	Annual	Protecting agriculture	EPP Air
TSP	90.0 µg/m ³	Annual	Health and well being	EPP Air

¹⁴¹ World Health Organisation Europe. 2013. Review of evidence on health aspects of air pollution –REVIHAAP Project Technical Report.

¹⁴² National Environment Protection Council. 2011. National Environment Protection (Ambient Air Quality) Measure Review. Review Report. NEPC, Adelaide.

Indicator	Air quality objective	Averaging period	Environmental value	Source
PM ₁₀	50.0 µg/m ³	24-hour ²	Health and well being	EPP Air
PM _{2.5}	25.0 µg/m ³ 8.0 µg/m ³	24-hour Annual	Health and well being	EPP Air
Dust deposition	120 mg/m ² /day	Monthly ³	Nuisance	DEHP Recommended

ppm parts per million

µg/m³ micrograms per cubic metreg/m²/month grams per metre squared per month

1 Not to be exceeded more than one day per year

2 Not to be exceeded more than five days per year

3 Not legislative, recommended goal to reduce likelihood of complaints

7.7.3 Ambient Air Quality

In order to characterise the existing air quality values in the Gladstone region, a desktop review of available air quality monitoring data was conducted. The Gladstone Air Study, a component of the Clean & Healthy Air for Gladstone project, monitored hazardous air pollutants between February 2009 to January 2010 with the aim to measure and report ambient air concentrations of PAHs, polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-*p*-dioxin/furans PCDD/Fs¹⁴³. Monitoring found the concentration of these pollutants in the air were within available health guidelines, did not contribute significantly to or exceed available international exposure standards and were consistent with or lower than the concentrations measured in other parts of Australia.

The Department of Science, Information Technology and Innovation (DSITI) currently report on air quality trend data for amenity and human health against an air quality index which converts measured pollutant concentrations into index values. The index value is the pollutant concentration expressed as a proportion of the National Environment Protection Measure for Ambient Air Quality (Air NEPM) standard or the Environmental Protection (Air) Policy 2008 (Air EPP) objective¹⁴⁴. Air NEPM standards are listed in Table 23 below.

Table 23 Air NEPM standards

Pollutant	Air NEPM standard	Averaging time
Ozone	0.10ppm	1 hour
Nitrogen dioxide	0.12ppm	1 hour
Sulfur dioxide	0.20ppm	1 hour

¹⁴³ Kennedy, K., Bentley, C. Heffernan, A., Paxman, C., Stevenson, G., Mueller, J. Gladstone Air Study 2009-2010: Monitoring for polycyclic aromatic hydrocarbons (PAHs), and polychlorinated dibenzo-*p*-dioxins (PCDDs) &-furans (PCDFs) and polychlorinated biphenyls (PCBs). The National Research Centre for Environmental Toxicology (Entox), The University of Queensland.

¹⁴⁴ Queensland Government website. <https://www.qld.gov.au/environment/pollution/monitoring/air-monitoring/regional-trends/>

Carbon monoxide	9ppm	8 hours
PM ₁₀	50ug/m ³	24 hours
PM ₂₅	25ug/m ³	24 hours
TSP	80ug/m ³	24 hours

Index values over 100 indicate the pollutant concentration exceeds the air quality standard based on health studies. In regards to visibility, index values over 100 only impact the aesthetic environment.

The air quality index comprises five colour-coded categories from very good, good, fair, poor to very poor. Live air data for the stations Boat Creek, Clinton, Auckland Point, South Gladstone within the proposed Gladstone master plan area in the Gladstone monitoring network as shown in Figure 18 are reported on line on the DEHP website and show the air quality indices for PM₁₀, PM_{2.5} and Visibility¹⁴⁵.

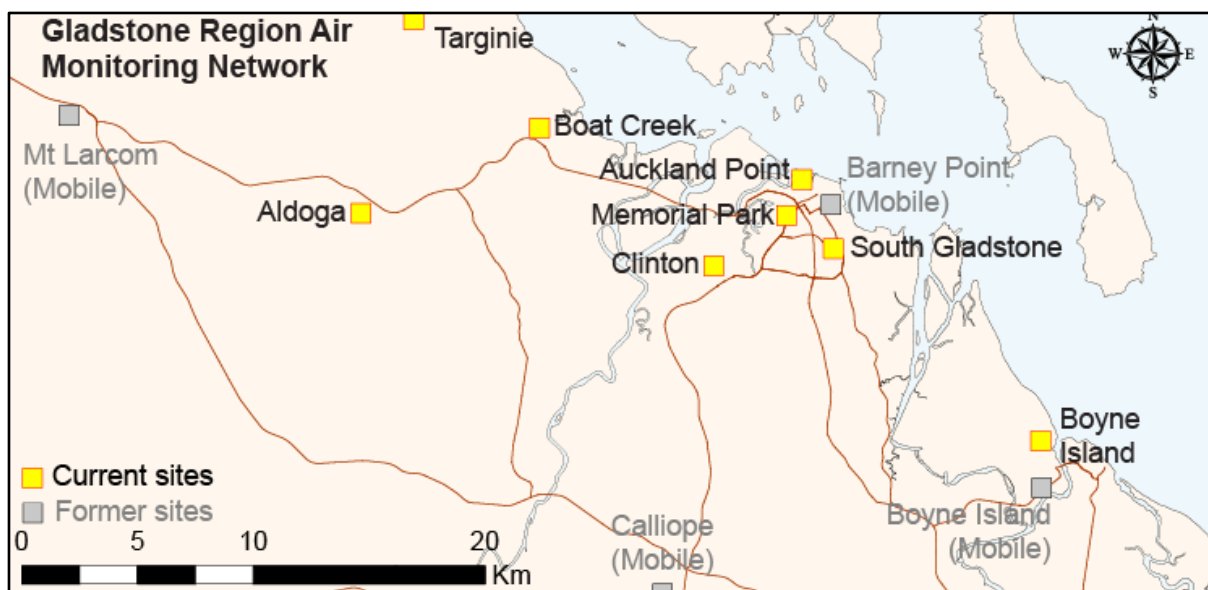


Figure 19 Gladstone monitoring network stations¹⁴⁶

The Department reports on regional trend data for air quality (human health) and air quality amenity for SE Queensland, Gladstone, Mackay, Townsville and Mt Isa based on the number of poor, fair and good air quality days for each year. Trend data for Gladstone from 2000 to 2015 is shown in Plate 4 and Plate 5.

¹⁴⁵ Department of Environment and Heritage Protection (DEHP) 2015, Hourly Air Quality Data, Source: <https://www.ehp.qld.gov.au/air/data/search.php>

¹⁴⁶ Smart Service Queensland 2015

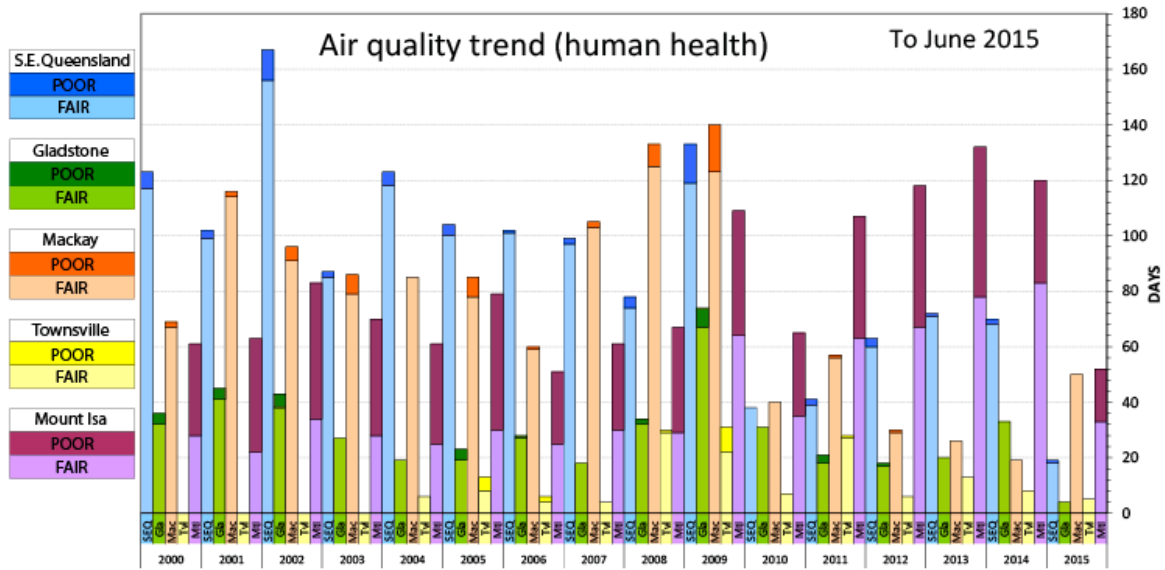


Plate 4 Air Quality Trend (human health) to June 2015 - Regional Queensland

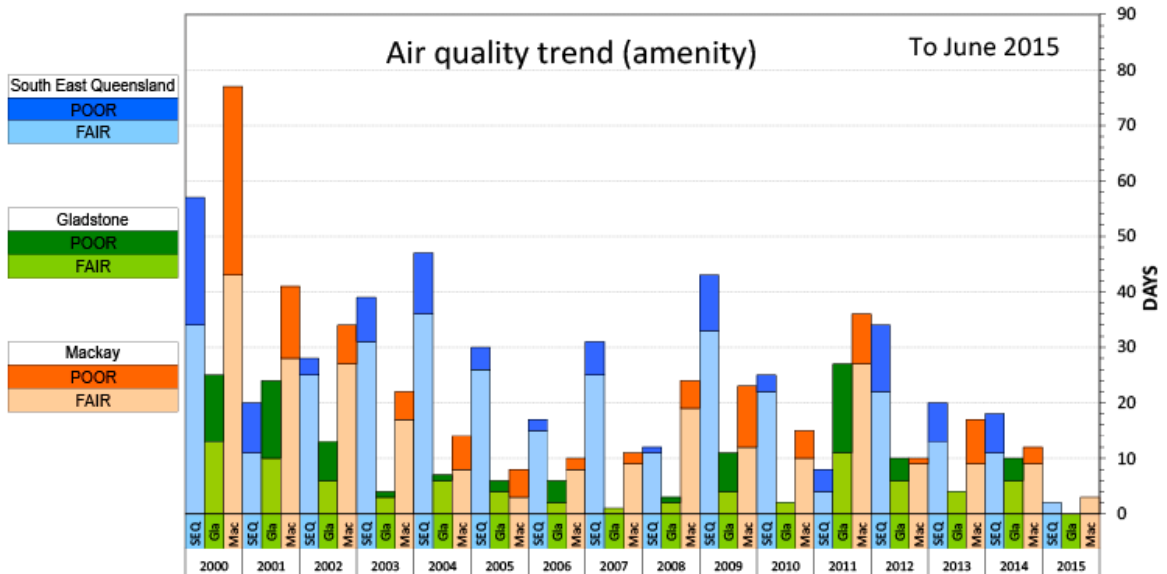


Plate 5 Air Quality Trend (amenity) to June 2015 - Regional Queensland

Trend data represented in the above graphs is expressed as:

- 'Poor' which reflects the number of days when at least one NEPM monitoring station did not meet the Environmental Protection (Air) Policy EPP (Air) air quality objective, reflecting poor visual amenity.
- 'Fair' equates to the number of days when all NEPM monitoring stations were within the EPP (Air) objective but at least one station reached at least half the objective for amenity or at least half the standards for one or more pollutants.
- 'Good' reflects the number of days when all NEPM monitoring stations were below half the NEPM air quality standards, reflecting good air quality or visual amenity.

It is noted that the DSITI and DTMR are developing a land use planning tool that (when finalised) may ensure a consistent approach to determining air and dust emission modelling and thus appropriate separation distances accounting for cumulative emission impacts for new developments.

7.7.4 Potential Threats, Pressures and Impacts

The Gladstone airshed currently has a large amount of air quality data available to aid in informing air quality assessment and is the subject of regular scrutiny. Further development within an airshed that is already showing exceedances of air quality objectives for particulate matter and contains a large number of combustion pollutant generating industries will need to be carefully planned. The region has prevailing winds typically blowing strongest from coastal locations, where port activities characteristically take place, inland to nearby residential land uses. Due to the existing ambient air quality environment and prevailing winds, potential air quality impacts for port activities need to be considered on a case by case basis.

The key threats to air quality in and around the proposed Gladstone port master planned area include:

- clearing and earthwork activities leading to dust creation
- bulk product stockpiling and handling leading to emissions
- construction activities including vehicle activity
- process industry emissions
- operational activities associated with the resource industry.

7.8 Conclusions

This report provides a high level review of environmental values in the proposed Gladstone port master planned area primarily using state and Commonwealth environmental databases. Detailed information exists in specific places within the proposed master planned area, often associated with development proposals. Ongoing site based specific surveys would be required to confirm local environmental values pertaining to any particular area and assessment of impacts on water and air quality values as set out under the relevant Environmental Protection Policies.