Port of Gladstone
Gatcombe and Golding Cutting
Channel Duplication Project

Environmental Impact Statement

Gladstone Ports Corporation
Growth, Prosperity, Community.

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2

Project description

Contents

2 Project description

2.1 Existing Port of Gladstone facilities and operations

2.1.1 General description of Port operations

The Port of Gladstone has several natural advantages as an operational port facility, including:

- A natural deep water harbour with protected waters provided by islands
- Stable weather patterns
- An abundance of nearby available land for industrial development
- Nearby regional natural resources linked by an efficient transport network
- A short sailing time of 10 to 12 days to the Asia Pacific region.

The Port's wharf centres and associated facilities cater for the import and export of raw materials, and the export of finished products associated with major industries within the Gladstone and Central Queensland regions. The Port consists of eight existing wharf centres, including:

- Auckland Point Terminal (four wharves operated by multiple companies)
- Barney Point Terminal (one wharf operated by GPC)
- Boyne Wharf (one wharf operated by Boyne Smelters Limited)
- Curtis Island (three wharves operated by LNG companies)
- Fisherman's Landing (four wharves operated by multiple companies)
- RGTCT (four wharves operated by GPC)
- South Trees (two wharves operated by Queensland Alumina Limited (QAL))
- WICT (one wharf operated by Wiggins Island Coal Export Terminal Pty Ltd (WICET)).

Figure 2.1 shows the location of the major existing and potential future Port wharf centres.

The major operational cargoes transported through the Port are summarised in Table 2.1.

Table 2.1 Port of Gladstone major cargoes

Imports		Exports	
Bauxite	Gypsum	Ammonium nitrate	General cargo
Break bulk	Liquid ammonia	Alumina	Grain
Bunker oil	Liquid pitch	Aluminium	Ilmenite
Caustic soda	Liquefied petroleum gas	Break bulk	Limestone
Containers	Magnetite	Calcite	LNG
Copper slag	Petroleum coke	Cement	Logs and woodchip
General cargo	Petroleum products	Cement clinker	Magnesia
		Coal	Magnesite
		Containers	Scrap metal
		Fly ash	

Source: GPC (2017)

The Port of Gladstone is open for ship movements and other Port-related activities 24 hours per day all year round.

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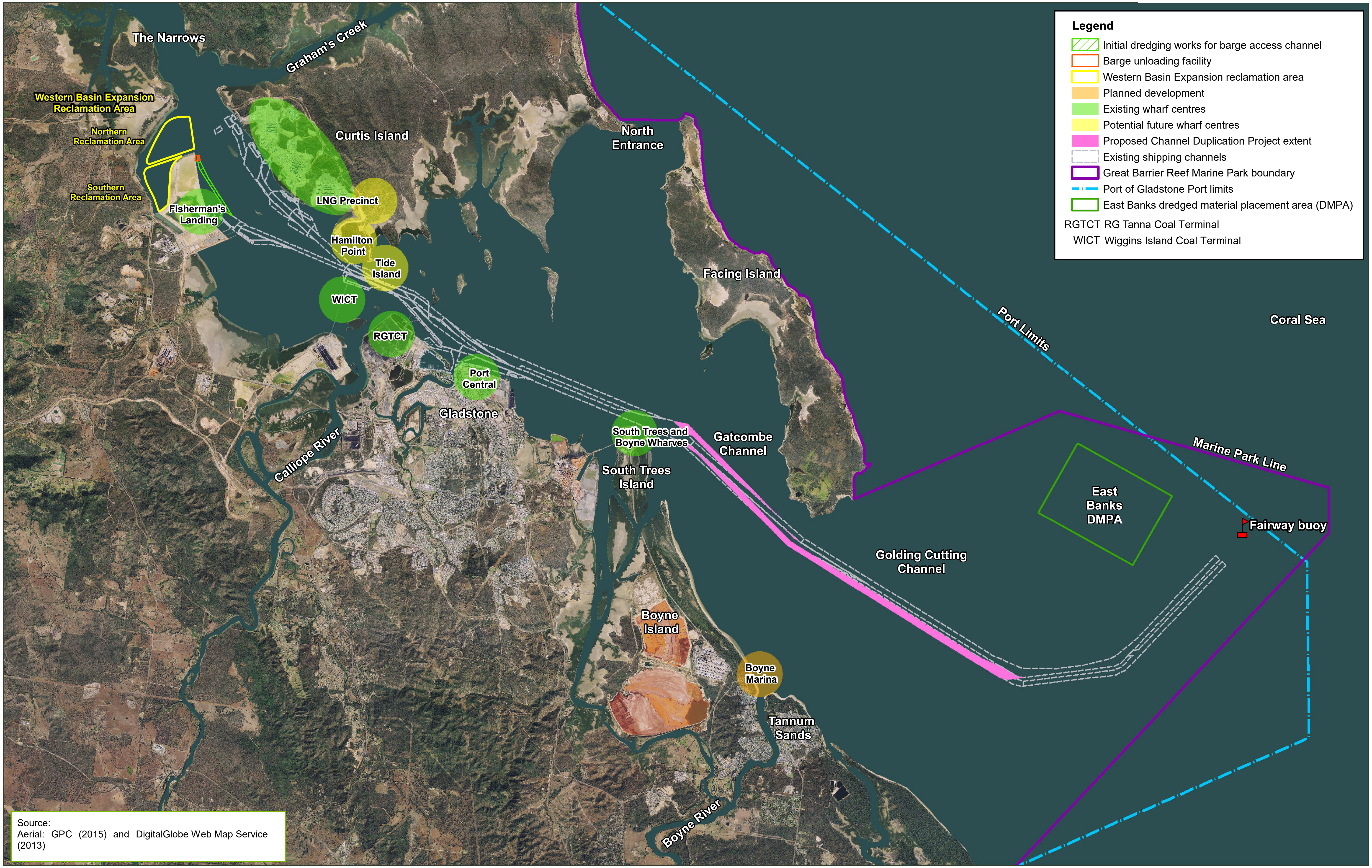

Source:
Aerial: GPC (2015) and DigitalGlobe Web Map Service (2013)

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Figure 2.1: Port of Gladstone major wharf centres

Details of the regional, state and national importance of the Port of Gladstone as an operational commercial port are provided in Section 1.4.

2.1.2 Existing and future Port wharves and other facilities

The Port of Gladstone is located within Port Curtis and is bounded by the mainland to the west and south, Facing Island to the east and The Narrows and Curtis Island to the north (refer Figure 2.1). The main entrance to the Port of Gladstone is from the southeast.

Table 2.2 summarises the existing operational wharves and expansion potential for additional wharves within the existing and future Port centres as outlined in the Strategic Plan.

Table 2.2 Port of Gladstone existing operational wharves and expansion potential for additional wharves

Port centres	Existing wharves in operation in 2019	Expansion potential for additional wharves[1]
Existing		
Boyne Wharf	1	0
South Trees	2	0
Port Central (Barney Point and Auckland Point)	5	3
RG Tanna Coal Terminal	4	1
WICT	1	3 (coal) 2 (other bulk cargo)
Fisherman's Landing (including the existing WB reclamation area)	4	7
Curtis Island (LNG Precinct)	3	1 (APLNG) 1 (QCLNG) 1 (Santos GLNG)
Future		
Hamilton Point (Curtis Island)		4
Tide Island		2
Total	**20**	**25**

Table note:

1 Potential additional wharves based on the Strategic Plan and likely future projects

Source: Adapted from GPC (2012)

Other existing Port associated facilities include:

- Gladstone marina and parklands (refer Figure 2.2)
- SPL that is leased for port and/or industrial purposes (refer Figure 2.2)
- Targinnie/Yarwun quarry area located 2km southwest of Fisherman's Landing (refer Figure 2.2)
- Offshore East Banks DMPA located within Port limits (refer Section 2.2.3 for further details)
- Internal and external anchorages (refer Section 2.1.5)
- GPC offices within Gladstone city.

2.1.3 Existing commercial shipping channels and vessel numbers

The dimensions of the existing shipping channels within the Port of Gladstone are provided in Table 2.3. Figure 2.3 illustrates the location of the existing shipping channels within the Port of Gladstone.

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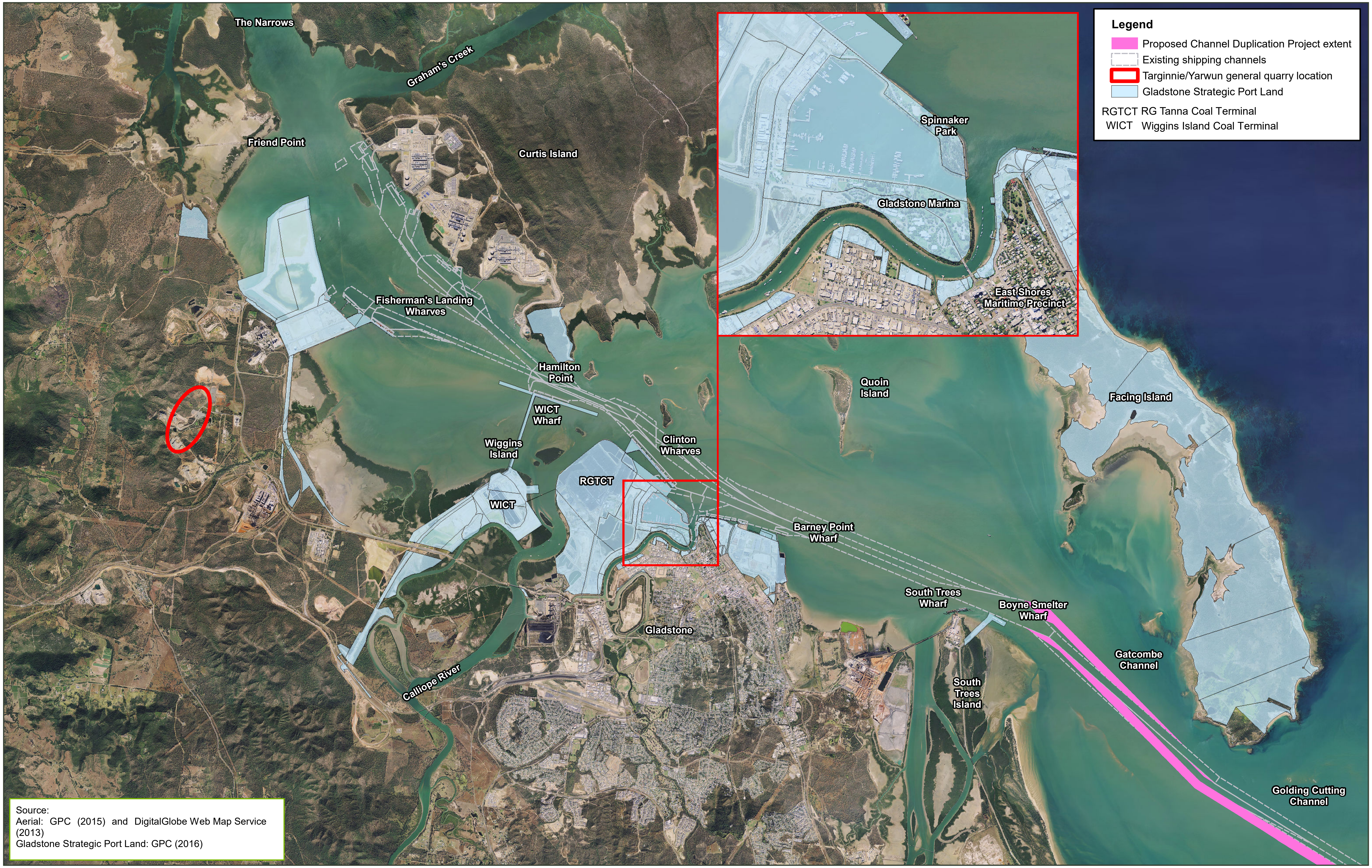

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Figure 2.2: Existing Gladstone Ports Corporation infrastructure

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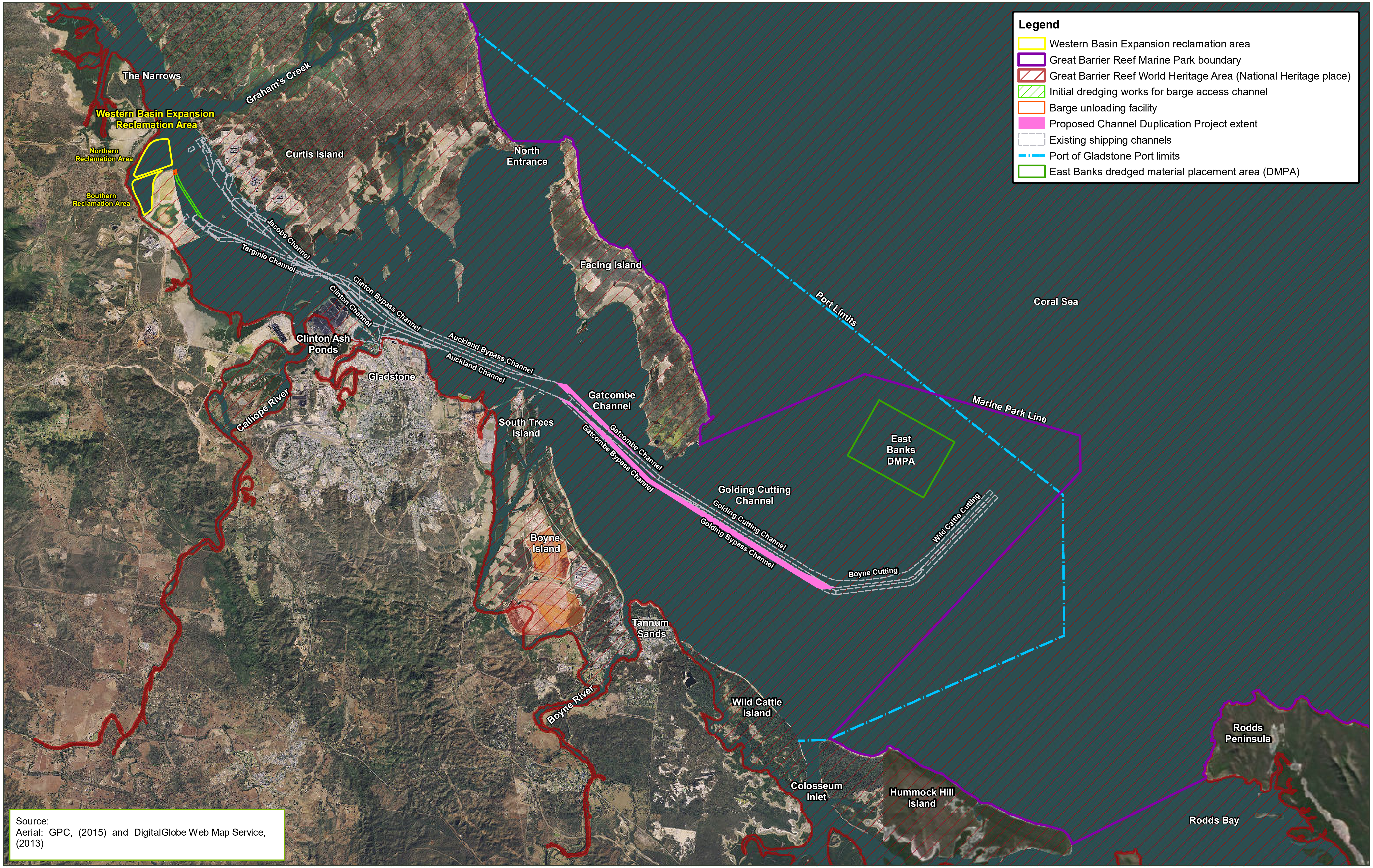

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Map by: RB

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Figure 2.3: Existing maintained shipping channels within the Port of Gladstone

Table 2.3 Existing shipping channels within the Port of Gladstone

Shipping channel	Length (m)	Width (m)	Maintained depth (m) (LAT)
Outer harbour channels - Wild Cattle, Boyne, Golding and Gatcombe Channels	22,450	183	-16.1
Golding Bypass Channel	8,900	183	-7.3
Gatcombe Bypass Channel	5,100	180	-12.5
Auckland Channel	8,700	180	-15.8
Auckland Bypass Channel	4,000	Natural	-6.8
Clinton Channel	2,200	180	-16.0
Clinton Bypass Channel	3,000	160	-13.0
Targinie Channel	6,100	120	-10.6
Jacobs Channel	4,000	200	-13.0

Source: GPC (2011)

The annual commercial vessel numbers within the Port of Gladstone since 2010/2011 are provided in Table 2.4. The commercial vessels accessing the Port range in size from coastal traders to Capesize vessels (i.e. 220,000 dwt, length overall of 308m and a draft of 18.0m). The commercial vessel numbers in Table 2.4 excludes commercial fishing and tourist vessels that utilise the Port.

The predicted increases in commercial vessel numbers, including the increasing trend towards the use of Capesize vessels for exporting coal are provided in Section 1.4.2.

Table 2.4 Number of commercial vessels accessing the Port of Gladstone

Financial year	Number of commercial vessels (import)	Number of commercial vessels (export)	Total number of commercial vessels
2010/2011	405	911	1,316
2011/2012	463	960	1,423
2012/2013	603	927	1,530
2013/2014	588	1,055	1,643
2014/2015	477	1,064	1,541
2015/2016	484	1,269	1,753
2016/2017	453	1,335	1,788
2017/2018	468	1,317	1,785

Source: GPC internal database records

2.1.4 Pilotage and reporting requirements for shipping in the Great Barrier Reef

Pilotage has been compulsory within the Great Barrier Reef since 1991 and the Australian pilotage regime came into existence for the Torres Strait-Great North East Channel in 2006. In accordance with the *Navigation Act 2012* (Qld), ships over 70m in length are required to embark a licenced coastal pilot when transiting the following coastal pilotage areas:

- The Inner Route (from Cape York to Cairns)
- The Great North East Channel (within the Torres Strait)
- Hydrographer's Passage
- Whitsundays (i.e. Whitsunday Passage, Whitsunday Group and Lindeman Group).

Figure 2.4 illustrates the location of the coastal pilotage areas, designated shipping area and Great Barrier Reef and Torres Strait Vessel Traffic Service (REEFVTS) area boundary.

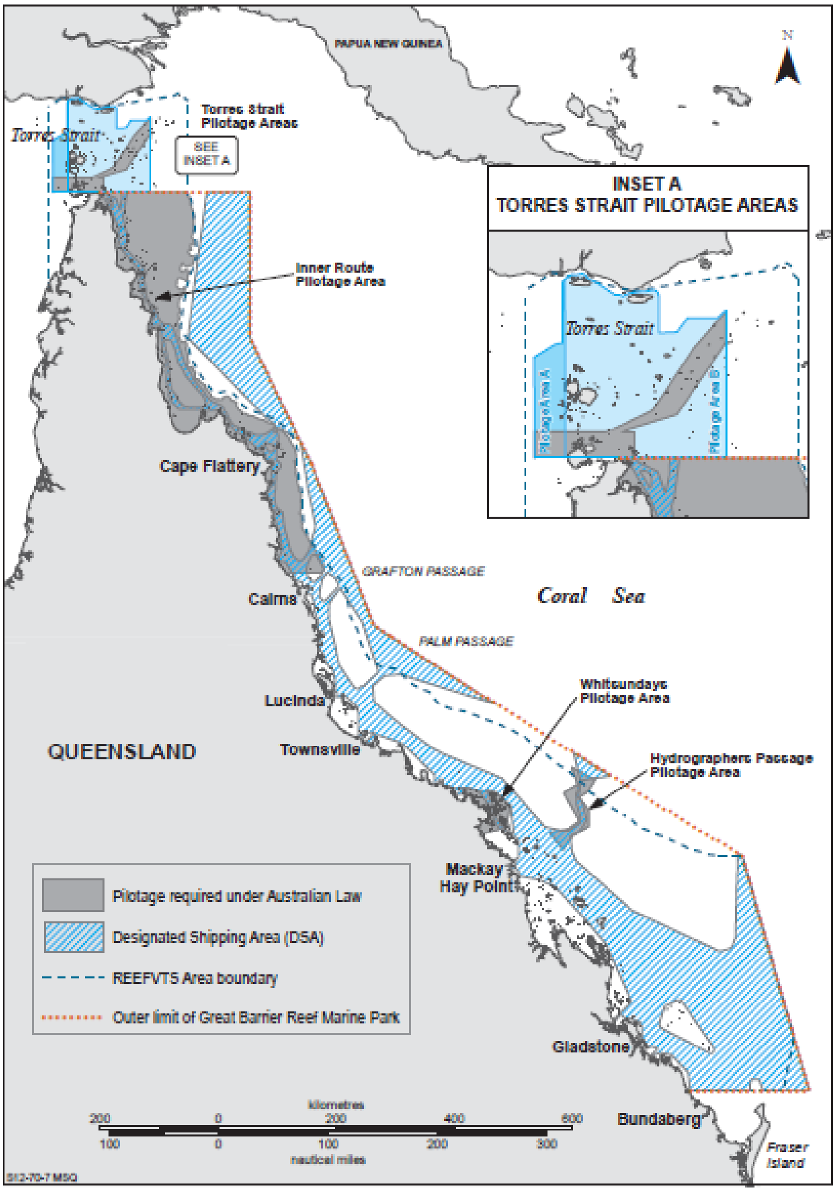

Figure 2.4 **Areas where pilotage is required under Australia law**

Source: AMSA (2014)

In July 2014, the Australian Maritime Safety Authority (AMSA) released the Queensland Coastal Passage Plan (QCPP) which seeks to improve pre-pilotage communications between coastal pilotage providers, the ships they service and the pilots embarked within these ships. The QCPP helps to prepare ships for transits of the coastal pilotage areas described in Marine Order 54 (AMSA 2014).

AMSA regulates coastal pilotage, including pilotage providers and pilots, via Marine Order 54, associated Marine Notices and Pilot Advisor Notices. The AMSA works closely with other Commonwealth and State Government organisations, and with the shipping industry to ensure that their supporting services and regulatory responses provide the highest levels of safety and protection of the marine environment. AMSA also works actively in the processes of the International Maritime Organisation to maximise safety outcomes within the internationally agreed standards that ships are required to adhere to.

The open coastal waters outside Port limits are located within the REEFVTS area boundary (refer Figure 2.4), and ships transiting through this area must report to REEFVTS, which operates 24 hours a day.

2.1.5 Port of Gladstone pilotage and existing navigational aids and marks

The Queensland Government Port Procedures and Information for Shipping – Port of Gladstone (DTMR 2012) defines the standard procedures to be followed in the pilotage area of the Port of Gladstone (refer Figure 2.5).

MSQ, through the authority of the Harbour Master, has jurisdiction over the safe movement of all shipping within the Port pilotage area. The scheduling of ship movements is initiated by the agent submitting movement details for a vessel to the Gladstone vessel traffic service (VTS) centre via the QSHIPS ship planning program in accordance with Section 3 (movement and traffic procedures) of the Port Procedures.

The Port Procedures and navigational charts clearly detail the transit route to be utilised by ships from the Fairway Buoy via the existing harbour channels to the wharf berthing location. The Procedure also provides relevant ship passing and weather restrictions.

The *Transport Operations (Marine Safety) Regulation 2016* refers to ships not being operated at a speed of more than six knots when within 30m of any jetty, wharf, boat ramp or pontoon, a vessel at anchor or moored or made fast to the shore.

With the exception of the above, no speed restriction is specified in the Port of Gladstone. However, a ship's master is made fully aware of the effects of interaction, particularly when passing ships moored at berths adjacent to the channels, and any directive given by Gladstone Harbour Control.

The coral reefs to the east of Gladstone, forming the southern extremity of the Great Barrier Reef, are enclosed in exclusion zones clearly shown on navigational charts.

The TOMSA specifies that, unless a current pilotage exemption certificate is held by the master of a ship, pilotage is compulsory for:

- A ship that is 50m or more in length
- A vessel towing another vessel where the combined length of the vessels is 50m or more
- A ship whose owner or master asks for the services of a pilot
- A ship whose master is directed by the Harbour Master to use the services of a pilot.

Anchorage limits and locations are designated on the Port navigational charts and the ship arrival limit without a pilot is six nautical miles radius from the Fairway Buoy. MSQ directs the ship master to the appropriate anchorage.

The TOMSA and regulation also defines the Port of Gladstone pilotage area where compulsory pilotage is required (refer Figure 2.5). Pilotage service is provided by the Gladstone Marine Pilot Service, an entity of GPC.

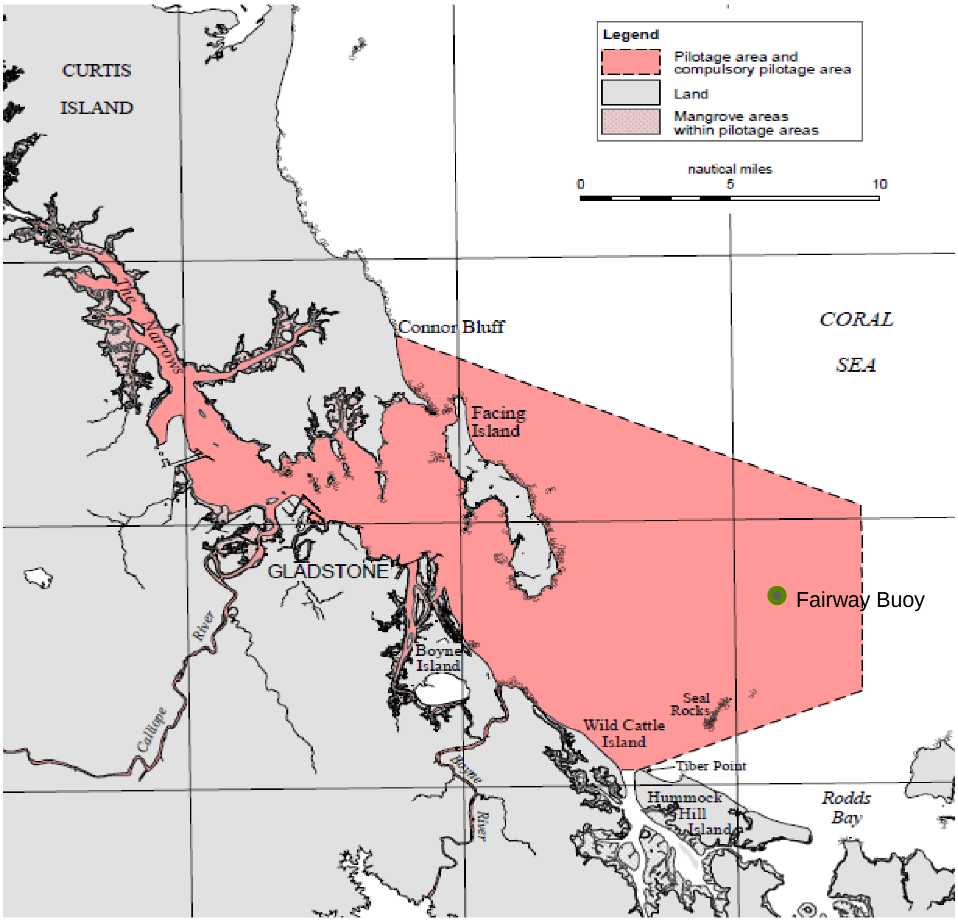

Figure 2.5 Port of Gladstone pilotage area

Source: DTMR (2014b)

The Port contains navigational aids, leading lights, beacons and buoys to assist ships' masters, owners and agents of vessels arriving at and traversing the Port. The Port Procedures provide details of the services and regulations, and procedures to be observed by vessels utilising the Port.

The location of the existing navigational aids (i.e. buoys and beacons) within the vicinity of the area to be dredged are illustrated in Figure 2.6.

Offshore ship mooring locations or external anchorages are available for vessels arriving off the Port of Gladstone. Designated anchorage positions are assigned by the VTS. Anchorages are assigned to vessels whilst awaiting berthing instructions. The external anchorages are shown on Port navigational charts and are identified by either a northern or eastern designation and a number. There are 14 northern anchorages and 12 eastern anchorages located to the north and east of the Fairway Buoy.

Internal anchorages are available for safe anchorage inside the harbour, including a designated emergency anchorage. The internal anchorages are shown on Port navigational charts and are identified by a location and a number. There are four internal anchorages (including an emergency anchorage) at South Trees on the northeastern side of the Gatcombe Channel and two internal anchorages near the Quoin Channel on the northeastern side of the Auckland Channel.

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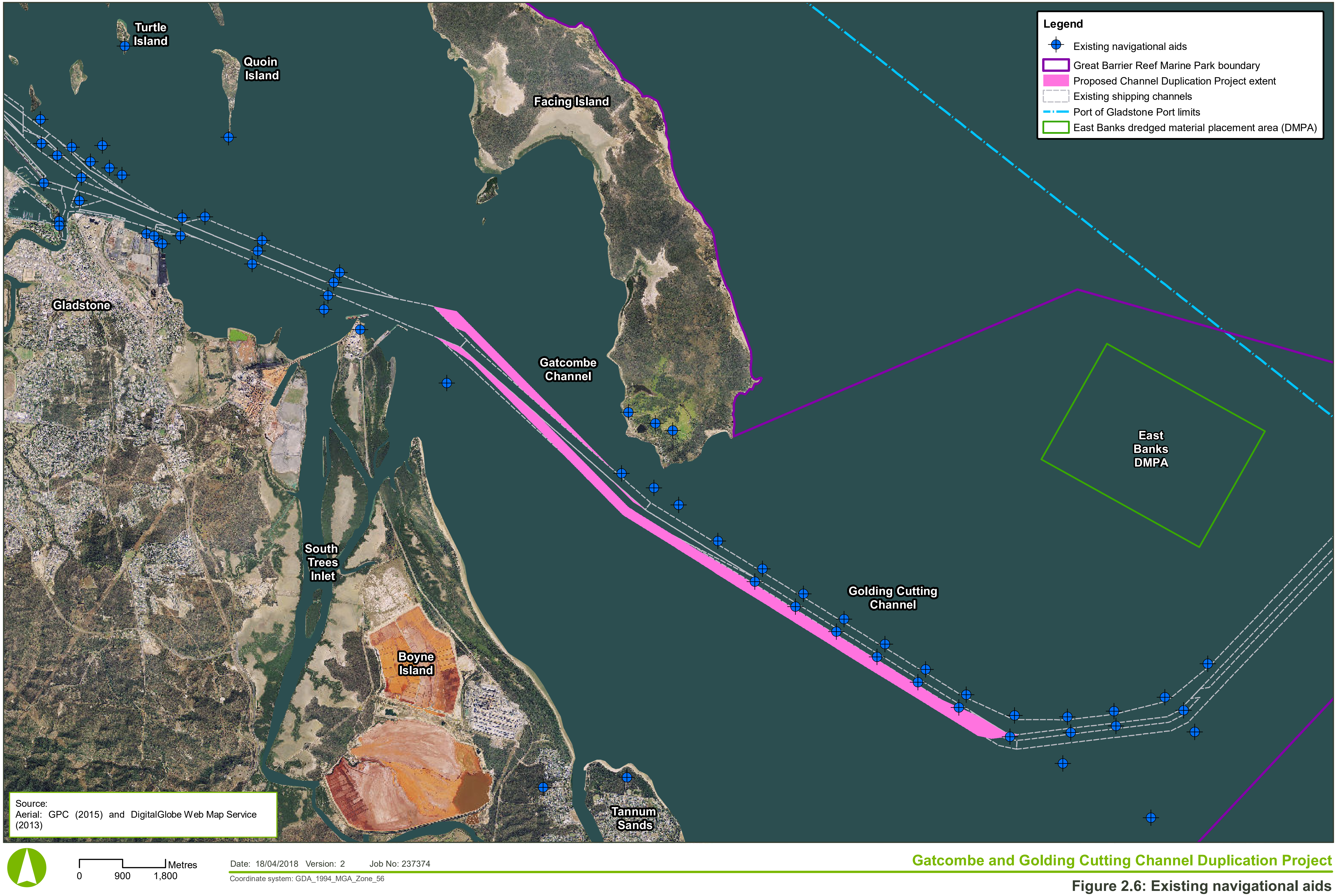

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.6: Existing navigational aids

2.2 History of dredging in the Port of Gladstone

2.2.1 Capital dredging and dredged material placement

The Port of Gladstone has a long history of undertaking capital dredging works to support major project development and port industry expansion. Capital dredging occurred in the 1960s for the Auckland Point and Barney Point berths, and harbour and entrance channels. Table 2.5 summarises past key capital dredging projects and known dredging volumes since the 1980s undertaken in the Port of Gladstone, with details of the two most recent projects provided in Section 2.2.4.

Table 2.5 History of key capital dredging projects in the Port of Gladstone

Date	Location	Volume (Mm^3)	Placement location
1980 to 1982	Approach channels to Clinton and Fisherman's Landing, and Gladstone Marina	20.0	Onshore and offshore
1986 to 1987	Inner harbour channels widened and berths deepened	3.0	Onshore
1987	Outer channel	2.5	Offshore
1997	Fisherman's Landing	1.0	Onshore
1997	Outer channel	1.0	Offshore
1998	Fisherman's Landing swing basin	2.0	Onshore
1999	Inner channel	2.0	Onshore
2001 to 2003	RG Tanna Coal Terminal Berth 3, Fisherman's Landing Berth 2 Targinie and Clinton Bypass Channels deepening	1.65 0.35	Onshore Offshore
2005	RG Tanna Coal Terminal Berth 4	0.75	Onshore
2008 to 2009	Fisherman's Landing Berth 1 and approach	0.66	Onshore
2010 to 2011	Early works access to Curtis Island	0.475	Onshore
2011	Wedge	0.5	Offshore
2012 to 2013	WICT Berth 1	2.9	Onshore
2012 to 2013	WBDDP (Stage 1A)	17.0 5.5	Onshore Offshore

Table notes:

Onshore = dredged material placement predominantly by cutter suction dredger directly into reclamation area
Offshore = majority of dredged material placement by trailing hopper suction dredger

Source: GPC internal database records

2.2.2 Maintenance dredging

Maintenance dredging is undertaken annually in the Port of Gladstone channels, berths and swing basins to remove sedimentation resulting from littoral drift, sediment laden stormwater runoff/flooding and tidal currents to maintain declared depths for commercial shipping access. Historically, within the Port of Gladstone, approximately 65% of maintenance dredging has occurred in the outer channels and approximately 35% has occurred in the inner channels.

The annual maintenance dredging volume for the Port of Gladstone between 2007 and 2012 was approximately 153,000m^3, which was dredged over an average period of 22 days per year. The maintenance dredging campaigns undertaken in the Port since the completion of the WBDDP capital dredging, and estimated volumes to 2019 are summarised in Table 2.6.

Table 2.6 Port of Gladstone maintenance dredging volumes

Annual campaign	Approximate dredged volume (Mm^3)
2014/2015	0.385
2015/2016	0.553 (including 0.305 for marina)
2016/2017	0.207
2017/2018	0.210
2018/2019	0.242

Source: GPC internal database records

The increase in annual maintenance dredging volumes within the Port since 2014 are due to the new maintained channels, swing basins and berth pockets completed as part of the WBDDP in 2013. The reductions in maintenance dredging volumes since the 2016/2017 campaign are due to the stabilisation of the channel and batter slopes over time.

2.2.3 Dredged material placement

Previous capital dredged material from the Port of Gladstone has been managed by either offshore (at sea) placement or within reclamation areas in close proximity to the dredged areas (e.g. intertidal locations adjoining the mainland). Reclamation areas previously established within Gladstone using predominantly dredged material are summarised in Table 2.7.

Table 2.7 Summary of Gladstone reclamation areas utilised for dredged material placement

Area utilised for dredged material placement	Status of completion and potential capacity to receive additional material
Auckland Point to Barney Point (Port Central)	Completed and no capacity to receive additional dredged material
Clinton Estate west of Auckland Inlet, includes marina and Spinnaker Parklands and RG Tanna Coal Terminal	Completed with the exception of being able to receive small maintenance dredging volumes from nearby areas (e.g. sediments within the marina)
Fisherman's Landing	Completed and no capacity to receive additional dredged material
Wiggins Island reclamation areas	Not completed and has limited capacity. This area is committed to receive capital dredged material from existing approved coal terminal expansions at the WICT.
Fisherman's Landing Expansion and WB reclamation area (established as part of the WBDDP)	Not completed and has some capacity to receive small volumes of capital dredged material

Offshore (at sea) placement of dredged material has occurred since 1980 within the existing East Banks DMPA, which is located north of the outer harbour shipping channels within Port limits and outside the GBRMP (refer Figure 2.3). Dredged material placement at this location has occurred in association with the Port's annual maintenance dredging, and various capital dredging campaigns.

The East Banks DMPA is currently used by GPC for placement of dredged material associated with the annual maintenance dredging of the channels, berth pockets and swing basins in the Port of Gladstone. The general specifications for the existing East Banks DMPA are summarised in Table 2.8.

Table 2.8 Existing East Banks DMPA general specifications

Specification type	Details
Global Positioning System (GPS) coordinates	■ 23° 53.84' S 151° 29.02' E ■ 23° 52.83' S 151° 27.10' E ■ 23° 51.53' S 151° 27.91' E ■ 23° 52.54' S 151° 29.84' E
Depth	Ranges from 8m to 13m below Port datum Average 11m below Port datum
Net available area	1,050ha
Remaining capacity	38Mm^3

Table 2.9 provides a summary of the previous dredging campaigns where the dredged material was placed within the existing East Banks DMPA.

Table 2.9 Port of Gladstone dredged material placed within East Banks DMPA

Type of dredging	Location	Dates	Dredged material volume (Mm^3)
Capital dredging	Deepening and widening Port channels	1980 to 1982	12
Capital	Inner harbour channels widened and berths	1986 to 1987	2.5
Maintenance and capital	Outer harbour channels	March 1993 to April 1995	1
Maintenance	Port channels and berths	May 1995 to June 1995	0.003
Maintenance	Port channels and berths	October 1996 to March 1997	0.1
Maintenance and capital	Outer harbour channels	April 1997 to October 1997	0.9
Maintenance and capital	Port channels and berths	April 1998 to April 1999	0.06 (capital) 0.1 (maintenance)
Maintenance	Port channels and berths	June 1999 to June 2000	0.1
Maintenance	Port channels and berths	July 2001 to June 2002	0.3
Maintenance	Port channels and berths	July 2002 to July 2007	1
Capital	Clinton Bypass Channel and Targinie Channel	March 2003 to September 2003	0.02
Capital	Clinton Bypass Channel	August 2008 to August 2009	0.1
Maintenance	Port channels and berths	November 2007 to November 2012	1
Capital	Channels, swing basins and berth pockets associated with WBDDP	May 2011 to March 2013	5.5

Table note:

Annual maintenance dredging volumes for 2014 to 2019 are provided in Table 2.6.

Source: GPC internal database records

The most recent capital dredging program involving offshore dredged material placement was carried out under the authority of Sea Dumping Permit No. SD2010/1742 issued on 22 October 2010 for a capital seabed material volume of up to 11Mm^{3}.

2.2.4 Recent reclamation projects within the Port of Gladstone

2.2.4.1 Wiggins Island Coal Terminal Project

All material dredged as part of Stage 1 of the WICT Project was placed within a 140ha intertidal reclamation and land-based containment area as fill for the establishment of the coal terminal and associated infrastructure, and other future port and industrial related industries.

Dredged material was hydraulically placed within Reclamation Area B (north of Gladstone Mount Larcom Road), approximately 5km from the centre of the dredged area footprint, using a CSD and two booster pumps. Hydraulic placement of dredged material required a combination of floating and submerged pipelines up to a length of 4km, before a further 1km of landside pipeline through the WICT Project footprint to reach Reclamation Area C dewatering ponds.

Figure 2.7 illustrates the general arrangement of dredging and placement operations completed for Stage 1 of the WICT Project.

Figure 2.7 Wiggins Island Coal Terminal Project dredging and reclamation infrastructure placement arrangement

The internal bunds of Reclamation Area B were designed to facilitate the settling of dredged material prior to the discharge of tailwater from licenced points into the Calliope River Anabranch. The use of primary, secondary and tertiary dewatering ponds allowed the progressive settlement of dredged material, with heavier materials (i.e. gravel and sand components) as well as some finer materials being deposited closer to the internal reclamation outlet points, followed by the remainder of the sand plus a proportion of finer materials, and finally the remaining fine materials within a residual pond area. Tailwater from the hydraulic placement of dredged material was managed in a 50ha area to reduce fines and turbidity prior to discharge.

This design provided for improved ground settlement within the Reclamation Area B closer to the outlet points, and the option to move dredged material to Reclamation Area C (south of Gladstone Mount Larcom Road) to improve the settlement pond capacity.

The onward pumping of fines (in suspension) from Reclamation Area B to Reclamation Area C occurred in order to ensure compliance with the licence water quality discharge limits. Photograph 2.1 and Photograph 2.2 show aerial views of the reclamation ponds and fines management system for the WICT Project.

Photograph 2.1 Wiggins Island Reclamation Area B

Photograph 2.2 Wiggins Island Reclamation Area C

2.2.4.2 Western Basin Dredging and Disposal Project

Adopted dredging methodology

Dredging undertaken as part of the WBDDP (Stage 1A) involved the combination of a TSHD, CSDs and backhoe dredgers (BHDs) with barges.

The WB reclamation area was constructed with an 8.8km outer bund wall with a height of approximately +7.0m LAT and consisting of approximately 2Mm^3 of material sourced offsite. The reclamation process required an area of approximately 270ha for inner bund walls and tailwater management.

Dredged material was hydraulically placed within the reclamation area using a CSD with up to a maximum of 5km of pipeline from the cutter head via a combination of floating, submerged and reclamation area pipelines to the discharge point within the reclamation area. For dredged material to travel this maximum distance two booster pumps were required. The CSD alone achieved a typical availability of 65% (factoring maintenance downtime), with each booster included in the dredged material pumping process 5% or 10 hours is deducted for efficiency. When placed in series, the CSD with two booster pumps achieved an availability of approximately 50%. The addition of a third booster pump would have further decreased the availability of dredging equipment to approximately 34%.

Availability of equipment and the length of the dredging program also impacted on the velocity at which material could be pumped. The high variability of material size and consistency encountered in the Port of Gladstone during this project caused variable pumping velocities and therefore the settling of material within the pipeline. As a result, a number of blockages occurred in the floating and/or submerged lines, as illustrated in Photograph 2.3. The location of the blockage of this submerged line needed to be identified and cut in situ on the seabed and raised by support craft fitted with cranes and replaced with a new pipeline section.

Photograph 2.3 Submerged pipeline blockage during the Western Basin Dredging and Disposal Project dredging (diameter of pipeline is 900mm)

A TSHD was used to remove dredged material for Western Basin dredging areas greater than 5km from the reclamation area due to the cohesive nature (i.e. high silt and clay content) of the material limiting the ability to pump the material ashore. The high silt and clay content of the dredged material was not able to be pumped directly from the hopper of the dredger into the WB reclamation area as bridging and rat holing restricted the feed of dredged material into the self-empty channel of the hopper (refer Section 2.4.3.2 for further explanation). Dredged material within these areas (and some potential acid sulfate soil (PASS) material) was placed offshore within the existing East Banks DMPA.

BHD/grab dredgers were also used to remove dredged material from areas where shallow depths occurred (e.g. LNG proponents berth pockets on Curtis Island), as there was insufficient under keel clearances for a CSD or a TSHD to operate.

The dredged material placed at the East Banks DMPA included material containing PASS as identified in the Project's sediment sampling and analysis. This material was managed through the dredging method and placement, ensuring the material was kept saturated during dredging by utilising a TSHD or BHDs, and during transport to the DMPA. Direct placement of the PASS material offshore ensured the material did not oxidise, and the risk was managed. The CSD also managed PASS by placing dredged material directly into the WB reclamation area and implementing an acid sulfate soil management plan (ASS Management Plan) to minimise potential water quality impacts.

Figure 2.8 illustrates an example of a general arrangement of dredging and reclamation operations for one of the dredging locations in Stage 1A of the WBDDP.

Figure 2.8 **Western Basin Dredging and Disposal Project dredging and intertidal reclamation arrangement**

Independent review of the Port of Gladstone

An independent review of environmental management arrangements and governance of the Port of Gladstone was commissioned in February 2013. A key component of the Australian Government's response to the 2012 decision of the World Heritage Committee regarding the ongoing protection and management of the GBRWHA is the independent review (Australian Government 2013).

The World Heritage Committee's Decision 36 Com 7B.8 requests the Australian Government to:

> *undertake an independent review of the management arrangements for Gladstone Harbour, that will result in the optimisation of port development and operation in Gladstone Harbour and on Curtis Island, consistent with the highest internationally recognised standards for best practice commensurate with iconic World Heritage status.*

The purpose of the independent review was to:

- Examine and report on the management arrangements for the Port of Gladstone to respond to the World Heritage Committee's Decision 36 Com 7B.8
- Advise the Minister on other relevant matters to inform decision making under the EPBC Act in response to the World Heritage Committee decision, or any other matters as requested by the Minister (Australian Government 2013).

The key findings and recommendations from the independent review, and the Channel Duplication Project's responses are provided in Appendix D.

Independent review of the bund wall performance

Between June 2011 and July 2012, during the WBDDP, events relating to the performance of the reclamation outer bund wall occurred. The *Gladstone Bund Wall Independent Review* was commissioned to examine and report on information relevant to the design, construction and functioning of the outer bund wall, and to consider the adequacy of monitoring requirements (Australian Government 2014).

The independent review found that aspects of the design and construction of the bund wall were not consistent with industry best practice. Inadequate restraint of a geotextile liner, piping of water and sediment through paleo-channels under the wall, and the erosion of mud outside the wall all contributed to changes in turbidity in the vicinity of the bund wall (Australian Government 2014).

The key findings and recommendations from the independent review, and the Channel Duplication Project's design and implementation responses are provided in Appendix D.

2.3 Overview of Project activities

The Gatcombe and Golding Cutting Channel Duplication dredging is required to improve Port of Gladstone operational and economical efficiencies (refer Section 1.4). It will improve the existing and future safe passage of vessels within the Port as throughput and associated vessel numbers increase, and the portion of predicted Capesize vessels also increases in the future.

The key components of the Project are summarised below with reference to the relevant section which contains further detail on the proposed activities.

- Construction of a BUF and the WBE reclamation area bund walls prior to dredging commencing (refer Sections 2.5.3 to 2.5.9)
- Initial dredging of approximately 0.25Mm^3 of seabed material (including dredging tolerance) to establish a 2.3km long access channel to -7m LAT to allow barges to transport dredged material from the Gatcombe and Golding Cutting shipping channels to the BUF (refer Section 2.4.4.2)

- Dredging approximately 12.6Mm^3 of seabed material (including dredging tolerance) to duplicate the main Gatcombe and Golding Cutting shipping channels. The duplication involves the deepening and widening of the existing Gatcombe and Golding Cutting bypass shipping channels, resulting in two shipping channels of the same depth to allow vessel passing (refer Section 2.4.1). The estimated total Project dredging volume, including initial dredging works, is 12.85Mm^3 and the length of the channel to be dredged is approximately 15km.
- Preferred dredging methodology involves utilising a TSHD which loads the dredged material from the Gatcombe and Golding Cutting shipping channels into barges (four barges will be working in cycles for the entire dredging operations) which will transport the material to the BUF to be unloaded using large excavators into trucks for placement within the existing WB and WBE reclamation areas (refer Section 2.4.4.2)
- Dredged material placement within the WB and WBE reclamation areas (refer Section 2.5.10)
- Provision of services to the Project activities (refer Section 2.6)
- Removal, relocation and installation of new navigation aids (refer Section 2.7)
- Demobilisation of dredging operation (refer Section 2.8)
- Project maintenance and operational phase activities, including:
  - Reclaimed land surface stabilisation and maintenance activities (refer Section 2.11.1)
  - Final land uses on reclaimed land and future wharf usage of the BUF (refer Section 2.11.2)
  - Maritime operation within duplicated channels (refer Section 2.11.3)
  - Maintenance dredging within duplicated channels and barge access channel (refer Section 2.11.4).

The Initial Advice Statement for the Project was prepared in September 2012 and stated that the length of the duplicated Gatcombe and Golding Cutting Channels will be 9.12km and the dredging volume is approximately 12Mm^3. Since 2012 more detailed bathymetry and geotechnical investigations within the channels have confirmed the Project dredging volume to be 12.85Mm^3 which is also attributed to the preferred dredging methodology requiring a barge access channel to comply with the Ports Act, and allowing for dredging tolerance. A check on the length of the channels was also made and is now confirmed as approximately 15km.

2.3.1 Project workforce

The workforce required for the establishment and delivery of the Project, including the post dredging works and annual maintenance dredging is shown in Table 2.10. The total maximum construction workforce for the Project across all activities during construction will be 386 people.

Table 2.10 Summary of Project workforce

Activity	Maximum workforce estimate (workers)	Sub-total
Reclamation bund wall and BUF construction	20 (excluding GPC workforce)	20
Dredging and dredged material placement		
▪ TSHD and barge marine operations crew	160	
▪ Barge unloading, including excavator operators and truck drivers	164	
▪ Reclamation area works, including bulldozers and graders operators and water-truck drivers	32	356
Navigational aid works	10	10
Total construction workforce		**386**

Activity	Maximum workforce estimate (workers)	Sub-total
Post construction works		
▪ Stabilisation and maintenance on WBE reclamation area	8	
▪ Annual maintenance dredging	15	23

2.3.2 Hours of operation

The expected hours of operation for the main Project activities are shown in Table 2.11.

Table 2.11 Hours of operation for Project activities

Activity	Hours of operation
Reclamation bund wall and BUF construction	6.30am to 6.30pm Monday to Saturday
Dredging and barge operations including unloading and placement of dredged material	24 hours per day, 7 days per week
Navigational aid works	6.30am to 6.30pm Monday to Saturday
Maintenance works on the WBE reclamation area	6.30am to 6.30pm Monday to Saturday
Annual maintenance dredging	24 hours per day, 7 days per week

2.3.3 Consultation with the Regional Harbour Master

Consultation with the Regional Harbour Master Gladstone was held in July 2014. The discussions included issues associated with the removal or re-location of existing navigational aids and the introduction of new navigational aids.

Further discussions regarding potential conflict with existing shipping while dredging will occur with the Regional Harbour Master during the tendering stage and outcomes will be detailed in the final Dredging EMP.

Shipping management is addressed under the Port Procedures (DTMR 2018) which provides details of the services and regulations, and procedures to be observed by all vessels utilising the Port of Gladstone. No changes to the Port Procedures are anticipated as a result of the Project.

2.3.4 Potential for Project changes during future phases

There is potential for components of the Project to be refined and/or changed during the detailed design and dredging contractor tendering phases of the Project (e.g. reclamation bund wall design, size of dredgers, number of construction workers, hours of operation). However the nature and scope of the Project activities as contained in this EIS are not expected to materially change.

Any refinements and/or changes made to the Project not addressed in the EIS will be assessed during detailed design, addressed in post EIS environmental approvals and where required additional mitigation measures included in the Project EMP, Dredging EMP and/or Environmental Monitoring Procedure.

2.4 Dredging component of the Project

2.4.1 Location of shipping channels to be dredged and material volume

The major dredging component of the Project involves the duplication of the main Gatcombe and Golding Cutting shipping channels. The duplication involves the deepening and widening of the existing Gatcombe and Golding Cutting bypass shipping channels, resulting in two shipping channels of the same depth to allow an improved two-way passage into the Port under all weather and tidal conditions. The location of the existing maintained channels and the proposed duplicated channels are shown in Figure 2.9.

The proposed duplicate channel will be approximately 15km long and dredging is proposed to be undertaken to an ultimate depth of -16.1m LAT, with a channel width (toe to toe) of 200m (refer Figure 2.9). This equates to the removal of approximately 12.6Mm³ of seabed material (including dredging tolerance) from the Gatcombe and Golding Cutting bypass shipping channels. Dredging tolerance is defined as the difference between the design depth (i.e. no seabed material to remain above this level at the completion of the capital dredging campaign) and the actual post dredging depth (i.e. average depth below the design depth to allow for the dredged profile and to accommodate siltation between maintenance dredging campaigns).

In addition to the 12.6Mm³ of dredging for the Gatcombe and Golding Cutting Channels, initial dredging works of approximately 0.25Mm³ of seabed material is proposed (including dredging tolerance) to establish a 2.3km long access channel to allow barges to transport dredged material from the Gatcombe and Golding Cutting shipping channels to the BUF to be unloaded using large excavators into trucks for placement within the existing WB and WBE reclamation areas (refer Section 2.4.4.2). The total estimated Project dredging volume is 12.85Mm³.

Two dredging campaign options are proposed and will be selected upon predicted throughput and associated vessel movements. At this stage it is envisaged that the Project dredging will be undertaken over two stages. However, should the need and/or growth for Port trade justify the need for the final design channel depth, the two stages will be combined into a singular campaign. As the dredging methodology is the same for both options, the initial dredging works will be required prior to either Stage 1 dredging or prior to the singular campaign. The likely volumes and timing of each dredging campaign option are outlined in Table 2.12.

Table 2.12 Dredging campaign and staging options, location and volumes

Stage	Location	Timeframe – likely start date or later (duration)	Design depth (m LAT)	Volume (Mm³)[1]
Initial dredging works	Barge access channel	2023 (6.5 weeks)	-7.0	0.25
1	Gatcombe and Golding Cutting Channels	2023 or later (33 weeks)	-13.5	7.25
2	Gatcombe and Golding Cutting Channels	2026 or later (25 weeks)	-16.1	5.35[2]
Singular campaign	Gatcombe and Golding Cutting Channels	2023 or later (58 weeks)	-16.1	12.60

Table notes:

1 Includes 0.3m (depth) allowance for average dredging tolerance
2 The Stage 2 dredged material volume assumes that the barge access channel is maintained at the Project design depth as part of the Port-wide maintenance dredging

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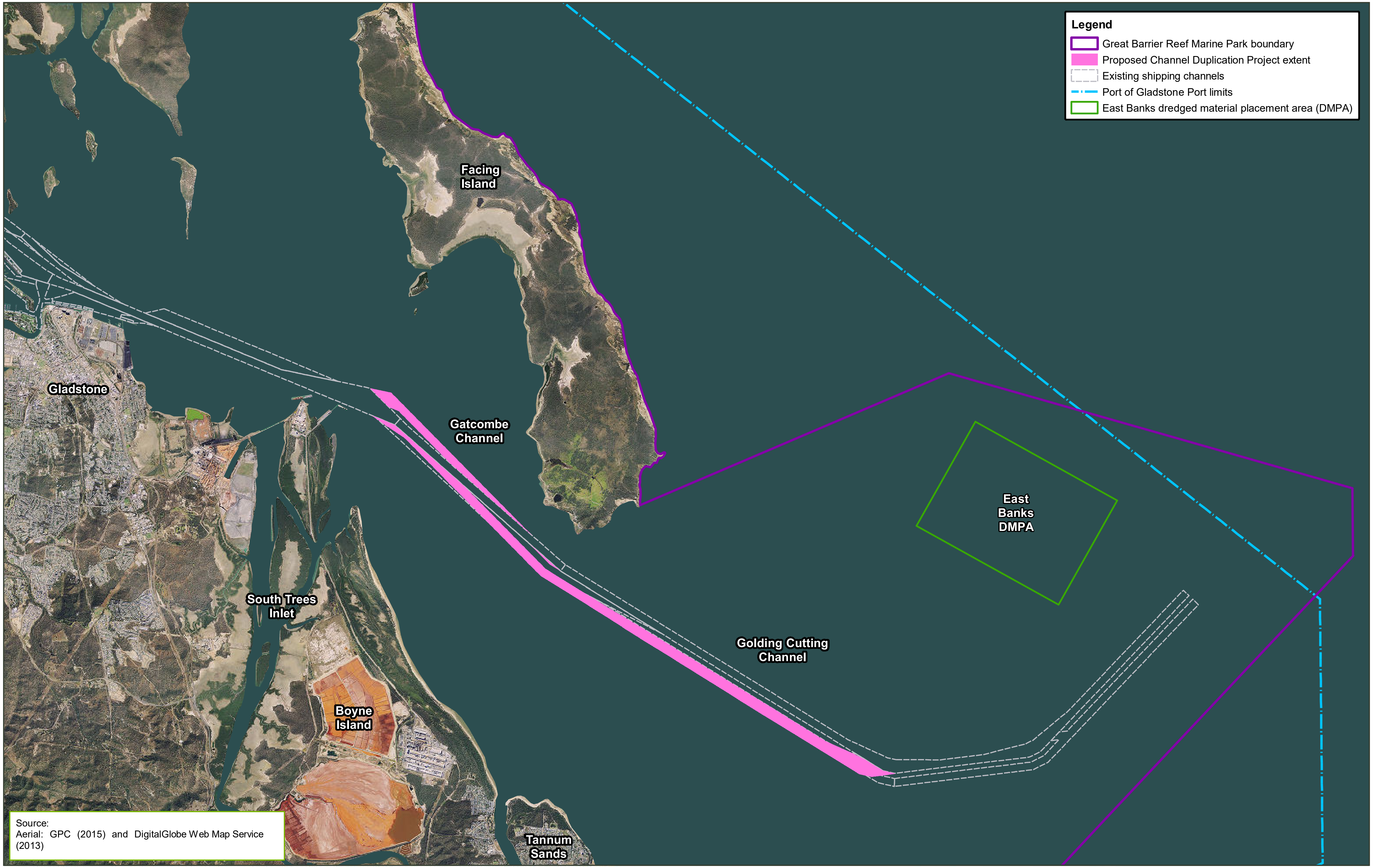

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.9: Gatcombe and Golding Cutting Channel Duplication Area

There is the potential for dredging to commence after 2023 subject to actual and predicted Port throughput and associated vessel movements over the next 5 to 10 years. The potential delayed commencement of the dredging program provides the opportunity to construct the reclamation bund walls over an extended period to minimise potential environmental impacts (e.g. noise, dust) and allow gradual placement and settlement of bund wall material.

Figure 2.10 shows the area to be dredged for Stage 1 which has a design channel depth of -13.5m LAT. The area to be dredged as part of Stage 1 is less than the Stage 2 impact area to be dredged as the existing bathymetry within parts of the channel are already sufficient for the Stage 1 design channel depth.

Figure 2.11 shows the ultimate area to be dredged to achieve the final design channel depth (i.e. design channel depth is -16.1m LAT).

2.4.2 Dredging equipment options

This section provides a general description of the characteristics and capabilities of the potential dredging equipment options available. The feasibility of the dredging equipment options for the Project are provided in Section 2.4.3.

2.4.2.1 Cutter suction dredger

A CSD is a stationary hydraulic dredger equipped with a cutter and pump power. CSDs operate by swinging about a central spud using anchors and winches (refer Figure 2.12). The CSD works by clearing an arc of cut by winching on alternate sides and moving forward by pushing against the central spud.

The practicality of using a CSD can be limited in areas to be dredged in close proximity to existing shipping channels and/or where high sea state conditions occur (i.e. high wind waves and swell experienced in exposed ocean areas).

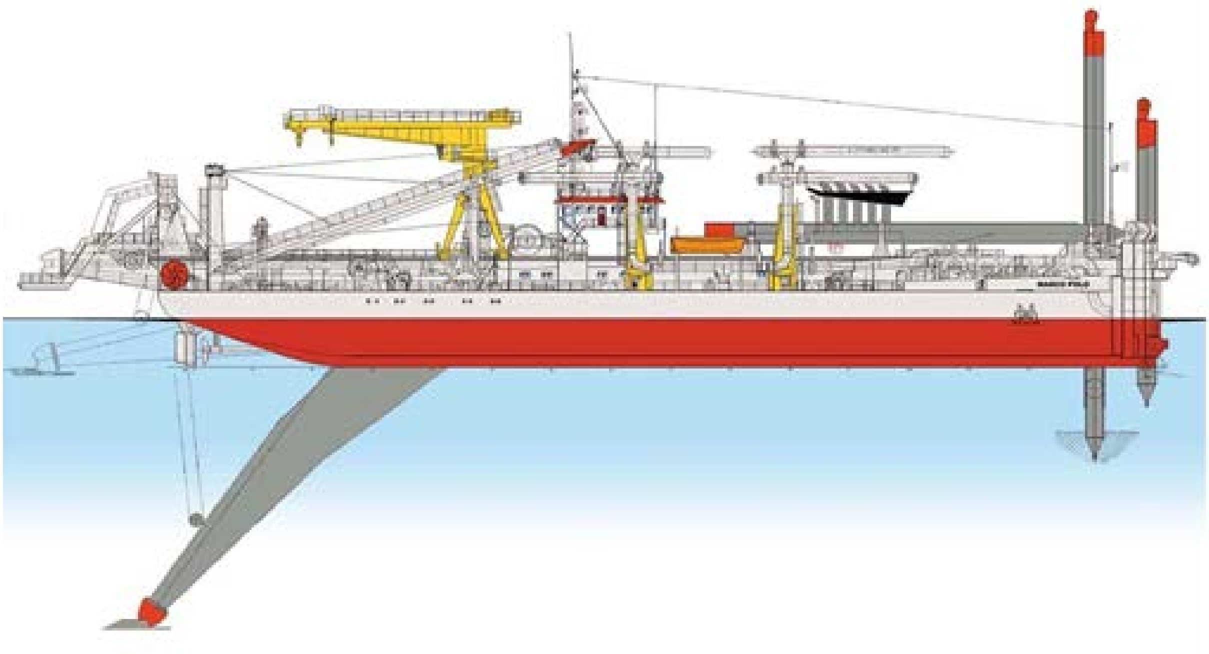

Figure 2.12 Typical cutter suction dredger

The cutter head is made up of cutting teeth along a rotary frame. The intake of the suction line is enclosed by the cutter head ‘basket’. During dredging, the cutter head rotates around the axis of the suction pipe, allowing the cutting teeth to excavate and dislodge material from the seabed. The suction pipe then draws a combination of material and water through the cutter head into the dredger to be discharged via the discharge pipeline.

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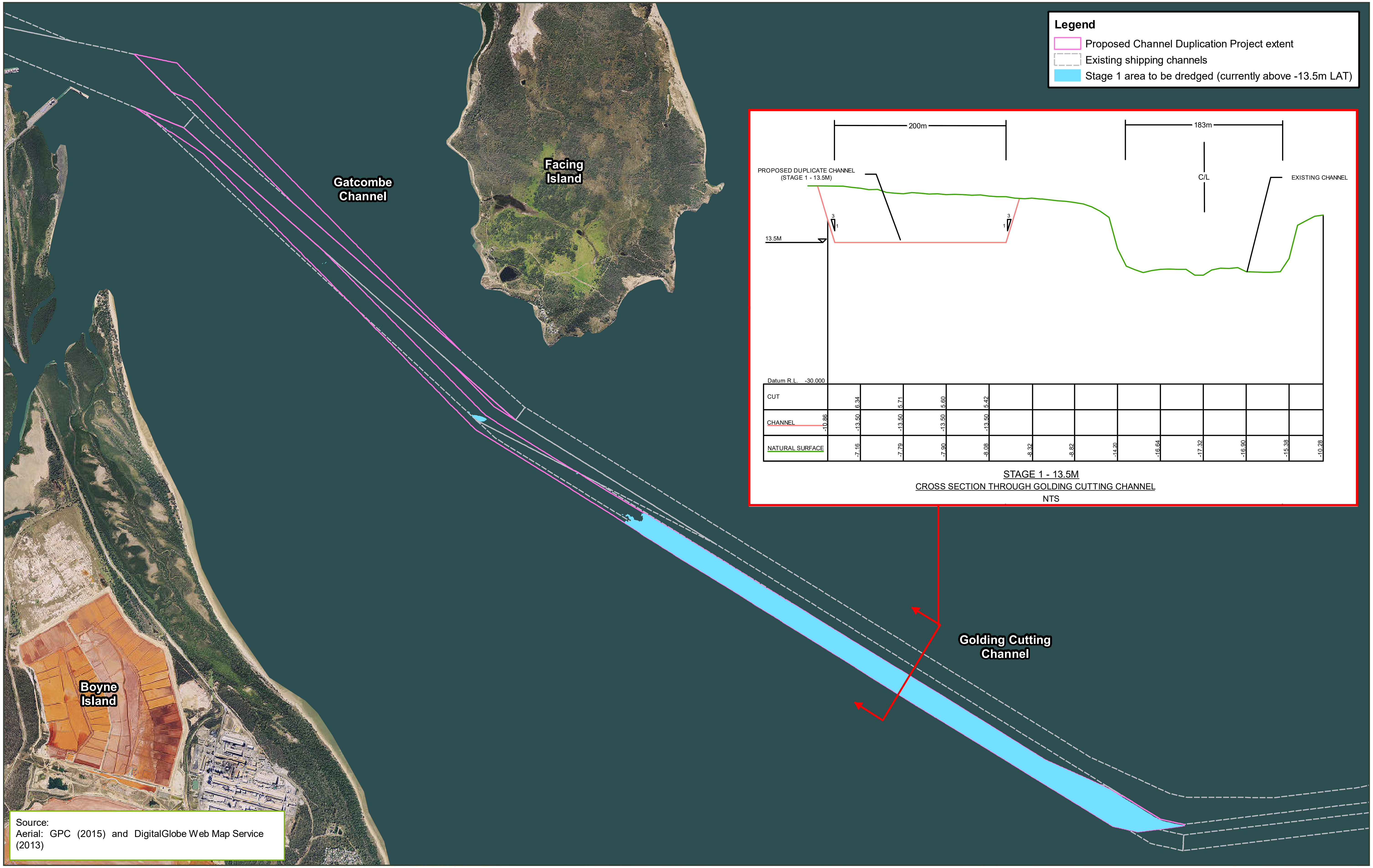

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.10: Proposed area to be dredged - Stage 1 (-13.5m LAT)

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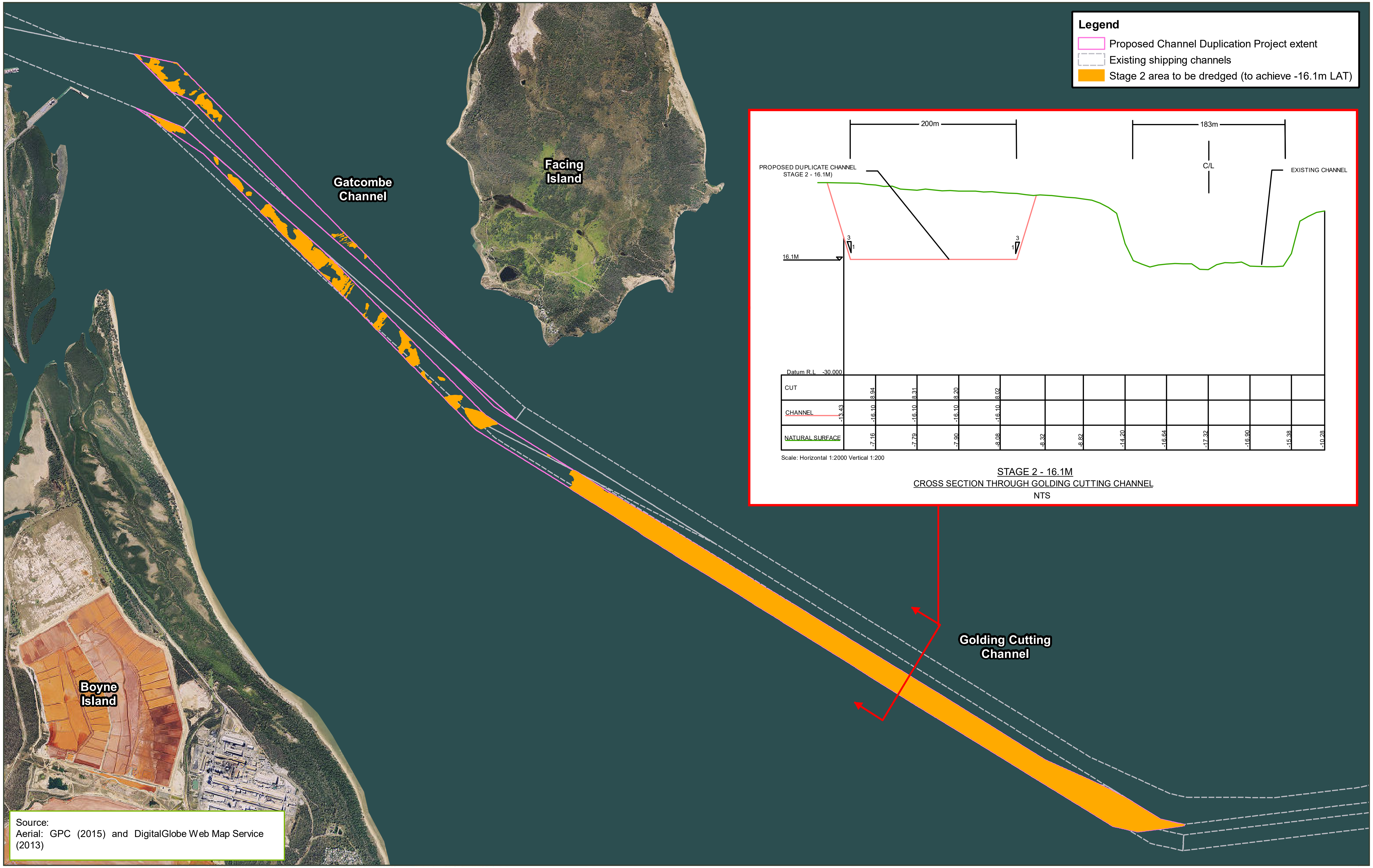

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.11: Proposed area to be dredged - Stage 2 (-16.1m LAT)

While the cutter head will cause some local turbidity, the turbidity will typically be in close proximity to the seafloor. The vast majority of the dredged material is drawn into the suction line for pumping to the placement area, which results in minimal plume generation at the cutter head. A CSD can also be used to load dredged material into a barge (refer Section 2.4.2.4).

CSDs also provide a reduced risk to marine fauna (e.g. turtles) as the dredger moves forward at a very slow rate and causes vibration while cutting.

The discharge pipelines are generally fitted with buoyancy sleeves or installed on pontoons floating behind the dredger. Some sections of the pipeline, however, may be required to be submerged (e.g. to enable other vessels to pass). Depending on the nature of the material a CSD may achieve a pumping distance of less than 3km without boosters; longer distances require multiple boosters to provide the required pressure for the hydraulic transport. The limitations of utilising a CSD and multiple boosters in the Port of Gladstone are discussed in Section 2.2.4.

Typically, medium to large CSDs generally work 24 hours a day, 7 days a week using multiple crews. Crews are not normally accommodated on the dredger due to the operational noise and vibration, and are required to disembark at the end of each shift.

2.4.2.2 Trailing suction hopper dredger

A TSHD is a self-propelled, highly manoeuvrable vessel that does not require any form of mooring or spud. Dredging is undertaken while the TSHD is navigating along pre-planned tracks with the drag arms lowered to the seafloor (refer Figure 2.13). During dredging, the TSHD fills a hopper contained within its structure while following a pre-set track. It is fitted with either single or twin (one on each side) suction pipes and material is hydraulically pumped through the suction pipes by one or more centrifugal pumps and discharged into the hopper.

Figure 2.13 Typical trailing suction hopper dredger

A TSHD pumps a mixture of water and dredged material through the suction pipes and into the hopper. The heavier soil particles settle to the bottom of the hopper, while the smaller, lighter particles remain in suspension. Once the hopper is full, the TSHD either ceases dredging (non-overflow dredging) or continues dredging (overflow dredging) and the low density mixture overflows back into the sea. The advantages in overflowing the hoppers include:

- Increase efficiency of dredging operation from an increased load in the hopper
- Minimise the period that dredging operations have the potential to impact the environment
- Minimise the fuel consumed.

On completion of loading into the hopper, the dredger sails to the site where dredged material is placed. Options for the placement of dredged material includes:

- Placement offshore (at sea) where the TSHD bottom doors or valves are opened to place the material on the seafloor
- Placement of the material into a reclamation area via:
  - Pumping ashore direct from the hopper, or
  - Temporary placement within a dredged material transfer location in close proximity to the reclamation area and using a CSD to relocate the dredged material into the bunded reclamation area.

A TSHD can also be modified to load dredged material into barges for transport and placement within:

- An offshore DMPA via opening the TSHD bottom doors or valves, or
- A reclamation area via mechanical unloading at a BUF (refer Section 2.4.2.5).

A TSHD is not very effective in dredging hard materials, such as stiff clays, however it can remove rock that has been loosened or blasted and fractured. A larger TSHD with higher power is required in stiff clays or weathered rock.

The loaded draft and operation of a TSHD requires a water depth in excess of 10m which can limit their use for dredging and operation in shallow areas (i.e. steaming to a dredged material placement location and the proximity to an unloading site for a reclamation area). The production capacity of a TSHD when used for placement into a reclamation area is dependent on the distance between the area to be dredged and the reclamation area (cycle time).

A TSHD operates 24 hours a day, 7 days a week using multiple crews who are accommodated on board the dredger. At two weekly intervals, the TSHD will cease operations and berth for approximately 12 to 18 hours or 24 hours to facilitate crew changes, bunkering and provisioning.

To minimise potential water quality and marine ecology impacts the TSHD operations include:

- ‘Green valves’ in the overflow pipe to control the amount of air contained in the excess water in order to reduce turbidity. Overflow discharge is managed using a computer-based management system to prevent excessive overflow discharge.
- When the drag head is not in contact with the seabed, and pumps are in operation, pump speed is reduced and the drag head water jets are activated to minimise the risk of turtle capture
- Dredger heads are fitted with fauna exclusion devices (e.g. turtle deflectors)
- Below keel discharge of tailwaters is via an anti-turbidity control valve
- The vessel has on-board systems for determining the density of dredged material (or solid to water ratio).

2.4.2.3 Backhoe dredger

A BHD is a stationary dredger that is anchored by three spud poles, two fixed to the front side of the pontoon and one movable at the aft side (refer Photograph 2.4). This means the dredging depth is limited to about 15m, with a maximum dredging depth of 25m for the larger BHDs. Bucket sizes vary from 2-3m^3 to 20m^3 which result in low production rates and a long uneconomic timeframe and associated high costs for implementing a large capital dredging campaign.

There are a large number of bucket interactions with seabed sediment over a longer period when undertaking backhoe dredging, compared to other dredging options.

The dredged material from a BHD can be loaded into self-propelled split hopper barges or non-propelled barges towed by a tug, for transport to the site where dredged material is placed (e.g. reclamation area). Sections 2.4.2.4 and 2.4.2.5 provide details on potential barge loading and unloading options relevant for the Project.

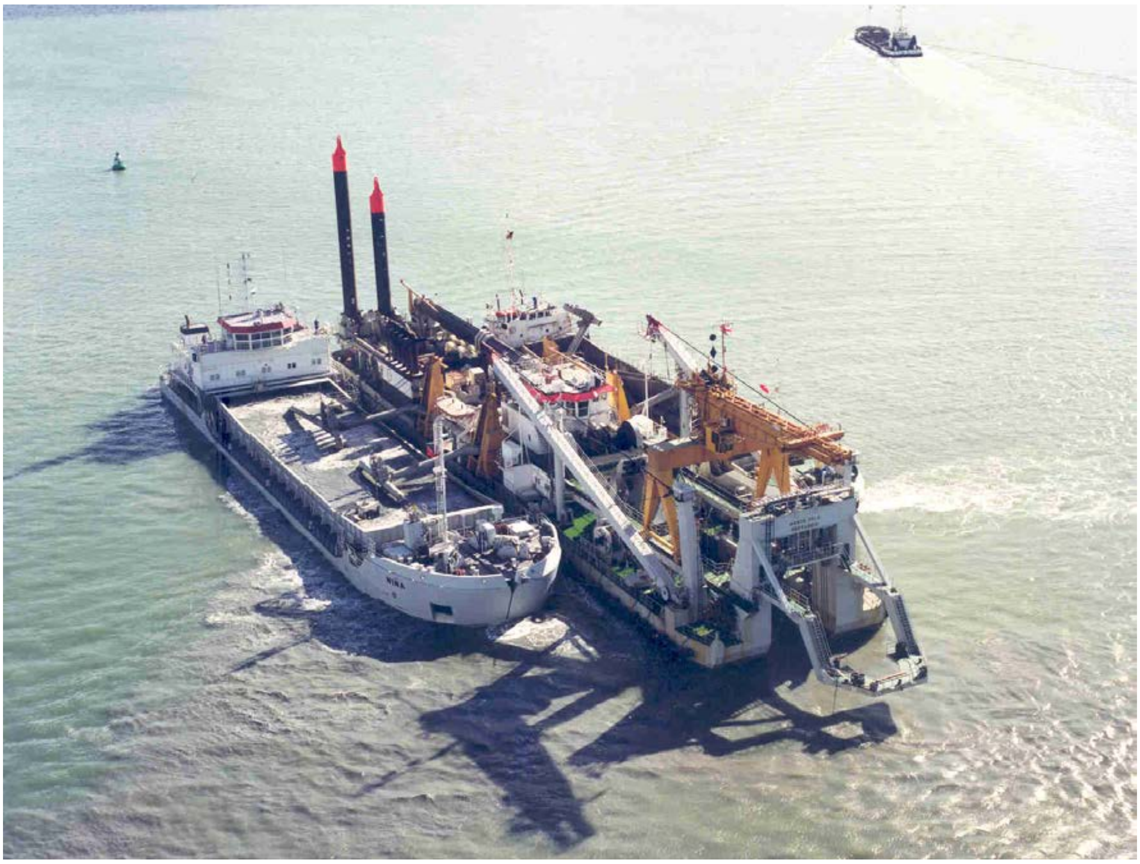
Photograph 2.4 Backhoe dredger

2.4.2.4 Barge loading

When it is not possible to pump dredged material directly ashore, the use of barges loaded by a dedicated barge loading facility, CSD, TSHD or BHD have been options implemented for dredging projects. The Great Lakes 'Spider Barge' (refer Photograph 2.5) is an example of a CSD loading a barge.

Photograph 2.5 Spider barge

Modern medium to large CSDs are typically fitted with dedicated barge loading facilities, allowing loading on both sides and, subject to barge availability, in a continuous manner and in relatively high sea states (refer Photograph 2.6).



Photograph 2.6 Large cutter suction dredger loading barge

As with TSHDs, effective loading of the barges will depend on the ability to overflow from the barges, with the sands and gravel expected to settle quickly and a large portion of the clay likely to be loaded as lumps or clay balls and with no pumping distance at relatively high concentrations.

2.4.2.5 Barge unloading to a reclamation area

Traditional barge unloader

The traditional barge unloader application has typically been restricted to small scale dredging projects, as CSDs have been able to pump longer distances and TSHDs have improved their ability to pump directly ashore from the hopper. It is the lack of market demand, especially for larger scale projects requiring high volumes of dredged material to be moved that have restricted their development and investment in construction.

Most existing barge unloaders have been designed for sand, where it may be favourable and economically feasible to transport the sand over distances for intertidal and/or land reclamation. As dredged material with high percentages of silt and clay are not generally suitable or desirable for reclamation they have typically in the past been permanently placed at offshore dredged material placement grounds or to the nearest shore for future beneficial use. Therefore, there has been historically minimal requirement to transport silt and clay to reclamation areas beyond the CSD pumping distances.

Due to these reasons, most of the largest dredging companies do not have significant (if any) barge unloaders in their fleet, and where available, the equipment is generally older with minimal investment occurring in new barge unloading equipment in recent years.

The operation of the traditional barge unloader is based on the unloading of sand. Typically the sand loaded in the barge will be largely drained of water; the barge unloader is fitted with a high capacity jet water nozzle adjacent to the unloading suction nozzle which injects water into the load to fluidise the material locally in the immediate vicinity of the suction nozzle. Once a hole is 'blasted' in the load the suction nozzle is inserted and the material is drawn through suction and pumped to the reclamation area. As the load is emptied the hole that is created in the load is filled from the adjacent fluidised material, this process is repeated until the load is emptied.

This traditional method is not suited to the Project due to the sediment characteristics of the material to be dredged (refer Section 2.4.3).

Mechanical barge unloader

Rather than relying on suction to discharge barge loads, mechanical unloading of barges can occur from an unloading facility attached to land or a reclamation area (refer Photograph 2.7). Barges can be loaded either by BHDs or other mechanical/hydraulic methods (e.g. TSHD, CSD), and transported to a reclamation area for unloading via large excavators into trucks, conveyors and/or pipelines for placement within the reclamation area.

Photograph 2.7 Marine based barge unloading facility

Other barge unloading methods

Other barge unloading methods that are available include:

- Barge mounted excavators which feed the material into a hopper which then pumps the material into a reclamation area
- DOP submersible dredging pumps fitted on an excavator and coupled to booster stations if pumping longer distances is required. DOP pumps can be fitted with jet water supply and can also be fitted with cutters of varying types depending on the material, alleviating the need to 'disintegrate' the material.

These other barge unloading methods are not feasible options for the Project due to the quantity and sediment characteristics of the material to be dredged (refer Section 2.4.3).

2.4.3 Factors influencing dredging methodology

The preferred method of dredging and size/capacity of the dredger equipment are dependent on a number of factors, which will have implications on how the material can be dredged, transported and managed within the preferred dredged material placement location, including:

- Design of the channel profile to be dredged
- Nature of material to be dredged (refer Sections 2.4.3.1 and 2.4.3.2)
- Quantities of materials to be dredged (refer Section 2.4.4.2)
- Timing, nature and scale of future Port increases in throughput
- Capital costs of implementing dredging methodology
- Depth of water (i.e. to maintain the vessel's required underkeel clearance)
- Sea conditions (e.g. wind, waves, currents)
- Environmental considerations
- Distance, availability and accessibility of dredged material placement location
- Potential for the dredged material placement location to be utilised for multiple dredging campaigns, especially due to the initial high cost of establishing a reclamation area
- Land use requirements
- Maintaining navigability of existing shipping channels
- Required schedule
- Dredger and associated equipment availability.

2.4.3.1 Grading and composition characteristics of material to be dredged

Summary of Project geotechnical investigation

A detailed geotechnical investigation of the Gatcombe and Golding Cutting Channels was undertaken between February and May 2015 as part of the EIS investigations (refer Appendix E1). A total of 23 boreholes were drilled over water from a jack-up barge. A summary of the grading and composition characteristics of the material to be dredged within the Gatcombe and Golding Cutting Channels is provided below.

- The sedimentary deposits observed during the geotechnical investigation were comparative to materials encountered in previous investigations undertaken in the Port, being composed primarily of clays, sands and significant gravel deposits
- Whilst the submarine soils would have likely been deposited in horizontal layers over time, the complex natural depositional and erosional environment of the Port of Gladstone has resulted in a complex and convoluted soil profile. Generally three layers were observed from the borehole section, including clay/silt (layer 1), sand (layer 2) and gravel (layer 3) (refer Figure 2.14).
- In general, sands overlying gravels were encountered within the Gatcombe Channel
- A significant deposit of gravel, likely containing cobbles and boulders, was identified between the Gatcombe and Golding Cutting Channels in the area of borehole GG12 (refer Figure 2.14). The geotechnical data suggests that Boyne River discharges into the Port have formed these cobble and boulder deposits.
- Cohesive material was recorded within the Golding Cutting Channel beneath the seafloor. This layer is medium to high plasticity and stiff to very stiff in consistency. Sand and gravel layers underlie this cohesive layer.
- Bedrock was not encountered during the geotechnical investigation within the Gatcombe and Golding Cutting Channels

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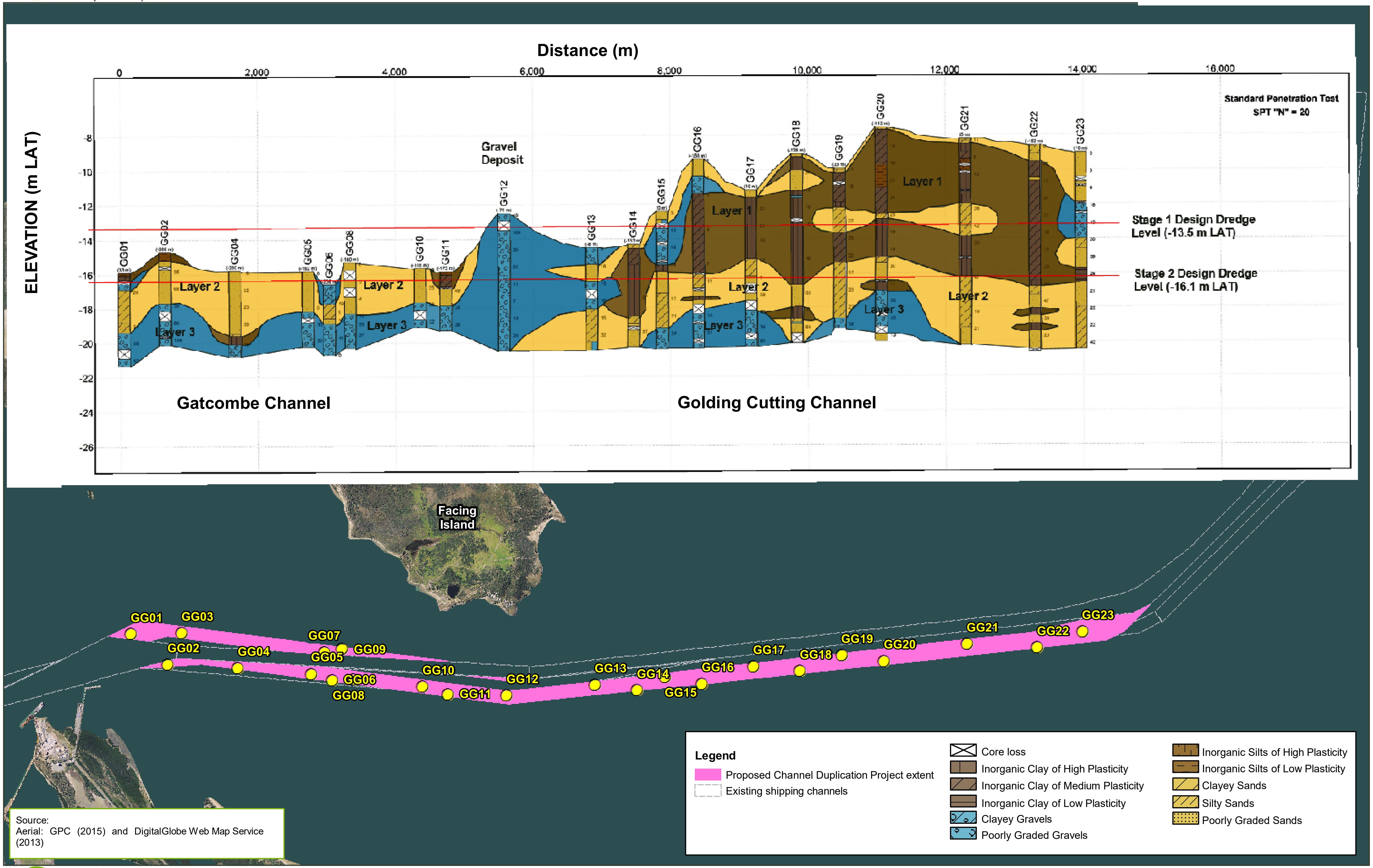

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.14: Interpreted geological section for the combined Gatcombe and Golding Cutting Channels

- There is a 5m change in seabed level in the vicinity of borehole GG15 (refer Figure 2.14) which is likely to be due to the complex underlying geological structures of the area, which is known to comprise a series of horst and graben structures and later sedimentary deposits.

Geotechnical investigations were also undertaken in 2015 for the WBE reclamation area (refer Appendix E2), and 2017 within the barge access channel. A summary of the grades and composition characteristics of the material to be dredged is provided below.

- In general, the material from the area to be dredged is mainly composed of silty clay and sand
- Silty clay is found to be located predominately to the north of the barge access channel, while sand is found to be located in the southern area of the barge access channel
- The silty clay is documented to be stiff to very stiff, the exception being one borehole to the north of the barge access channel where the consistency was very soft to soft near the surface of the borehole becoming stiff to very stiff as the depth increased. Fine to medium sub-angular gravel and fine to coarse sand were also found in the layers.
- The second prominent component is a loose to medium dense fine to coarse sand with fine to medium sub-angular to angular gravel and traces of shell fragments.

The geotechnical investigation findings of the material to be dredged have direct implications on the type, scale and nature of dredging equipment that can be utilised for the Project, and the dredging methodology (refer Section 2.4.3.2).

Summary of Project geochemical investigation

A detailed geochemical investigation was also undertaken in February 2015 as part of the EIS investigations (refer Appendix E4). The geochemical investigation was carried out within the proposed dredging footprint for the Gatcombe and Golding Cutting Channels in accordance with the approved Sampling and Analysis Plan under the NAGD (2009) requirements, relevant legislation, standards and other guidelines. A total of 78 locations within and adjoining the channel duplication area to be dredged were drilled and assessed during the investigation. A geochemical investigation was also undertaken in January and February 2018 within and adjoining the barge access channel (refer Appendix E6). The WBDDP geotechnical investigation undertaken in 2009 was also used to supplement the Project geochemical investigation. A summary of the results from the geochemical investigations are provided below.

- The 95% upper confidence limit (UCL) of all parameters analysed were below the relevant NAGD (2009) screening levels (with the Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (EPA 1998) used for manganese)
- A small number of arsenic, chromium and nickel sample values demonstrated values slightly above the NAGD screening levels, however none of these exceedances were recorded at levels greater than their respective NAGD high levels
- Manganese was also recorded at elevated concentrations within the samples which are likely to be naturally occurring and are in line with levels reported within Port Curtis in previous studies, and below background ranges of up to 850mg/kg of manganese observed in Australian soils
- Dioxin concentrations across Port Curtis were in line with previous testing undertaken by the former EHP in 2012 and were typical of estuaries around Australia when compared with the National Dioxins Program (Müller et al. 2004)
- The investigation also identified the presence of acid sulfate soils (ASS) within a small portion of the proposed channel duplication area to be dredged, and part of the barge access channel.

The Project geotechnical and geochemical investigations concluded that the material to be dredged is suitable for placement within an intertidal and/or land based reclamation area. In addition, sediment results from the WBE reclamation area are also considered clean in accordance with NAGD (2009) and is chemically suitable to receive the Project dredged material. Management of ASS in dredged material is addressed in Section 5.5.3.

2.4.3.2 Material type implications for dredging methodology

Summary of material types

The geotechnical data collected for the channel duplication area to be dredged has been incorporated into a database which allows interrogation of the key material properties in 0.5m dredging sediment layers and this has influenced the development of the dredging methodology.

Table 2.13 provides a summary of material types in Stage 1 of the channel duplication dredging works, with sand and clay in relatively equal portions.

Table 2.13 Summary of Stage 1 material types (channel duplication)

Material type	Percentage for each material type	Percentage for general material group
Sand	17%	52%
Silty **sand**	8%	
Clayey **sand**	5%	
Gravelly clayey **sand**	6%	
Gravelly **sand**	15%	
Gravelly silty **sand**	1%	
Gravel	1%	6%
Sandy **gravel**	5%	
Clay	1%	37%
Silty **clay**	25%	
Sandy **clay**	11%	
Gravelly sandy **clay**	0%	
Gravelly silty **clay**	0%	
Clayey **silt**	3%	5%
Silt	2%	

Table 2.14 provides a summary of material types in Stage 2 of the dredging works, with sand being dominant, however clay material types occur in high portions. Gravel is found throughout the material to be dredged, which is typical of the seabed material found within Port Curtis.

Table 2.14 Summary of Stage 2 material types (channel duplication)

Material type	Percentage for each material type	Percentage for general material group
Sand	18%	61%
Silty **sand**	12%	
Clayey **sand**	4%	
Gravelly clayey **sand**	8%	
Gravelly **sand**	18%	
Gravelly silty **sand**	1%	
Gravel	1%	5%
Sandy **gravel**	4%	
Silty **clay**	21%	32%
Sandy **clay**	9%	
Gravelly sandy **clay**	1%	
Gravelly silty **clay**	1%	

Material type	Percentage for each material type	Percentage for general material group
Clayey **silt**	1%	2%
Silt	1%	

While different sediment type layers have been shown to occur from the results of the Project geotechnical investigation, the sediment to be dredged forms a complex and convoluted soil profile, with lenses of different sediment types, which is difficult to predict, thereby making it infeasible for a dredger to work and target the stratigraphy of different sediment types.

The sand and stiff to very stiff clay form a significant quantity of the sandy clay in the form of sandy clay lumps and clay balls. This characteristic of the dredged material for the Project is a major determining factor in selecting the most appropriate dredging equipment.

The impact of the material types to be dredged on the CSD and TSHD dredging methodologies are provided below.

Material characteristics impacting on cutter suction dredger dredging methodology

Pumping ashore with a CSD is often a preferred method for dredged material placement in land reclamation, but is generally limited by pumping distances. While it may appear that the ability of a CSD to pump long distances is only a function of pump power, there are other practicalities that dictate the maximum theoretical pumping distance.

There are many instances of CSDs pumping long distances (e.g. in excess of 10km with booster pumps), but these cases are typically in ideal conditions and with fine homogeneous sand which is pumped in a constant homogeneous flow. The material to be dredged for the Project is anything but homogeneous, with high variable particle sizes of sand, different levels of gravel and large elements of clay constantly changing the flow characteristics. This makes the system very hard to control, as there will be varying material properties along the length of the line. As an example, over a 10km line and a velocity of 5m/s what will be discharged at any given time will have been dredged over 33 minutes prior, and the remainder of the line will vary according to what has been dredged in the previous 33 minutes. It becomes extremely difficult to control and the likely result is often line blockages, as has been experienced on previous Port of Gladstone dredging campaigns (refer Photograph 2.3) where only two boosters were able to be deployed pumping less than 5km.

The nature of the material is not only varying in terms of in situ properties, the behaviours of the clay component will vary. The behaviour of dredged clay in a slurry system has some unknown factors. It is well understood that in certain conditions, especially with the use of a CSD that clay will form balls of varying size which are subsequently deposited within the reclamation area. Dredging projects rely on the formation of clay balls to provide suitable reclamation material or for building of bunds and the understanding of their formation are largely due to the work of the US Army Corp of Engineers.

The creation of clay balls is still not well understood and the resulting size and composition of the clay balls from the Project dredged material are likely to vary considerably, affecting the flow regime and pumping performance, another variable that will be difficult to adapt to when pumping over longer distances.

The formation of clay balls is largely dependent on the in situ strength, the Plasticity Index and Liquidity Index, the latter a function of in situ water content as a function of liquid and plastic limits. Generally the clay encountered in the Project geotechnical investigation are considered likely to form clay balls during the dredging process. In almost all cases, the Liquidity Index is extremely low, this coupled with reasonably high plasticity means clay balls are likely to form. Further, for the stiff to very stiff material there is not expected to be any significant clay ball degradation when pumping through a pipe line, maximising reclamation properties and minimising the distribution of fines in the reclamation.

A CSD and the associated boosters are normally considered to have approximately 50% to 60% availability, although experience has shown that the older equipment often deployed can have much lower availabilities, in particular when dredging highly abrasive material such as the gravel expected for the Project. Experience in similar material from previous Port of Gladstone capital dredging projects showed this clearly, with very low availability figures for the ‘Al Mahaar’ and ‘Castor’ with up to two boosters and with pumping distances between 3km and 5km.

For the material expected to be encountered on the Channel Duplication Project, CSDs of similar size and power to the ‘Al Mahaar’ or ‘Castor’ would be expected to need boosters every 1km. Based on experience from the WBDDP (refer Section 2.2.4.2) it is likely that eight boosters would be required to pump a distance of 10km with the availability of the CSD and the eight boosters being less than 10%, which is clearly not a feasible prospect. This does not include the potential effect of sudden booster failures which in the most severe situations cause line blockages and long delays.

The use of boosters has in many cases been negated by the use of the mega CSD such as Van Oords’ ‘Athena’ or DEME’s ‘Ambiorix’ which both have large installed cutter and pump power, and hence can pump long distances, such as the case with the previous Port of Gladstone capital dredging, where the ‘Athena’ was able to pump just over 4km independently of any boosters. These types of dredgers run with very high pump pressures and flow rates, and there are few (if any) boosters which can be utilised in conjunction with them, limiting their pumping distance to what they can deliver independently. This was confirmed during the previous Port capital dredging when unsuccessful attempts were made to couple a booster to the ‘Athena’.

Even if theoretically possible, the use of multiple boosters pumping the Project dredged material would result in regular breakdowns and pipeline blockages.

In addition, the installation of submerged lines and connection of risers to the boosters in the Project outer harbour location represents a high risk activity, which has the potential to result in unacceptable dredging equipment damages and workforce injuries.

With the preferred reclamation option under consideration as part of the EIS (refer Section 2.5), being located between 19km and 34km from the channel duplication area to be dredged, it is not practical or technically feasible to only utilise a CSD and boosters for dredging and placement of the material into the reclamation area.

Material characteristics impacting on trailing suction hopper dredger dredging methodology

The ability for a TSHD to pump material ashore directly from the on-board hopper is generally constrained by the type and quantity of clay in the load. When pumping ashore the material is fed into the self-empty channel through self-empty doors in the bottom of the hopper. The material is expected to flow into the self-empty channel and typically requires the material to be fluidised. The hopper with bottom doors (or valves) and self-empty doors is essentially a silo and it is from silo design theory that optimum door sizes for different materials are chosen. In general, the ratio between discharge opening and well size should be around 30%, but can be as little as 10% for silt and up to 50% for clay. It is for that reason TSHDs with large bottom doors or split hoppers which have a high effective opening when split are the most effective when placing dredged material ashore with high clay content.

However the bottom door size may still be too small as the most effective discharge loads often require fluidisation with jet water to maximise the flow. Unfortunately cohesive material such as clay may resist fluidisation and hence can be difficult to remove from the TSHD.

The size of the self-empty channel opening in the TSHDs available globally has generally been optimised for the handling of non-cohesive material such as sand and gravels for placement within a reclamation area, and hence is much smaller in size with respect to the hopper well size with typical ratios in the order of 25%, which is much lower than that required for clay. The resulting effect when attempting to pump ashore clay, in particular with clay of high plasticity, there are two phenomenon that can regularly occur, including ‘bridging’ or ‘rat holing’, which in both cases restrict the feed of material into the self-empty channel (refer Figure 2.15).

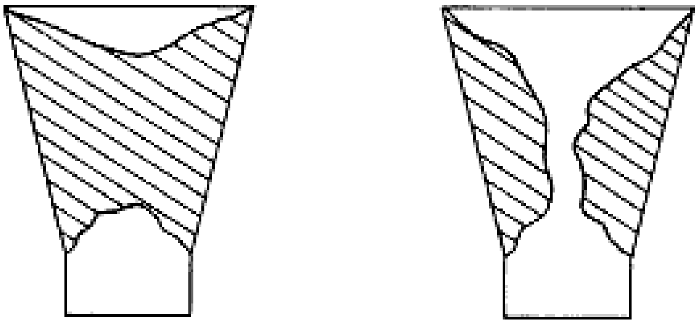

Figure 2.15 Bridging (left) and rat holing (right)

Given the generally fixed size of the self-empty channel openings, limiting the material composition in the on-board hopper is the only effective means to control the ability of the material to enter the self-empty channel and hence be able to be effectively pumped ashore into a reclamation area. An industry rule of thumb of 30% clay (maximum) has been referenced as the limit of clay content before pumping ashore becomes uneconomical and not feasible. Further liaison with industry has indicated 30% as a reasonable target, although clay content up to 40% and as long as the remaining 60% are sands, this material may be technically pumped ashore albeit with some potential difficulties at times.

Importantly in assessing the Project, the 60:40 sand and clay mix may consist of either sand within a clay matrix or can be pure clay and sands strategically dredged and layered within the hopper, with the intermediate sand layers effectively providing weak links in the hopper load.

It is not considered feasible to pump the complete Project dredged material volume directly ashore from a TSHD. The required 60:40 ratio of sand to clay/silt will not be able to be achieved for either Stage 1 or Stage 2 dredging works.

The predominance of stiff to hard clay material, and the complex, convoluted and inconsistent soil profile of the area to be dredged, results in the majority of the material not being able to be pumped ashore directly from the TSHD hopper. Therefore, the Project dredged material in the TSHD hopper needs to be removed via mechanical unloading and/or placed at a dredged material transfer location predominantly enclosed within a reclamation area for dredging by a CSD to allow placement within the reclamation area.

Alternatively the TSHD can be modified to pump the dredged material into a series of large barges which can transport the material to a BUF adjacent to a reclamation area and then unloaded via large excavators into trucks, conveyor and/or pipeline for placement within the reclamation area.

2.4.4 Project dredging methodology

2.4.4.1 Dredging equipment options

Based on the characteristics of the material to be dredged and the above factors, a number of dredging equipment and methodology options were investigated as part of the EIS. Table 2.15 summarises the feasibility of potential dredging methodologies.

The Project dredging equipment and methodology options are based on the Project channel duplication dredged material being placed within the existing WB and WBE reclamation areas (refer Section 2.5).

Table 2.15 Summary of potential dredging methodology options and feasibility issues

Dredging equipment and methodology option	Feasibility issues
1. TSHD dredging and direct pumping from the on-board hopper into a reclamation area	▪ The presence of large quantities of stiff high plastic clay material will result in the formation of clay balls within the hopper, the suction channels will become clogged when attempting to pump the material in the hopper ashore (refer Section 2.4.3.2). The dredged material characteristics result in this option not being technically and economically feasible for the majority of the Project dredged material.*
2. TSHD dredging, dredged material transferred to a dredged material transfer location predominantly enclosed within a reclamation area that allows a CSD to place the dredged material into a reclamation area	▪ A TSHD is the preferred dredger for the Gatcombe and Golding Cutting Channels due to the ability to operate in high sea state conditions and its mobility to not obstruct the existing Port shipping channels ▪ Material types to be dredged and their complex and convoluted soil profile result in this option being technically feasible
3. TSHD dredging, pumping into barges and mechanical unloading from the barges into a reclamation area	▪ A TSHD is the preferred dredger for the Gatcombe and Golding Cutting Channels due to the ability to operate in high sea state conditions and its mobility to not obstruct the existing Port shipping channels ▪ Material types to be dredged and their complex and convoluted soil profile result in this option being technically feasible
4. CSD dredging and pumping directly into a reclamation area	▪ Pumping distance constraints (refer Section 2.4.3.2) result in this option not being technically and economically feasible ▪ The practicality of using a CSD is limited due to the proximity of the existing Port shipping channels and high sea state conditions
5. CSD dredging, pumping into barges and mechanical unloading into a reclamation area	▪ The practicality of using a CSD is limited due to the proximity of the existing Port shipping channels and high sea state conditions
6. BHD(s) loading barges and mechanical unloading from the barges into a reclamation area	▪ Low dredging production rates for BHD(s) and a long and uneconomic timeframe for undertaking a large capital dredging campaign (i.e. Project dredging campaign increased to more than 2.5 years continuous dredging and unloading) ▪ The practicality of using BHDs is limited due to the proximity of the existing Port shipping channels and high sea state conditions

Table note:

* TSHD dredging and direct pumping from the on-board hopper into a reclamation area may be able to be implemented for a small quantity of Project dredged material that is predominantly sand (e.g. Gatcombe Channel), however for the purposes of the EIS it is has been assumed that the full Project dredged material volume will need to adopt an alternative dredging methodology option

The dredging equipment and methodology options feasibility assessment summarised in Table 2.15 shows that options 2 and 3 are technically feasible and that the TSHD is the preferred dredger for undertaking the Channel Duplication dredging. The preferred dredging equipment and methodology option for the Project is TSHD dredging, pumping into barges and mechanical unloading from the barges into a reclamation area (option 3) due to the:

- Reduced initial dredging works and associated reduced potential water quality and marine ecology impacts for the option 3 barge access channel (i.e. 0.25Mm^3) compared to the initial dredging works required for option 2 TSHD access channel (i.e. 3Mm^3)
- Reduced footprint and associated reduced potential water quality and marine ecology impacts for the option 3 BUF (i.e. 2.7ha) compared to the dredged material transfer location area required for option 2 (i.e. 17ha) to allow a TSHD and CSD to operate within the transfer location at the same time

- Reduce volume of dredging water to manage within the existing WB and WBE reclamation areas, and therefore reduced volume of licenced discharge water into Port Curtis for option 3 (i.e. 5,000m^3 to 30,000m^3 per day) compared to option 2 (i.e. 150,000m^3 to 190,000m^3 per day). The reduced volume of licenced discharge water into Port Curtis also has reduced potential water quality and marine ecology impacts for option 3 compared to option 2.

2.4.4.2 Preferred dredging equipment, methodology and dredged material placement area

As discussed in Section 1.6, a supplementary DMPOI and DMPOI have been undertaken as part of the EIS (refer Appendix B1 and Appendix B2, respectively). This investigation and analysis process identified a number of preferred DMPAs to be investigated as part of the EIS process.

A supplementary DMPOI was undertaken during the EIS process which identified the WBE reclamation area as the preferred DMPA to be included in the detailed impact assessment (refer Figure 2.16). During the EIS and Project concept design process it has been identified that the existing WB reclamation area is likely to have capacity to receive a small volume of the Project dredged material.

A reclamation area can either be engineered or unconfined, depending on the nature of the dredged material, the intended final use of the site (e.g. industrial land) and available technology and associated costs. The high silt and clay content of material previously dredged within the Port of Gladstone indicates that the preferred method of dredged material placement for reclamation would be an engineered perimeter system (e.g. rock bund walls) to contain the dredged material.

While a number of methods are available, including caissons, sheet piles and counterforts, the generally preferred method is the use of rock bund walls, including internal bunds to create a system of settlement ponds or basins to allow the settlement of fines content ensuring adequate discharge water quality.

The design of the engineered reclamation area will incorporate a number of considerations, including the bulking factor of material and the ratio of fines to 'core' material. For the purpose of this Project an average bulking factor of 1.25 has been adopted. The area is then managed for a number of years to achieve the required settlement for the intended land use.

Details of the reclamation and dredged material dewatering process are provided in Section 2.5.10.

Based on the nature and volume of the material to be dredged, availability and limitations of dredging equipment, and location of the WB and WBE reclamation areas, the Project dredging methodology adopted for the EIS includes:

- Initial dredging over a 6.5 week period for a barge access channel (design depth of -7m LAT) from the existing Port shipping channels to the BUF, including dredging approximately 0.25Mm^3. It is anticipated that a TSHD (e.g. Brisbane) will remove approximately 150,000m^3 of material from the southern portion of the channel, while a CSD will remove approximately 100,000m^3 of material from the northern portion of the channel. The dredged material from the barge access channel will be placed directly into the existing WB reclamation area by the TSHD and CSD.
- A large sized TSHD (i.e. 20,000m^3 hopper capacity with production in the order of approximately 0.2Mm^3 per week) dredging the Gatcombe and Golding Cutting channel duplication areas
- The dredged material from the TSHD will be placed into a series of large barges (i.e. four barges with a capacity of approximately 7,000m^3 to 10,000m^3) which transport the material to the BUF adjacent to the existing WB reclamation area. Once the barge is docked within the BUF, excess water will be pumped onshore into the WBE reclamation area. Each barge will be unloaded via large excavators (with a bucket capacity of approximately 7m^3) into trucks for placement within the existing WB and WBE reclamation areas. The dredged material placed within the reclamation areas will be managed for dewatering purposes with licenced discharges of excess water into Port Curtis (refer Section 2.5.10 and Figure 2.19).

The Project impact assessment has been based on the dredging works discussed above.

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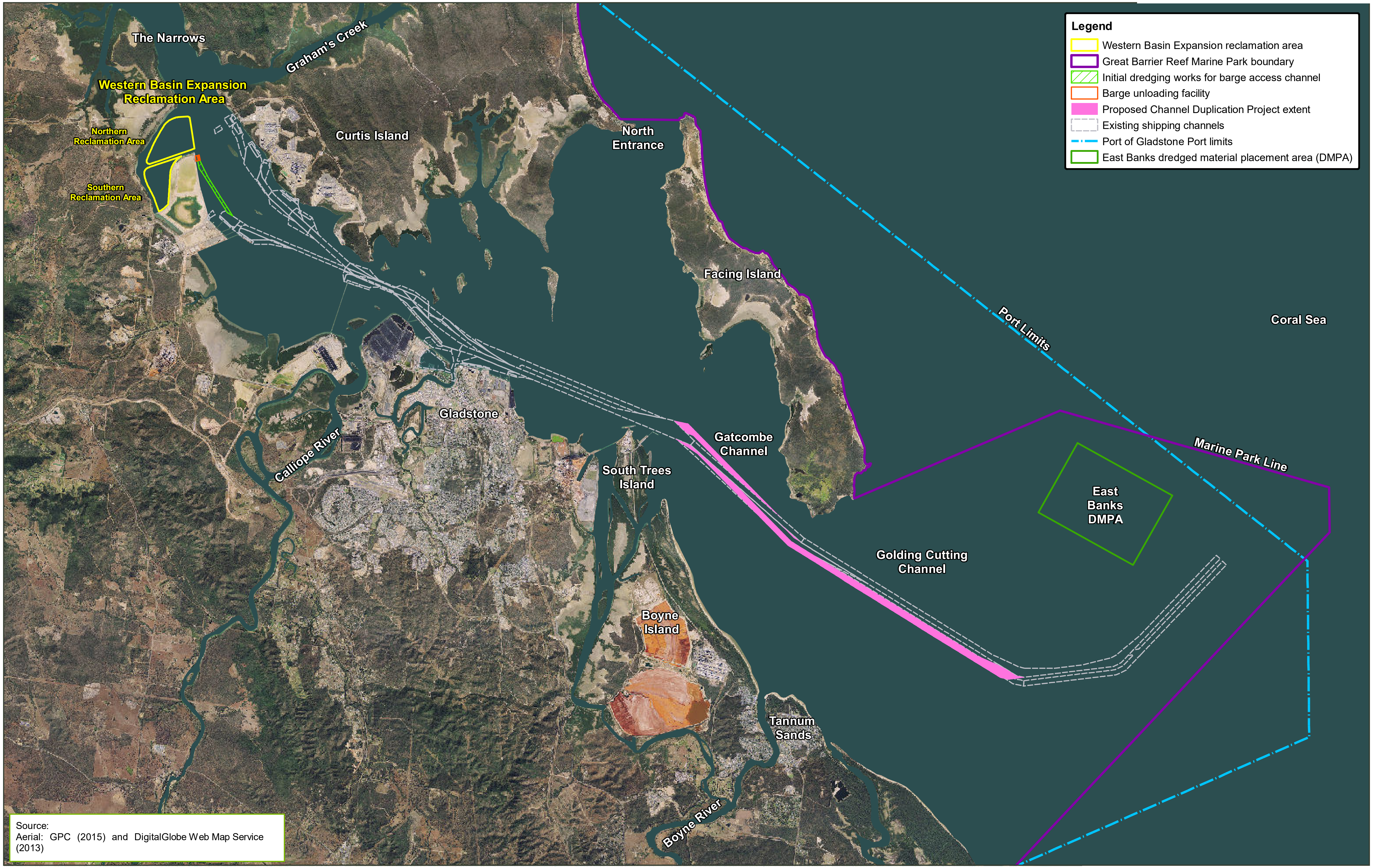

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.16: Areas to be dredged, barge unloading facility and Western Basin Expansion reclamation area

Notwithstanding the above, it is important to note that during the Project dredging detail design and tendering process the dredging methodology may be amended to include (for example) dredged material being pumped into barges by a CSD and/or backhoe dredger, and a small volume of dredged material being pumped directly from the hopper of the TSHD into the reclamation area depending on the suitability of the material.

Figure 2.16 shows the location of the barge access channel, WB and WBE reclamation areas and Gatcombe and Golding Cutting channel duplication area to be dredged.

Figure 2.17 shows the location of the areas to be dredged to form the barge access channel.

The global dredging fleet is limited and access to specific size plants at the required Project time cannot be guaranteed. It is also important to note that the proposed dredging works will undergo a tendering process. The available dredger equipment to execute the dredging works will depend on the market at the time of tendering and any environmental and technical performance requirements specified in the Project approval conditions.

The final dredging methodology adopted for the Project will be subject to MSQ Regional Harbour Master acceptance of the successful dredging contractor's detailed execution plan. The dredging contractor will also need to comply with MSQ's *Standard for Commercial Marine Activities – Gladstone Region* (DTMR 2017a).

Operational management of the preferred dredging methodology is addressed in Section 2.4.4 (Project dredging methodology) and Section 2.11.4 (maintenance dredging methodology) with the impacts on water quality addressed in Sections 8.6.5 and 8.6.6, impacts on turtles addressed in Section 9.19.3 and impacts on marine megafauna addressed in Section 9.21.3.

2.4.4.3 Dredging hours of operation

The dredging activities will be undertaken 24 hours per day, 7 days a week over the dredging and dredged material placement campaign. Due to night work being required for the placement of dredged material within the WB and WBE reclamation areas, temporary lighting will be installed on the BUF and the reclamation areas internal road network.

2.4.4.4 Dredging workforce

The Project dredging workforce is expected to be 154 people for the TSHD, barges and marine operations crew, operating over two shifts per day. For the TSHD half the workforce resides on the dredger during their shift. This includes the workforce to transport the workers to and from the dredgers. The Project work boats and dredger shuttle service will operate from Port Central and/or the Gladstone Marina.

It is expected that, to access the dredgers, the workforce will mobilise by boat from the existing Port Central area, where there may be a Project site office and car parking.

At two weekly intervals or as required the TSHD will cease dredging and berth at the existing Auckland Point wharf area for approximately 6 hours to facilitate crew changes, bunkering and provisioning. The barges will also cease dredged material transportation at two weekly intervals (at the same time as the TSHD ceases dredging) to facilitate bunkering and provisioning.

The unloading operations workforce at the reclamation areas, including excavator operators and truck drivers will be up to 176 people (over two shifts) during the dredging period.

The reclamation area workforce for placement, dewatering and shaping of dredged material will be up to 32 people during peak dredged material earthworks and dewatering periods.

The likely maximum dredging workforce (based on the TSHD, barges and on land) will be 362 people.

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Source:
Aerial: GPC (2015) and DigitalGlobe Web Map Service (2013)

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.17: Proposed area to be dredged for barge access channel and barge unloading facility

2.4.5 Need for blasting

The Project geotechnical investigation did not identify rock within the areas to be dredged, and as such blasting will not be required for duplicating the Gatcombe and Golding Cutting shipping channels, and the barge access channel.

2.5 Reclamation and dredged material placement

This section contains project description information relevant to the construction of the BUF, WBE outer reclamation bund walls, internal bund walls for the management of dredged decant water, material placement methodology and associated infrastructure.

Figure 2.16 shows the location of the BUF and WBE reclamation area.

The potential Project impacts and issues/risks associated with the beneficial reuse of dredged material within the WB and WBE reclamation areas are provided in the relevant EIS chapter impact assessment section.

2.5.1 Reclamation area capacity, timeframe and workforce

The Project dredging is expected to commence in 2023, however the timing of the commencement could be after this time subject to actual and predicted Port throughput and associated vessel movements over the next 5 to 10 years. Pre-dredging reclamation works will be required prior to commencing dredged material placement, such as site establishment and construction of the BUF and WBE reclamation area bund walls.

The construction of the reclamation bund walls will commence three years prior to the Channel Duplication dredging commencement. While the Project impact assessment assumes a three year construction period for the establishment of the WBE reclamation area and BUF, a shorter period may be adopted subject to the Project dredging commencement date. The construction period for the WBE reclamation area and BUF will be confirmed during the detailed design phase of the Project.

A connection structure (e.g. bridge or series of culverts) will be constructed between the WBE reclamation area (southern area) and the WBE reclamation area (northern area). The location and design of the connection structure will be determined during the detailed design phase of the Project. The workforce during the construction of the WBE reclamation area bund walls and BUF will be up to 20 people.

As part of the reclamation area concept design and based on experience with similar dredged material in the Port an average bulking factor of 1.25 has been adopted. The bulking factor is the ratio of dredged volume after placement within the reclamation area, to the in situ volume of sediment to be dredged. In relation to the Project, the in situ dredged volume is 12.85Mm^3, while the volume of the bulked dredged material within the WB and WBE reclamation areas will be 16.06Mm^3. It is important to note the majority of the Project dredged material will be placed within the WBE reclamation area.

Table 2.16 provides the Project dredged material volume proposed to be included in the WB and WBE reclamation areas.

Table 2.16 Dredged material volume to be managed within the existing Western Basin reclamation area and Western Basin Expansion reclamation area

Project dredging component	Dredged material volumes (Mm^3)		Dredged material volume managed within the existing WB and/or WBE reclamation areas (including bulking factor) (Mm^3)		
	In situ	Within existing WB and/or WBE reclamation areas (including bulking factor)	Existing WB reclamation area	WBE reclamation area (southern area)	WBE reclamation area (northern area)
Initial dredging works	0.25	0.31	0.31	-	-
Stage 1 dredging	7.25	9.06	0.20[2]	5.00	3.86
Stage 2 dredging	5.35	6.69	0.20[2]	2.00[1]	4.49
Total	**12.85**	**16.06**	**0 .71**	**7.00**	**8.35**

Table notes:

1 Including 2.00Mm^3 of Project dredged material within the southern area assumes that there is a four year or greater duration between Stage 1 dredging finishing and Stage 2 dredging commencing

2 It is likely that only the initial dredging works material and approximately 0.20Mm^3 of Stages 1 and 2 dredged material will be accommodated within the existing WB reclamation. It is important to note that the volume of Stages 1 and 2 dredged material could be lower or higher than the 0.20Mm^3 included in Table 2.16. The volume of Project dredged material to be included within the existing WB reclamation area will be confirmed during the detailed design phase of the Project.

The existing WB reclamation area and the southern and northern placement areas of the WBE reclamation area (refer Figure 2.16) will be required to accommodate the Project Stage 1 dredged material due to the factors summarised below.

- The limited capacity within the existing WB reclamation area
- The Stage 1 volume of the material to be dredged, bulking factor of the dredged material and the need for managing the dewatering process within both the southern and northern reclamation areas to achieve the quality of tailwater discharge
- The limited size and capacity within the WBE reclamation area (southern area) (111.12ha). As the dredged material is being transported by trucks and not being pumped, as the area starts to fill up, there will be limited space for movement of trucks and equipment given the fact that the dredged material has a high clay content.

The above reasoning is based on the assumption that by the time the Project dredging commences, it is possible that the existing WB reclamation area is unavailable due to the prospect of new industries planning to establish in Gladstone and their dredging requirements being incorporated into the existing WB reclamation area. This could result in most of the excess material (about 6Mm^3) from the southern pond moved into the northern pond with no further capacity available in the existing WB reclamation area unless a mound is created or moved to a different location. However, except for a small quantity (a couple of million cubic metres of the peripheral bunds +16m LAT high) constructing a mound with the rest of unconsolidated mix of dredged material and water is not possible for several years.

Based on Project concept design for the WBE reclamation area and the volume required to manage the initial dredging works and the Stage 1 dredged material volume (i.e. 9.06Mm^3 over a 33 week period), implementing the proposed dredging methodology (refer Section 2.4.4.2), both the southern and northern WBE reclamation areas are required to be constructed prior to the Stage 1 dredging commencing.

The workforce post dredging for the reclaimed land will involve maintenance activities (e.g. dust control, erosion and sediment control) and stabilisation works. The workforce is likely to be minimal and will peak at 8 people over 2 to 3 months during stabilisation activities.

2.5.2 Property details and tenure

The relevant property details and tenure for the land parcels within the WB and WBE reclamation areas and BUF are provided in Table 2.17, and shown on Figure 2.18.

Table 2.17 Property and tenure details for the Western Basin reclamation area, barge unloading facility and Western Basin Expansion reclamation area

Lot	Plan	Tenure	Ownership details	Area within WBE reclamation area (northern) (m^3)	Area within WBE reclamation area (southern) (m^3)	Area within WB reclamation area footprint (m^3)	Area within BUF footprint (m^3)
Unallocated State Land (USL)			Owned by the State of Queensland (represented by the DNRME)	1,649,820	876,768	235,539	16,037
508	SP239687	Leasehold	Owned by the State of Queensland (represented by the DNRME) and leased to GPC	234,458	-	541,876	3,158
504	SP245961	Leasehold	Owned by the State of Queensland (represented by the DNRME) and leased to GPC	-	-	46,679	1,791

2.5.3 Reclamation area concept design

The layout of the bund wall for the WBE reclamation area is shown in Figure 2.19. Typical cross sections of the bund wall are provided in Figure 2.20 and Figure 2.21 (refer Figure 2.19 for the location of the cross sections).

The bund wall concept design has allowed for storm tide and sea level change allowance of +1.88m above the existing HAT level at Fisherman's Landing as part of establishing an EIS concept design bund height of +7m LAT (refer Sections 11.3.8 and 11.7).

A detailed analysis of storm tide and climate change allowances will be undertaken during detailed design of the bund wall. The existing Fisherman's Landing reclamation area adjacent to the WB reclamation area was constructed to a bund wall level of +6m LAT and the WB reclamation area was constructed to a bund wall level of +7m LAT. This level has been adopted for the WBE bund wall for preliminary design and EIS purposes.

The Project dredged material placement within the WBE reclamation area has been assumed to reach up to a maximum height of +8m LAT within the enclosed bund walls to cater for surface drainage gradient.

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.18: Property details and tenure for Western Basin Expansion reclamation area

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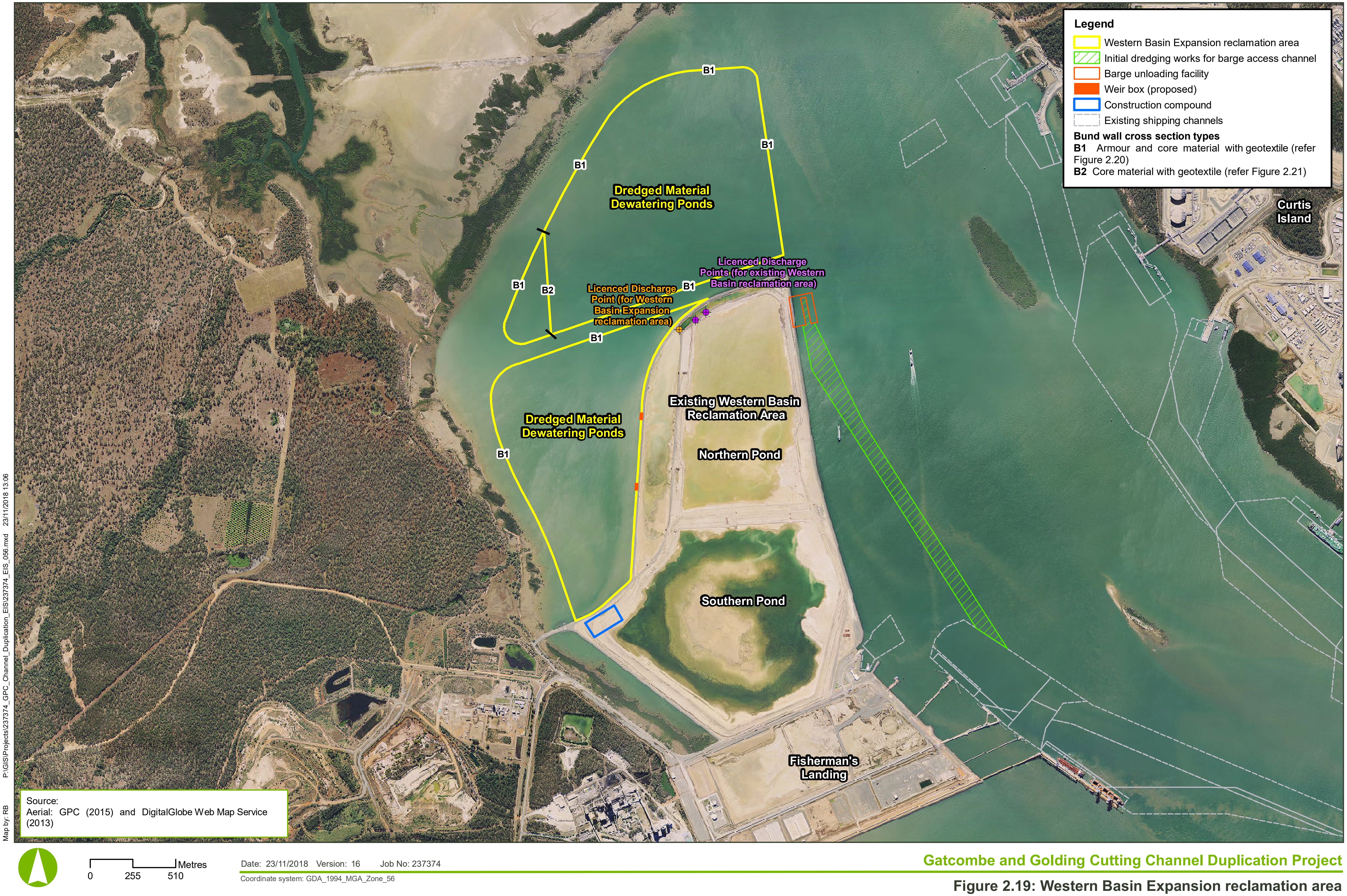

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.19: Western Basin Expansion reclamation area

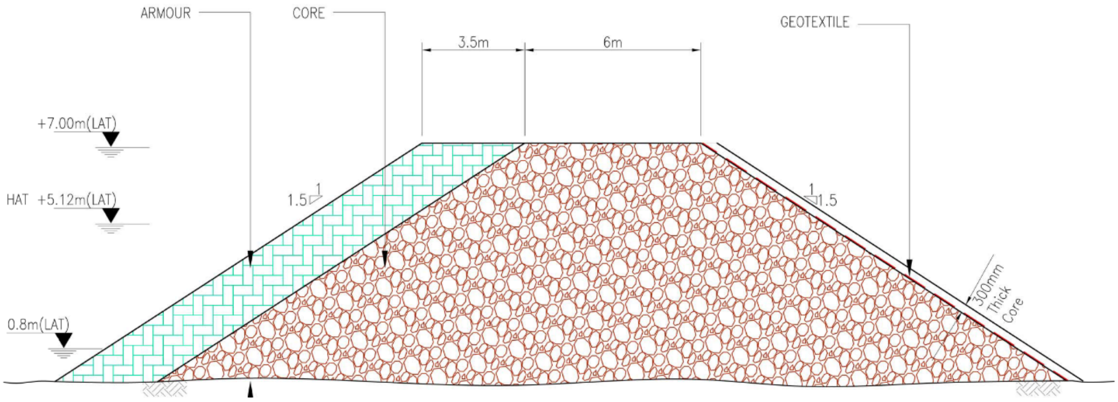

Figure 2.20 **Western Basin Expansion typical section of peripheral bund wall – armour, core and geotextile (bund wall type B1)**

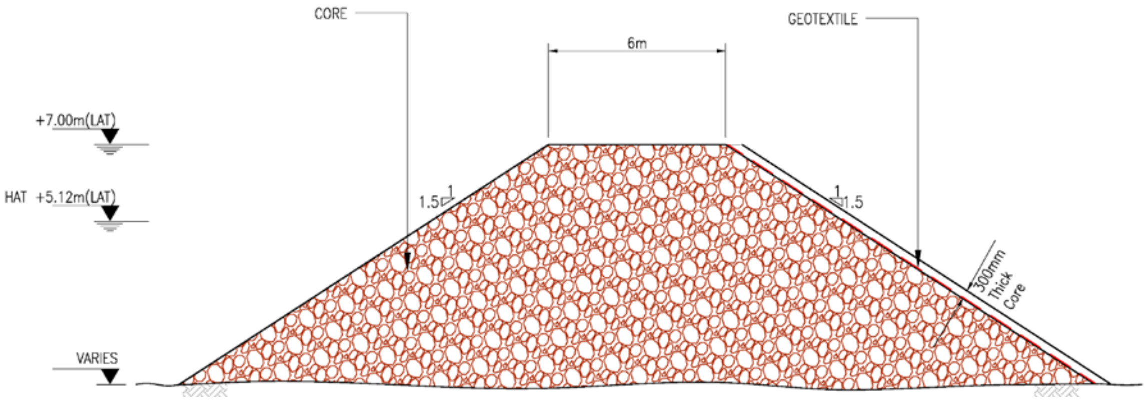

Figure 2.21 **Western Basin Expansion typical section of bund wall – core material and geotextile (bund wall type B2)**

Approximate BUF and WBE reclamation area bund wall material volumes are summarised in Table 2.18. The final material volumes for the BUF and reclamation area will be determined during the detailed design phase of the Project.

Table 2.18 **Western Basin Expansion bund wall and barge unloading facility material volumes**

Rock type	Description	Weight range (kg)	Southern area approximate quantity (m^3)	Northern area approximate quantity (m^3)	Total approximate quantity (m^3)
Armour	Hard, durable rock, of a size suitable for use in the marine environment, as revetment/armouring to withstand environmental conditions	200 to 300	60,000	113,000	**173,000**
Core	Hard, durable rock also suitable for use in the marine environment, but typically of a smaller size to the armour, to be used to form the core of the reclamation area bund wall and part of BUF wall	10 to 100	387,568	567,730	**955,298**
Total rock volumes			**447,568**	**680,730**	**1,128,298**

Table notes:

Rock density is 2.6t/m^3
Quantity volumes are based on a 1.3 allowance for sinkage and contingency
Core material will contain fines (approximately 5%) to assist in the sealing of the outer bund wall
Refer Figure 2.20 and Figure 2.21 for the typical cross section location of rock types
Armour and core material quantities includes allowances for BUF wall requirements

It is important to note that sufficient capacity will be available within the WBE reclamation area (southern and northern areas) when dredged material is mounded to cater for other Port capital dredging campaigns. For the purpose of GPC's lease under the Land Act over the WBE reclamation area, a lease timeframe of 20 to 30 years is appropriate given the potential for other Port capital dredging campaigns to utilise the area. However, this EIS does not seek to obtain Government approval for incorporating other Port capital dredged material within the WBE reclamation area.

During the placement of dredged material within the WB and WBE reclamation areas, a series of decant ponds will be constructed internal to the outer bund wall to allow for the fine material to settle from the tailwaters. The internal ponds will be designed to store the soil-water mix for a sufficient time, as to allow the suspended sediments in the discharge water to reduce to acceptable levels (i.e. less than or equal to 100 milligrams per litre (mg/L)). The dewatering discharge water will be released into Port Curtis at the locations shown in Figure 2.19. Depending on the requirement, the tailwater from the WBE reclamation area (northern area) will be pumped into the WBE reclamation area (southern area) to allow discharge from the licenced discharge points shown in Figure 2.19.

The final decant pond configuration and design will be undertaken during the detailed design phase of the Project. The final decant pond will also capture stormwater discharges from within the reclamation area and the final land use.

Mitigation measures to minimise the potential environmental impacts of bund wall construction are included in the Project EMP (refer Appendix Q2 (Sections 5.8 and 7)).

Management and treatment measures for any PASS or actual acid sulfate soils (AASS) are included in Section 5.6.1.

2.5.4 Source of reclamation bund material and potential transport modes

The rock material for the construction of the bund walls will be sourced from the existing local quarries within the Gladstone region. Rock material is likely to be transported to the reclamation area via the existing public road network depending on the location of the quarry site, or via a private haul road if the existing GPC operated Ticor quarry is utilised (i.e. the reestablishment of the Western Basin Project private haul route subject to the corridor being available for this use).

The final preferred quarry, transport modes and haul routes to supply rock material for the bund walls are not known at this EIS stage of the Project. The commercial supply of rock material for the bund walls will be subject to a competitive construction tendering process post EIS approval.

The environmental assessment and approvals for the extraction and transport activities associated with reclamation bund wall construction will be the responsibility of the quarry operator(s) and the reclamation area construction contractor.

Notwithstanding the above, for the purpose of the EIS transport, noise and social impact assessments it is considered appropriate to adopt the most likely and viable general quarry location, transport mode and haul routes for the supply of bund wall material (refer Table 2.19). Further details on the potential quarry sources of bund wall material are provided in Appendix E7.

Table 2.19 Potential general quarry location and likely transport mode options for reclamation bund material

Potential general quarry location	Likelihood of transport mode options to reclamation area		
	Public road network only	Private haul road only	Rail only
Targinnie/Yarwun area	**Most likely**	Possible if GPC operated Ticor quarry is utilised[1]	Not considered viable
West of Gladstone (off Bruce Highway)	Not considered viable	Not feasible	Not considered viable
South west of Gladstone (off Dawson Highway)	Not considered viable	Not feasible	Not considered viable

Table note:

1 If a private haul route is utilised to transport bund wall material from the existing GPC operated Ticor quarry to the reclamation area, the potential environmental impacts will be assessed as part of the post EIS environmental development applications (e.g. NC Act).

For the purposes of the EIS, the potential general quarry location is within the Targinnie/Yarwun area and rock material is likely to be transported to the BUF and WBE reclamation area via the public road network (i.e. Landing Road/Guerassimoff Road) (refer Figure 2.22).

2.5.5 Construction equipment and compound

Construction equipment required for the reclamation bund walls includes trucks (either GPC contractors with body truck with trailer, or other road going vehicles).

A construction compound is likely to be located on the established Fisherman's Landing and/or WB reclamation area (refer Figure 2.19). A site office for 20 construction staff will be utilised during the reclamation bund wall construction and expanded for up to 196 people (over two shifts) during the dredging operation. A carpark for office and workshop staff will also be established within the construction compound area. The final location and layout of these facilities will be determined prior to the reclamation area construction commencing and will take into account adjoining land use activities and access requirements.

2.5.6 Construction rate and timing

The reclamation bund wall construction program for the southern and northern areas will be approximately 18 months each, and constructed separately at a rate of approximately 64,740t per month and 98,410t per month, respectively.

The estimated daily one way truck movements along the Gladstone Regional Council road network (i.e. Landing Road/Guerassimoff Road) to construct the BUF and WBE reclamation area (southern and northern areas) are approximately 65 and 99 per day, respectively.

The WBE reclamation area bund construction sequence methodology is provided in Section 2.5.7.

The construction of the BUF will take approximately 12 months as part of the reclamation bund wall construction program.

2.5.7 Bund construction sequence and dredged material filling

2.5.7.1 Overview

Bund construction and dredged material filling methodology for the WBE reclamation area will involve the following construction sequence:

- Placement of core material
- Placement of armour material
- Topping off

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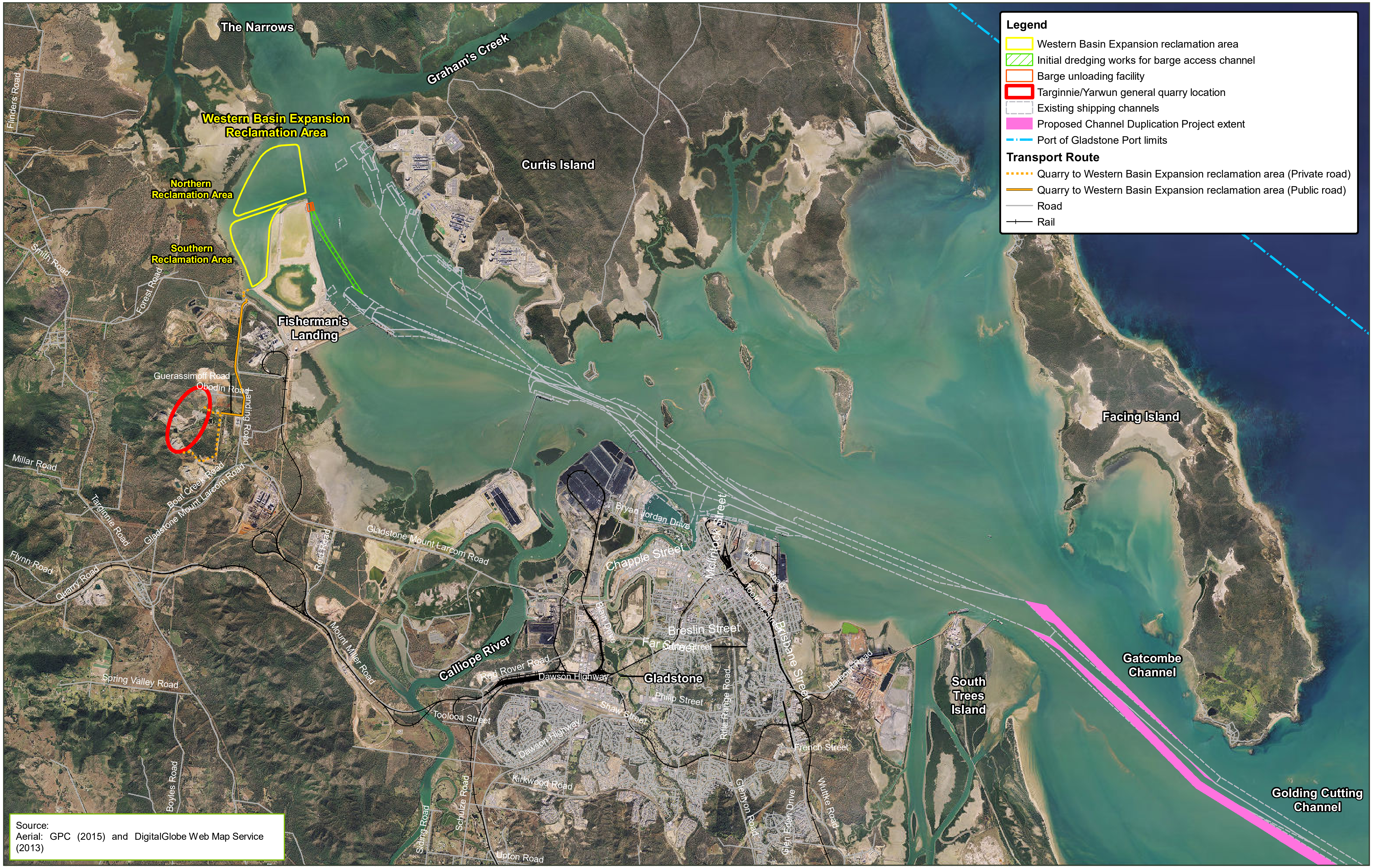

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.22: Western Basin Expansion - potential quarry location and likely haul route

- Placement of geotextile including placement of 300mm core layer on top of the geotextile (refer Section 2.5.8)
- Drainage control structures/weir boxes to manage water flow
- Dredged material filling and decant management (refer Section 2.5.9)
- Final surface completion (refer Section 2.11.1).

The construction methodology to be adopted for the bund wall construction and dredged material filling tasks is provided below. The bund wall design and construction implementation will address the relevant findings and recommendations of the *Gladstone Bund Wall Independent Review* (refer Appendix D).

2.5.7.2 Placement of core material via trucks transported along public roads

Core material for the reclamation bund walls will be delivered from the Targinnie/Yarwun quarry location and transported via public roads (refer Section 2.5.4) directly to the outer bund wall work faces.

Core material for the WBE reclamation area will be placed directly over the existing sediments by:

- End tip material onto the bund, with the material being pushed over the face by a bulldozer or end loader, and/or
- End tip directly over the end of the core material bund
- Bund material will then be shaped by bulldozer, grader or long arm excavator depending on location and required bund profile.

The specification and selection of the core material will include a range of material gradings as finer/smaller rock and earth material diameter sizes will assist in reducing the likelihood of piping through the reclamation bund walls during the dredged material dewatering process within the reclamation area.

The core material for the seaward and intertidal locations will sink through the soft silt bed to settle on the stiff clays underneath. In the process of settling through the soft bed, the silt material has the potential to:

- Become embodied in the matrix of the core material
- Push out a mud wave ahead of the bund, and/or
- Push out a mud wave to either side of the bund.

Potential environmental impacts from placing rock material on the seabed and intertidal areas will be minimised by implementing the mitigation measures detailed in the Project EMP (refer Appendix Q2).

Based on the preliminary geotechnical investigations undertaken as part of the EIS process it is not anticipated that soft paleo channels will occur under the proposed reclamation area bund walls. An additional geotechnical investigation will be undertaken during the detailed design phase of the reclamation area, and if paleo channels are found to occur in the reclamation area, appropriate design and construction methodologies will be implemented to minimise the potential for piping under the bund walls and mud wave erosion on the outside of the wall. The 18 month reclamation bund walls establishment timeframe for each reclamation area will assist in minimising potential piping impacts through the bund walls.

The initial placement of core material for the finished seaward bund wall will be to a level above the HAT. The finished crest level will be a minimum of +7m LAT and approximately 6m wide to allow construction vehicles to transport material above the marine water level. The crest will also comprise an additional 3.5m for the armour material (refer Figure 2.20 and Figure 2.21).

Core material will also be used for the intertidal/landward and internal bund walls (refer Figure 2.21).

Surveyors will control and guide the progression of the bund wall to the required alignment and levels as it extends out into the water. As the bund wall extends off the coastline, there will be the need to provide turning areas and lay-bys to facilitate the efficient and safe movement of construction plant and equipment.

2.5.7.3 Placement of armour material via trucks transported along public roads

To protect the bund core material from wave and storm conditions, armour material will be placed along the seaward exposed face of the core material following behind the core work face (refer Figure 2.20 and Figure 2.21). This normally involves at least partial installation of the protective armour as soon as practically possible.

Rock armour at the front of the bund will sink through the soft silt bed, creating a secure foundation for the armour above. Rock armour is tolerant of some movement and settlement. Monitoring of line and level during construction will identify any areas of settlement. Additional rock can then be easily added to maintain the required coverage.

A stockpile of armour material will be held at the quarry, sufficient to cover any exposed core material if a cyclone were to approach Gladstone. The reclamation construction contractor will prepare an emergency plan which will include procedures to address severe climatic events such as cyclones and minimise where practicable the potential environmental impacts from the reclamation works.

2.5.7.4 Topping off

After completion of the bund wall placement of core and armour material, the bund will be topped off with core material (run of pit) to bring the bund walls to final design levels (+7m LAT). Depending on the reclamation design, an appropriately secured and continuous inner geofabric filter material will be installed on the bunds inner face to reduce the passage of fines through the rock structure. Some additional rock protection will be required on the inner face of the bund on top of the geotextile to provide additional protection from wave action generated by standing water within the sediment ponds or placement of dredged material during operation.

2.5.8 Geotextile placement

Geotextile material will be placed against the inner face of all of the outer bund walls. The purpose of the geotextile material is to minimise the migration of dredged material fines through the bund wall to the marine waters of Port Curtis.

The geotextile material will be keyed into the rock armour material at its base and ultimately at the crest of the wall to prevent slippage and deformation from occurring prior to placement of the core material or over the life of the reclamation process. The geotextile material will be laid on the bund wall such that no wrinkles, gaps, folds or deformations occur in the material. All joints will be sewn to create seams and will conform to the requirements of AS3706 (Geotextiles – Methods of Test). Overlaps in the fabric will be directly vertically down slope of the armour material.

The geotextile material will be non-woven and generally comply with the specification or acceptable equivalent below.

- Weight > 542g/m^2
- Tensile strength > 1,690N
- Trapezoidal tear > 644N
- Puncture resistance > 1,070N
- Permittivity < 0.7sec^{-1}
- Apparent opening size < 0.150mm.

The placement and restraint of the geotextile liner will be specified in the detailed design phase of the reclamation bund wall and will meet industry best practice, recognised industry standards and the relevant findings of the *Gladstone Bund Wall Independent Review*, including:

- Be placed on the inner bund wall material and then be overlaid and secured by core material (up to 300mm thick layer)
- Be laid on the bund wall such that no wrinkles, gaps, folds or deformations occur in the material, with all joints sewn to create seams and to conform to the requirements of AS3706: (Geotextiles – Methods of Test). Overlaps in the fabric will be directed vertically down the slope of the bund surface.
- The geotextile will be secured in place and protected with a 300mm thick layer of core material.

2.5.9 Construction of the barge unloading facility

The construction of the BUF will involve the installation of sheet piles or similar earth retaining structure to form a 'U shaped' barge dock adjacent to the existing WB reclamation area (refer Figure 2.23). The footprint within the enclosed sheet pile or similar earth retaining structure will be filled with material to allow excavators (i.e. six in total with three each side of the dock) and trucks (in the order of 32 trucks) to transport dredged material from the barges into the existing WB and WBE reclamation areas.

Two short rock bunds made up of core material and protected with armour sourced from the Targinnie/Yarwun quarry location will be installed between the sheet pile or similar earth retaining structure dock and the existing WB reclamation area bund wall. The footprint within the rock bunds and sheet pile walls or similar earth retaining structure will be filled with material (approximately 0.2Mm^3 of existing dredged material from within the existing WB reclamation area) to allow excavators and trucks to travel between the BUF and the existing WB reclamation area.

The construction of the BUF will commence 12 months prior to dredging commencing.

The location and dimensions of the BUF are shown on Figure 2.17, and a typical cross section of the BUF is provided in Figure 2.23.

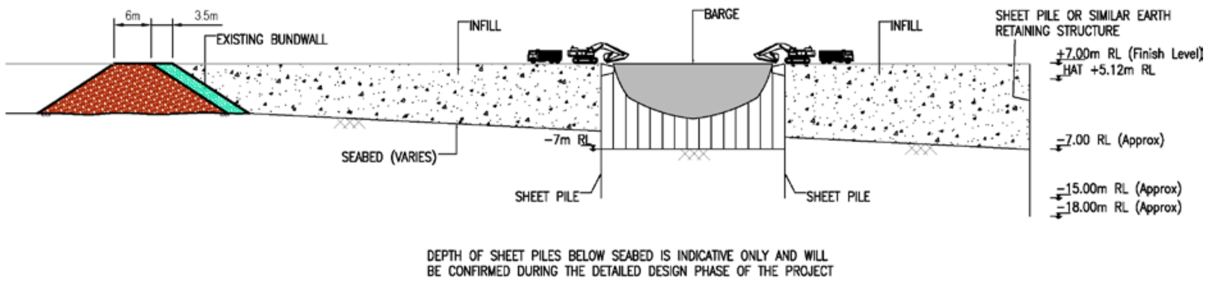

Figure 2.23 Barge unloading facility typical section

The eastern side of the barge dock wall within the BUF will form the wharf line for a future shipping berth for the WB port land when it is no longer required for unloading dredged material from Port dredging campaigns.

2.5.10 Proposed dredged material placement method

Once the outer reclamation and internal bund walls are complete, and the geotextile material is restrained and stabilised, dredged material will be transported into the WB and WBE reclamation areas (refer Section 2.4.4). A series of internal roads will be established to allow the trucks to place dredged material and water mix into primary internal cells to be filled out in turn. A secondary cell and final polishing cell will be utilised to ensure settling of suspended particles and limit the suspended fines in the decant water to acceptable levels (i.e. less than or equal to 100mg/L).

Dredged material placement within the existing WB and WBE reclamation areas will be mounded to the final profile as much as possible from direct placement from the trucks.

It is estimated that the tailwater flows may vary from 5,000m^3 to 30,000m^3 per day. This tailwater flow rate is indicative only and will be finalised with the selected dredging contractor. The quantity of tailwater during Project dredging will also be confirmed with the selected dredging contractor during the detailed design phase of the Project.

Notwithstanding the above, it is important to note that during the Project detailed design and tendering process the dredged material placement method may be amended to include (for example) dredged material being placed in the reclamation areas via conveyors and/or pipelines.

The internal dewatering cells will be designed to ensure the surface area and volume is large enough, and the detention/residence time is sufficient to address the settling rate of fine sediments from all dredged material types, and meet the required decant water quality licenced discharge limit (i.e. less than or equal to 100mg/L). Variable height weir boxes will be installed between the cells, allowing the rate of discharge and movement of waters between cells to be controlled. The cells will be designed and maintained so that a freeboard of not less than 0.5m is maintained at all times during the dredging operation. This freeboard allowance is considered sufficient to accommodate extreme climatic events within Gladstone (e.g. cyclone, flooding), including any changes in rainfall volume caused by climate change.

Two decant licenced discharge points will be utilised for the Project dewatering from the existing WB reclamation area, while one decant licenced discharge point will be utilised for the Project dewatering from the WBE reclamation area. The location of these discharge points are shown in Figure 2.19. A conventional drop inlet structure will be installed and connected to an outlet culvert through the bund wall. The tailwater from the WBE reclamation area (northern area) will be pumped into the WBE reclamation area (southern area) to allow discharge from the licenced discharge point shown in Figure 2.19.

2.5.11 Transport requirements

The existing transport infrastructure within Gladstone and the transport requirements for the Project are provided in Chapter 15 (transport), a summary of the key transport requirements include:

- Haulage of construction materials for the BUF rock walls and WBE reclamation area bund walls
- Bund wall construction
- Dredging traffic associated with the TSHD and the four barges used to transport dredged material from the Gatcombe and Golding Cutting shipping channels to the BUF
- Other vessel movements within the Port associated with dredging shuttle, work boats and a barge for changes to navigational aids.

Equipment, plant and other materials for the construction of the BUF and WBE reclamation area will be transported via the existing Gladstone road network.

Trucks used to haul rock from the quarry to the BUF and WBE reclamation area will be based at the quarry. No hazardous material will be transported, except for fuel for the construction vehicles, which will be provided at the quarry site (rock haulage trucks) and a temporary fuel storage facility within the WBE reclamation area construction compound.

Dredging equipment crews will be transported on small work boats from one or more existing Port wharf facilities, including the existing Gladstone Marina and/or existing pontoon facilities either at Fisherman's Landing or Port Central area depending on the location of the dredger. Dredger workers will utilise the existing parking areas within these areas.

All floating plant and associated moorings will be kept clear of navigational channels when working or moored. The moorings will be marked in accordance with the requirements of the Regional Harbour Master or representative. Navigational lights, buoys, marks and any warning signs which the Regional Harbour Master considers necessary, will be supplied, installed and maintained. All navigational aids will be constructed and operated in accordance with the requirements of the Regional Harbour Master or representative.

All marine plant and equipment used during the dredging and dredged material placement activities will:

- Comply with the TOMSA and the *Transport Operations (Maritime Safety) Regulation 2004*
- Comply with all the requirements of 'Standards of Marine Construction Activity within Gladstone Harbour'
- Be maintained to minimise the discharge of noxious fumes and pollutants.

2.6 Services

2.6.1 Water supply and storage

The Project does not require permanent facilities for the supply of raw or treated water to the BUF and WBE reclamation area during any phase of the Project. Future uses of the WBE reclamation area may require permanent services, these requirements will be addressed as part of the future land use development application process.

Treated water required to service the dredger activities will be sourced from existing GPC facilities within the existing Port Central area.

2.6.1.1 Treated water

Treated water will be required to service potable water requirements onsite associated with office, ablutions and potentially for other minor and miscellaneous activities. Treated water will be sourced from existing GRC or GPC facilities and supplied by road transport into temporary tanks, with a maximum typical size of 20,000 litres and located within the reclamation construction compound.

2.6.1.2 Raw water

The BUF and WB and WBE reclamation areas will typically only require a source of raw water for dust suppression during quarry activities and the construction of the bund walls. Raw water will be able to be sourced via a temporary connection from the existing GPC raw water network within the Fisherman's Landing Precinct or the existing dam water near GPC's Ticor quarry.

2.6.2 Sewerage

Permanent sewerage services will not be established to the proposed BUF and WBE reclamation area during either the construction or dredged material placement phases of the Project. Temporary toilet facilities will be provided at the site compound for the duration of the construction. A licenced contractor will regularly collect waste from any temporary toilet facility for disposal offsite. Future uses of the WBE reclamation area that may require a sewerage service will be addressed prior to their establishment.

Sewage generated by the dredger activities is to be disposed of in a controlled manner, in authorised and designated areas or through approved service as per the *Port Procedures and Information for Shipping – Gladstone* (DTMR 2018). On-board tertiary sewage treatment facilities may be utilised if available on Project dredging and barge vessels.

2.6.3 Energy

Where existing mains power is located adjacent to the reclamation area construction compound, a temporary connection will be installed where practical. Where mains power connection is not available, generators will be utilised for the provision of power into the construction compound and for temporary construction lighting requirements. No permanent power services are proposed to service the reclamation area immediately post dredging and reclamation activities.

2.6.4 Communications

It is likely that mobile telecommunications will be utilised for the majority of Project communications, however existing nearby cables will be used where practical to service the reclamation area construction compound. No permanent services are proposed.

2.6.5 Waste generation and management

2.6.5.1 Generation

The generation of wastes during the Project is expected to be minimal on the basis that:

- Dredged material will be utilised for land reclamation in the WB and WBE reclamation areas, and is not considered a waste
- Material required for the construction of the BUF rock walls and WBE reclamation area bund walls will be sourced from existing quarries within the Gladstone region, and therefore no process waste will be generated
- Workforce numbers associated with the dredging and construction of the reclamation bund wall will be limited and will not generate large quantities of waste
- Waste bulk oils from the dredgers and other Project vessels will be stored on the vessels and transferred to existing Port wharves via the dredgers and/or work boats
- Waste relating to truck and equipment maintenance will not be generated or stored onsite during reclamation activities. All truck and equipment maintenance will be undertaken offsite at either the quarry, GPC facilities or contractor facilities (where relevant).
- Following completion of reclamation construction and dredging activities, waste generation will be limited to green waste, including grass clippings, as part of maintenance activities of the WBE reclamation area.

No major hazardous materials to be transported, stored and/or used within the Project site. Further details of the wastes to be generated by the Project are provided in Chapter 14 (waste).

2.6.5.2 Waste management

General

Centralised waste management was introduced to the Port of Gladstone in 2016/17 to manage and record all waste streams from point of generation through to collection and transport at GPC's facilities, offices, public spaces and project areas.

It is intended that waste produced by dredging vessels will be disposed of in a controlled manner, in authorised and designated areas or through approved services. The collection of tank washing slops, oily bilge water and oily mixtures containing chemicals, oil sludge and sewage is provided by Nationwide Oil Pty Ltd, while garbage sterilisation and disposal is provided by GPC as per the *Port Procedures and Information for Shipping – Gladstone* (DTMR 2018). Management of waste from dredging vessels will comply with the relevant waste management legislation and guidelines. It is intended that waste management services will be available upon vessel mooring for collection and removal of solid and liquid waste to a licenced facility.

Inert waste

There will be no green waste generated during construction and from maintenance activities of the BUF and WBE reclamation area.

The bund wall material will be sourced from a commercial quarry and solid waste generated from the quarry will be managed under a separate waste management plan and is therefore not considered part of this Project.

General waste

Minimal quantities of solid general waste will be generated by the temporary construction compound and site office established for the construction of the reclamation area bund walls. The solid waste generated from the site office will primarily be municipal wastes (i.e. food waste, plastic wrappings and other small waste items).

Solid waste will be temporarily stored onsite, in accordance with the relevant legislation and guidelines, and regularly collected by a licenced waste disposal contractor and, where recycling is not feasible, transferred to a licenced waste facility within the GRC area (e.g. Benaraby Landfill).

Regulated waste

Waste water generated by the dredger activities will be stored on the dredger and transferred to the Auckland Point wharf area for collection and transport to the GRC sewage treatment plant. Where dredgers have on-board tertiary waste water treatment facilities, the generated waste water will be treated within these facilities.

Waste water will also be generated as a result of the operation of the reclamation area construction compound and site office. Liquid waste will be generated through the operation of temporary ablution facilities (i.e. sewage) and kitchen facilities (i.e. greywater).

The compound and site office will support up to 20 construction staff onsite during establishment of the bund walls and up to a maximum of approximately 196 (over two shifts) staff during peak dredging operations. The site office will be operational throughout the Project.

All sewage and greywater will be temporarily stored onsite in accordance with the relevant waste management legislation and guidelines and removed and transported to the GRC sewage treatment plant by a licenced waste management contractor.

Quarantine waste

All vessels arriving at the Port of Gladstone are required to follow the DTMR's *Port Procedures and Information for Shipping – Gladstone* (DTMR 2018), which details quarantine requirements.

Upon arrival within the Port of Gladstone, all wastes, including quarantine waste, from the dredging vessels must be arranged for collection and disposal. Quarantine waste must be kept in sealed plastic bags on board until collection by a licenced contractor (e.g. liquid waste, oil containing waste and sewage) or GPC (general garbage) (DTMR 2018). Quarantined waste will be sterilised prior to disposal at a licenced facility.

2.7 Navigational aids

The key operational infrastructure associated with the Project is the removal of two existing navigational aids (i.e. one front lead light and one rear lead light), the relocation of five navigational aids (i.e. beacons and lead lights) and the installation of five new navigational aids (i.e. beacons and lead lights) (refer Figure 2.24). Outer BUF and bund wall warning lights will be installed every 100m along the outer BUF and WBE seaward reclamation area bund wall in accordance with MSQ requirements.

MSQ requires navigational aids to be located in the Gatcombe and Golding Cutting Channels to ensure safe boating and passage for commercial vessels. The proposed location and configuration of the navigational aids are in accordance with the recommendations of the International Association of Marine Aids to Navigation and Lighthouse Authorities and were developed in consultation with the Regional Harbour Master.

The removal of the navigational aids will involve a barge and a pile extractor, then removed from the water by a crane on a barge and delivered to an existing Port facility in Gladstone.

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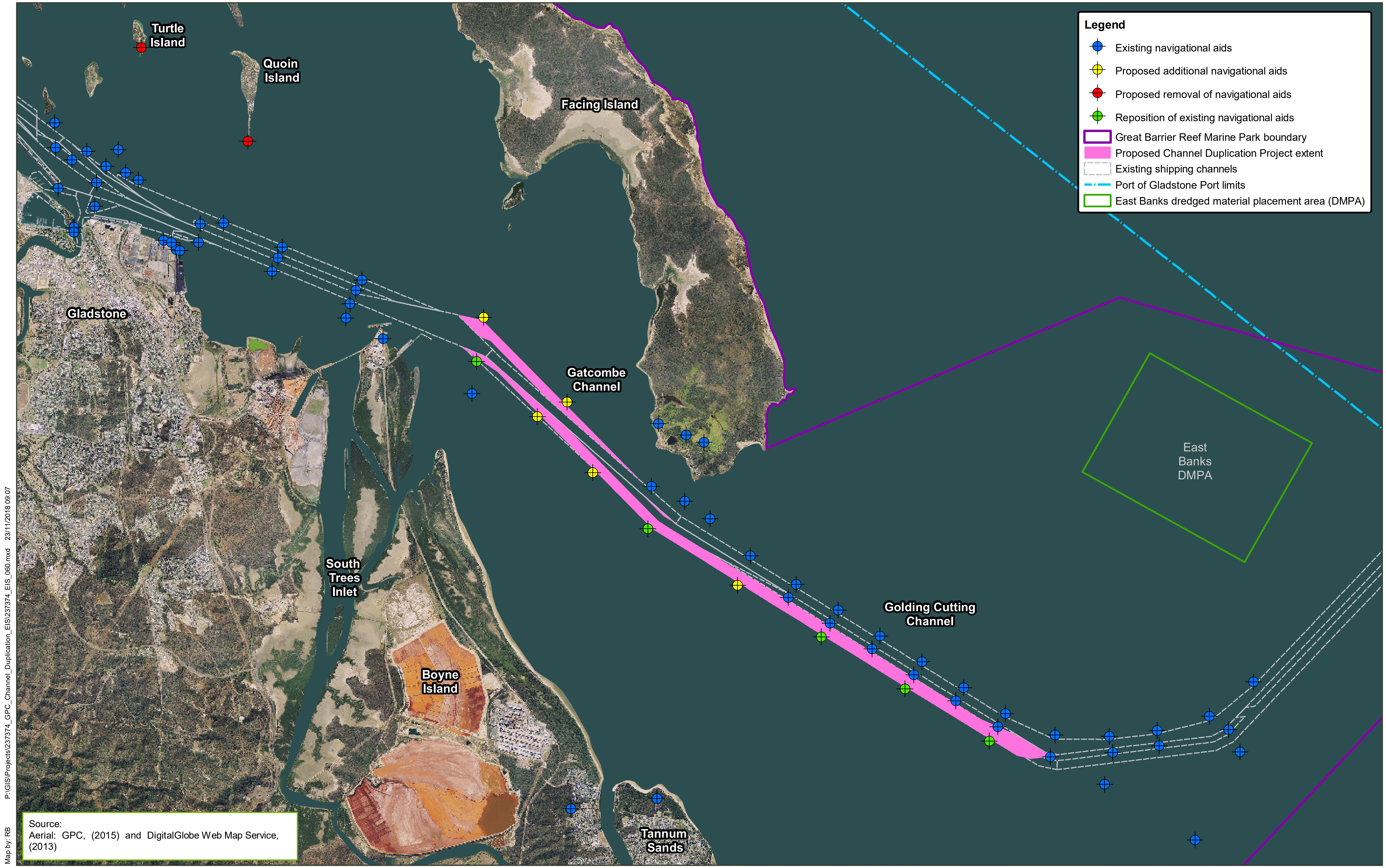

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.24: Proposed changes to navigational aids

The installation of the relocated and new navigational aids will involve the following steps:

- Relocated piles will be removed from their current location and transported via barge to an existing Port facility storage yards (e.g. Auckland Point wharf area)
- New piles will be loaded onto a barge at an existing Port facility (e.g. Auckland Point wharf area) and transported to the proposed location
- The pile will be attached to a crane on the barge and lifted and moved into a vertical position, then the pile hammer will be attached to the head of the pile
- Once the pile is in the correct position, the pile will be lowered to the seafloor by the crane, and the hammer will start driving the pile utilising small hammer drops to ensure the penetration is vertical and the position is not affected as it penetrates the soil
- The hammer will continue to drive the pile until the design depth is reached and soil presents the specified resistance
- Welders will prepare the surface and install the pile cap and platform, and pile protection material application will be undertaken by using divers if required
- Batteries, solar panels and the specified lights will be installed at the piles in accordance with MSQ requirements
- The new navigational aids will be tested as part of the commissioning phase, prior to becoming operational.

The estimated timeframe for the navigational aid works is summarised in Table 2.20. One barge and one work boat will undertake the proposed navigational aid works over a 2 to 3 month period.

Table 2.20 Estimated timeframe for navigational aid works

Navigational aid task	Estimated average timeframe
Removal of existing navigational aids (piles)	1 to 2 days per pile
Installation of piles at new location	2 to 3 days per pile
Fit equipment on piles	2 to 3 days per pile
Pile protection	3 to 4 days per pile
Install electronics	1 to 2 piles per day

The navigational aid relocation and installation methodology will be confirmed and approved by MSQ prior to work commencing.

The workforce will consist of the barge and work boat crew including the piling technicians. Therefore, over the proposed navigational aid works program, there will be approximately 5 to 10 people involved.

2.8 Demobilisation and decommissioning

All dredging equipment and the WBE reclamation area construction compound will be removed after the Project capital dredging operation has been completed.

Decommissioning of the reclamation ponds at the end of the Project dredging works is required to facilitate longer term drainage and consolidation of the reclaimed materials.

Decommissioning works include lowering of tertiary pond outlet (via removal of drop boards) to anticipated final consolidated ground levels, and installation of drains into and out of and erosion controls around the low level culverts.

Following the completion of the filling operations within the WBE reclamation area, GPC will undertake surface stabilisation works for the portion of the reclamation area that has achieved the final design surface level. These works are likely to include capping the final surface with material of an appropriate grade or vegetating with appropriate species.

Maintenance activities within the reclaimed area will also be undertaken to minimise dust and erosion as required.

Equipment, supporting infrastructure and site offices will be removed and the construction compounds removed and the area reinstated to similar surface level treatments as the surrounding reclamation areas.

Decommissioning of the navigational aids activities will involve removal of plant and equipment and all site based construction support infrastructure.

The eastern side of the barge dock wall within the BUF will form the wharf line for a future shipping berth for the WB port land when it is no longer required for unloading dredged material from Port dredging campaigns. The BUF structural components east of the dock wall will require decommissioning. The fill between the eastern side of the barge dock wall and the eastern most structural wall of the BUF will be removed and used to fill the barge dock area. The excess material will be used to reclaim within the WB reclamation area.

2.9 Cost of Project

The capital cost of the establishment of the BUF and WBE reclamation area, dredging works (initial dredging works, and Stages 1 and 2) and installation of the navigational aids has been estimated at $760 million.

The final capital cost for the Project will be dependent on detailed design and outcome of the dredging operation and reclamation tendering process.

The Project maintenance dredging and maintenance activities on the WBE reclamation area costs will form part of the Port-wide annual maintenance dredging and Port land management requirements, respectively.

2.10 Environmental design features and principles

Key environmental design features and principles of the Project include:

- The seaward bund walls to be designed to 100 year average recurrence interval (ARI) immunity and the detailed design will include allowances for storm surge, sea level rise, wave climate, and flood levels within this part of Port Curtis
- Lining of the inner face of all outer bund walls of the WBE reclamation area with geotextile fabric to reduce the migration of fines through the bund wall
- Use of internal cells and adjustable weir boxes within the WB and WBE reclamation areas to allow retention of dredged tailwaters and settling of suspended solids
- Implementation of adaptive design measures during the detailed design phase for the Project to minimise the potential impacts on the ecological values of Port Curtis
- Dredger equipment and dredging methodology to be selected on the basis of dredger availability, the nature of the material to be dredged, consideration of environmental impacts, and minimisation of dredging timeframes
- Dredging operations to be undertaken during suitable conditions (i.e. within the operational parameters of the dredger, for example not during high energy situations such as storm surges). If the Bureau of Meteorology (BoM) issues a severe weather warning, dredging works within the affected area to cease.

- The barges to be fitted with 'green valves' in the overflow pipe to control the amount of air contained in the excess water in order to reduce turbidity. Overflow discharge to be managed using a computer-based management system to prevent excessive overflow discharge.
- Dredger heads to be fitted with fauna exclusion devices, including but not limited to, turtle deflector/exclusion device
- Below keel discharge of tailwaters to be via an anti-turbidity control valve
- Vessel to have on-board systems for determining the density of dredged material (or solid to water ratio)
- Vessel to have electronic positioning system for defining the location and depth of dredging activities
- When the drag head is not in contact with the seabed, and pumps are in operation, pump speed to be reduced and the drag head water jets to be activated to minimise the risk of turtle capture
- Stormwater management system to form part of detailed design of WBE reclamation area which will include drainage systems and stormwater treatment measures to manage runoff and minimise discharge of sediment laden and turbid waters into Port Curtis
- Progressive installation of stormwater management measures on the final reclamation surface as it is completed
- At the completion of filling of the reclamation area, the retention of a large stormwater pond to manage stormwater quality runoff from the final surface
- Progressive capping and revegetation of the reclamation surface to manage stormwater quality and dust
- Other design measures included in the Dredging EMP, Project EMP and Environmental Monitoring Procedure (refer Appendices Q1, Q2 and Q3).

2.11 Project maintenance phase

2.11.1 Reclaimed land surface stabilisation and maintenance

Following the completion of the filling operations within the WBE reclamation area and prior to use of the area, surface stabilisation works will be required to be carried out for the portion of the reclamation area that has achieved the final design surface level. These works are likely to include capping the final surface with material of an appropriate grade or vegetating with appropriate species.

Maintenance activities within the reclaimed area will also be undertaken to minimise dust and erosion in accordance with GPC's EMS.

2.11.2 Project completion land use on reclaimed land

The Project completion land uses for the WBE reclamation area post Project dredging (Stages 1 and 2) will be stormwater ponds and port and port-related industry with three to four wharves attached to the northern area (refer Figure 2.25).

As stated in Section 2.5.1, the WBE reclamation area has the potential to be filled with dredged material from other Port capital dredging campaigns.

No changes to recreational and public usage of foreshore areas is anticipated as a result of the Project activities. A reduction in available waterway area within the Port limits will result from the creation of the BUF and WBE reclamation area.

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Gatcombe and Golding Cutting Channel Duplication Project

Figure 2.25: Western Basin Expansion final land uses - Project dredged material

2.11.3 Maritime operation

Once the proposed changes to the navigational aids associated with the Project have been implemented, tested and commissioned (refer Section 2.7), the duplicated shipping channels will be utilised by commercial vessels within the Port. The deepening of Gatcombe and Golding Cutting bypass channels will not change the existing Port maritime operation. The existing procedures will be implemented for vessel movements within the duplicated channels (refer Section 2.1.5).

It is important to note that while the Project will facilitate an improvement in the existing and future vessel movement efficiency, and a reduction in the likelihood of vessel incident risk, the duplication of the Gatcombe and Golding Cutting Channels will not have any direct influence on increasing commercial vessel movement numbers within the Port.

Due the implementation of the pilotage and reporting requirements for shipping in the Great Barrier Reef (refer Section 2.1.4) and the Port of Gladstone pilotage and existing navigational aids and marks (refer Section 2.1.5), the Project will have no change to the existing potential for commercial shipping groundings.

2.11.4 Maintenance dredging methodology

Maintenance dredging will generally be required annually for the Gatcombe and Golding Cutting duplicated channels, and the Project barge access channel following the Project dredging works as the sediments stabilise. Based on previous maintenance dredging in the Port of Gladstone, maintenance dredging requirements are unlikely to be significant and will be restricted to batter slipping and siltation at the toe of dredged areas. Analysis of the sediment dynamics modelling results indicates that the overall net annualised siltation rate within the shipping channels of the Port is likely to increase by approximately 7% following the completion of the Project.

Based on previous extreme climatic events that have occurred within the Port of Gladstone and upstream catchments, only minor increases in the Port maintenance dredging volume are likely after these extreme events (e.g. cyclones, floods).

A number of factors are considered in the selection of dredging equipment for maintenance dredging, including:

- Maintenance dredged material is relatively unconsolidated
- Depth limitations for operation of the dredger are generally not a limiting factor
- Shipping movements
- Historically annual maintenance dredged material volumes have been small (refer Section 2.2.2), and GPC has used the TSHD Brisbane to place material within the existing East Banks DMPA
- As maintenance dredging is an ongoing annual requirement for the Port of Gladstone, the Project maintenance dredging will form part of the Port-wide dredging campaign to ensure a cost effective option is adopted.

Based on the above factors, a TSHD is the most appropriate type of dredger to undertake the Port maintenance dredging. It is anticipated that the dredged material from annual Port-wide maintenance dredging (including the Channel Duplication Project areas to be dredged) will be placed within the existing East Banks DMPA (until full capacity is achieved). The Port-wide maintenance dredging and offshore placement will be subject to the relevant Commonwealth Government approval process (e.g. Sea Dumping Permit) and other approvals as required at the time of dredging.

Based on the Port of Gladstone Long Term Monitoring and Management Plan for Sea Disposal of Maintenance Dredged Material the contaminant status of maintenance material to be dredged over the next 5 years has been ascertained to be clean in accordance with National Assessment Guidelines for Dredging 2009 (GPC 2015).

During Port-wide maintenance dredging campaign (i.e. generally 4 to 6 weeks/year) approximately 10 to 15 people will be employed in this activity.

2.12 Ship-sourced pollution management

The TOMPA and regulations protect Queensland's marine and coastal environment by minimising deliberate and negligent discharges of ship-sourced pollutants into coastal waters. Marine pollutants include:

- Oil (including diesel fuel, petrol and oil products) and oily residues or mixtures
- Chemicals and chemical residues
- Sewage
- Garbage (i.e. food wastes, paper products, rags, glass, metal, bottles, crockery, fishing gear, nets, bait boxes, lining, packing material, deck sweepings, paints, wood products, wire residues and all plastics).

The *International Convention for the Prevention of Pollution from Ships 1973* (MARPOL*)* requires that applicable ships carry certain documentation relating to ship-sourced pollutants. Under the provisions of the TOMPA and its supporting regulation, MSQ has imposed additional documentation requirements for some ships operating in Queensland waters. The MARPOL requirements are also mirrored in the state legislation. Failure to carry the required documentation is an offence under Queensland law.

It is an offence to discharge pollutants (either deliberately or negligently) and severe penalties apply. Ships operating in Queensland waters must carry the applicable pollution prevention documentation summarised below.

- *Pollution prevention for ships required documents* (Queensland Government 2010a) which specifies the documents to be carried under the provisions of MARPOL, the Act and regulation, including:
  - Shipboard Oil Pollution Emergency Plan
  - Oil Record Book
  - Ship-to-ship Oil Transfer Operation Plan
  - International Oil Pollution Certificate
  - Noxious liquid substances in bulk procedures
  - Dangerous goods in bulk procedures
  - Shipboard Sewage Management Plan and Sewage Disposal Record Book, System Documentation, Service Manual, and International Sewage Pollution Prevention Certificate
  - Garbage disposal requirements
- Other pollution prevention documents (i.e. not required under MARPOL documents) required for ships in Queensland waters (Queensland Government 2010b)
- Guide for the prevention of ship-sourced pollution and for the safe transfer of bunkers in Queensland waters (Queensland Government 2013).

2.13 Biosecurity and minimising risk of introduced marine species

GPC implements biosecurity procedures and measures to protect the communities in which they operate from harmful pest flora, fauna, viruses and diseases that pose a risk.

Operating under the *Biosecurity Act 2015*, the Port of Gladstone has the necessary permissions for particular classes of vessels and goods to be landed at Biosecurity Entry Points within the Port. A Biosecurity Entry Point is a designated area within the Port, typically berths, for international vessels.

All Project wharf users must meet the First Point of Entry Biosecurity Standards which describe the requirements for landing. In addition, all Project wharf users operating at GPC's multiuser wharves/berths must comply with GPC's biosecurity procedure, guide, training and reporting.

Dredging equipment will conform to Australian Quarantine and Inspection Services (AQIS) Guidelines to minimise the risk of the introduction of any introduced marine species.

In the event that marine pests are introduced into the local environment by the Project, the dredging contractors' Ballast Water Management Plan will be implemented in accordance with the Australian Ballast Water Management Requirements (Version 7) (Commonwealth Government 2017) and under the Project and Dredging EMPs. The management plans will include contingency measures that include, but are not limited to, the following:

- Immediate notification to DAF (Biosecurity Queensland), Department of Agriculture and Water Resources, DES and MSQ
- Follow any directions or notices given by a regulator in relation to marine pests
- Corrective actions (i.e. immediate investigation strategies, holding the balance of ballast on board, transferring the balance between tanks, examining ship to shore transfer options, etc.)
- Consequential reporting/liaison requirements.

2.14 Security

All GPC sites operate under the *Maritime Transport and Offshore Facilities Security Act 2003* and Regulations. This act requires the establishment of maritime security zones in and around the Port and wharf facilities as part of GPC's maritime security plans. These regulated zones place restrictions and limitations on who may enter.

There are a number of security requirements potentially relevant to the Project, including:

- The Maritime Security Identification Card, which is a nationally recognised identity card which identifies the holder as a person who has met the necessary background requirements to work in a maritime security zone. It shows that the holder has met the minimum security requirements to work unescorted or unmonitored in a maritime security zone and is not considered a threat to maritime security.
- Security access requirements (i.e. maritime security levels, landside restricted zones and security restricted zones)
- Port inductions for contractors, Port users, consultants and essential services.

2.15 Sustainable development

In the scoping and planning phases of the Project, sustainable development principles have been considered and incorporated into the Project definition and scoping phases, including the consideration of dredging equipment and dredging methodology options, the consideration of dredged material placement options, the concept design for the preferred dredging methodology and the preferred option for dredged material placement and the development of mitigation measures to manage impacts.

In 1990, ESD was identified in Australia by the Commonwealth Government as one of the greatest challenges facing Australia's governments, industry, business and community in the coming years. The following definition of ESD was adopted in the National Strategy for Ecologically Sustainable Development:

> *using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased* (Commonwealth of Australia 1992).

In December 1992, the Council of Australian Governments endorsed the National Strategy for Ecologically Sustainable Development. The overall goal of the Strategy is to achieve:

> *Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends* (Commonwealth of Australia 1992).

A comparative analysis of how the Project complies with the objectives of the National Strategy for Ecologically Sustainable Development is provided in Table 2.21.

Table 2.21 Project compliance with the objectives of the National Strategy for Ecologically Sustainable Development

Objectives and principles	Project compliance
Core objectives	
To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations	The Project objective is to improve the operational and economic efficiency of the Port of Gladstone, reducing vessel incident risk and enabling economic benefits for the region to be realised now and into the future
To provide for equity within and between generations	The Project will ensure that the economic benefits of the growth of the Port to the Gladstone region are not constrained by vessel access to the Port and that these economic benefits are available to future generations With the effective implementation of mitigation measures, the Project impacts are of an acceptable nature and duration that is not predicted to compromise the sustainability of ecological systems ensuring the health of the environment for future generations
To protect biological diversity and maintain essential ecological processes and life-support systems	With the effective implementation of mitigation measures, the Project impacts are of an acceptable nature and duration that are not predicted to compromise the sustainability of ecological systems
Guiding principles	
Decision making processes should effectively integrate both long and short term economic, environmental, social and equity considerations	The consideration of Project alternatives and the concept design of the preferred options for dredging and dredged material placement have taken into account a balance of economic, environmental, social and equity considerations (refer Section 1.4 and Appendix B)
Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	The preferred dredged material placement location is within a location where the level of scientific information regarding project impacts is satisfactory to predict Project impacts with a reasonable degree of certainty (refer Chapter 9 (nature conservation))
The global dimension of environmental impacts of actions and policies should be recognised and considered	The impacts of the Project on the GBRWHA have been recognised and considered and are predicted to be acceptable (refer Chapter 9 (nature conservation))
The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised	The Project objective aligns with the principle of developing a strong, growing and diversified economy by improving the operational and economic efficiency of the Port of Gladstone (refer Chapter 19 (economic impact assessment))
The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised	The Project will realise the economic benefits of improving the operational and economic efficiency of the Port of Gladstone without compromising the sustainability of ecological systems (refer Chapter 9 (nature conservation) and Chapter 19 (economic impact assessment))
Cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms	The Project aligns with national, State and regional policies regarding sustainable growth of priority ports, including the National Ports Strategy, priority port planning in response to Reef 2050 and the Port Strategic Plan (refer Section 1.4)
Decisions and actions should provide for broad community involvement on issues which affect them	The Project has involved broad community input during the EIS process (refer Section 1.8 and Appendix N2 (engagement report))