Gladstone Ports Corporation

Growth, Prosperity, Community.

Chapter 5 - Land

5. Land

Overview

This chapter of the EIS addresses Section 3.2 of the ToR (Appendix A). A number of elements of the general environment in which the Project will occur are described in this chapter including:

- Geology;
- Soils and quarry materials;
- Land use and tenure (including Native Title);
- Topography;
- Acid sulphate soils; and
- Land contamination.

Potential impacts of the project on these aspects of the environment and proposed mitigation measures are described.

As the Project area is located beneath the high water mark, the focus of this section is on the marine environment. Details regarding marine sediment and the characteristics of the dredged material are included in Chapter 7 and are not discussed in this chapter. Discussion of the quality and management of wastewater/stormwater leaving the reclaimed area is included in Chapter 5. Transport and Landscape and Visual Character are discussed in Chapter 11 and Chapter 14 respectively.

A detailed assessment of acid sulphate soils is provided in Appendix I.

The relevant legislation and guidelines relating to topography, geology, soils, quarry materials, land use and tenure, land contamination and acid sulphate soils is listed below.

State Legislation

- *Aboriginal Cultural Heritage Act 2003*

Guidelines

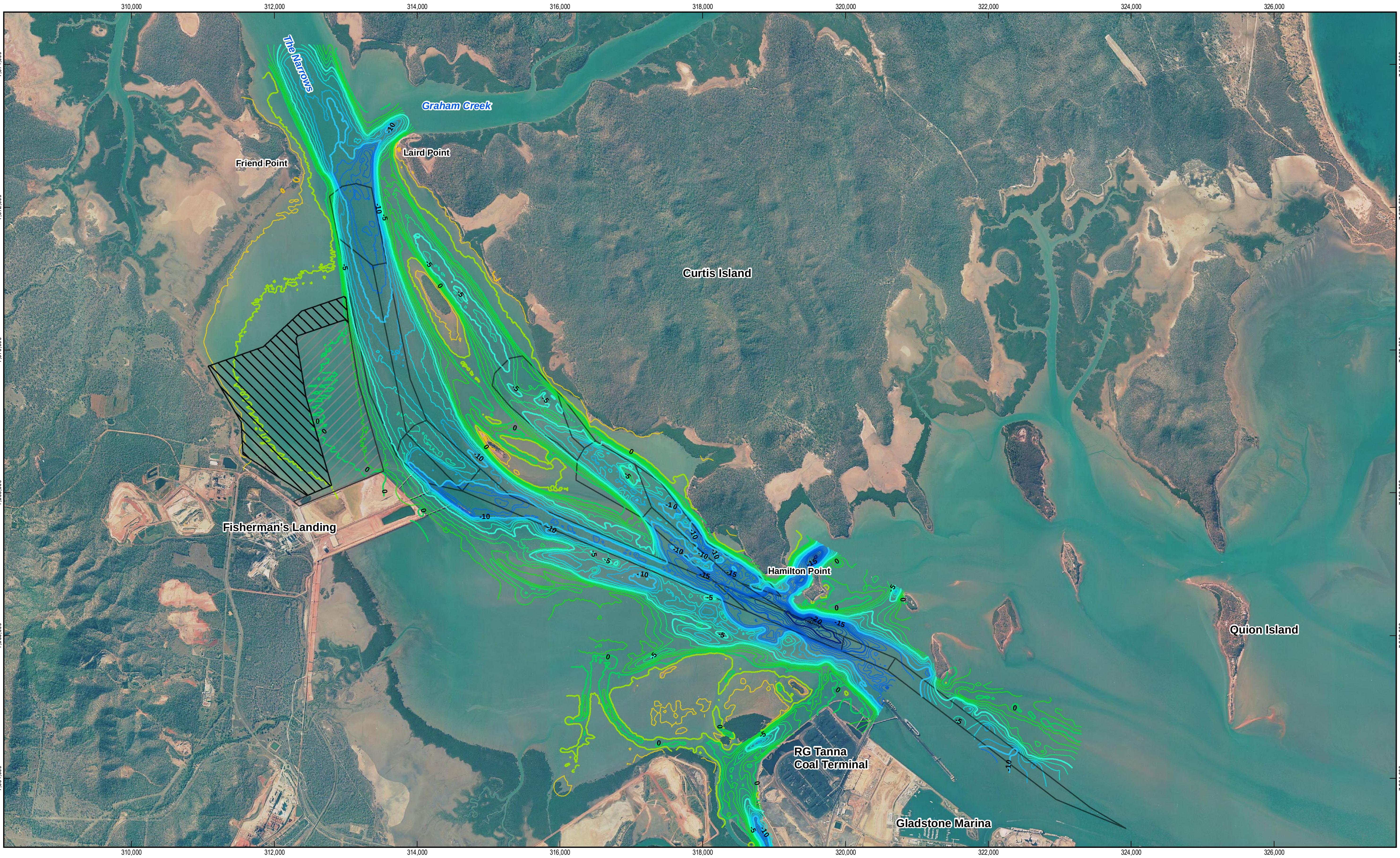
- Queensland Acid Sulphate Soil Technical Manual (QASSIT) Soil Management Guidelines (QASSIT 2003).
- Queensland Acid Sulphate Soils Management Advisory Committee (QASSMAC) guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils in Queensland (DNRM&E 1998).
- National Assessment Guidelines for Dredging (NAGD, Commonwealth of Australia 2009).

5.1 Topography

The estuaries along the Curtis Coast represent a series of drowned valleys submerged with past rising sea levels (DNRM 2004). Filling of the valleys with sediments from both fluvial and marine sources would have occurred during the Holocene (last 10 000 years) sea level rise (DNRM 2004). The predominantly tidal flats of fine sediment that are present today indicate low energy deposition of a marine dominated rather than a fluvial dominated deposition regime (DNRM 2004).

The bathymetric map of the Western Basin Reclamation Area (Figure 5-1) shows the seabed elevation relative to the Lowest Astronomical Tide (LAT). The seabed ranges from around 0 m LAT in the east to around +2 m LAT in the west of the proposed reclamation area. The mean low-water neap tide level for the Fisherman's Landing area is 0.71 m LAT and the mean low-water spring tide level is 1.61 m LAT (GHD 2009g), thus central and eastern parts of the proposed Reclamation Area prior to filling will be underwater at the mean low water neap tide level.

The bathymetry in the areas to be dredged varies across the dredging stages. A few areas are very shallow, requiring the removal of up to 13.0 m of material to achieve the required declared depths in shipping channels and swing basins, while some areas are already deeper than the required depths (e.g. Hamilton Point). In general, the current depths in the areas to be dredged are between -5 m and -10 m LAT.



1:50,000 (at A3)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Western Basin Reclamation
- Fisherman's Landing Northern Expansion
- Proposed Dredge Footprint

Bathymetry (1 metre contour interval LAT)

- 3
- 1
- 0
- -5
- -10
- -15
- -20
- -25

Port of Gladstone
Western Basin Dredging and Disposal Project

Bathymetry, Western Basin
Project Area

Job Number	42-15386
Revision	A
Date	30 Sept 2009

Figure 5-1

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5.2 Land Use and Tenure

5.2.1 Description of Environmental Values

The Project will incorporate dredging in various areas of the Port of Gladstone and a proposed reclamation area 10 kilometres north of Gladstone City within the local government area of Gladstone Regional Council (formerly Calliope Shire). The Project footprint is regarded as unallocated state land under the administration of DERM. The surrounding land use and tenure for the Project Area is shown in Figure 5-2, indicating a variety of freehold and leasehold tenures, with various land owners, including private owners and government agencies.

The Project Area is located in an area that is currently used for various recreational activities. Common recreational activities include jet skiing and boating. Bird watchers access the mainland coast area, particularly around Friend Point, to sight migratory and wader bird species. Graham Creek is a popular recreational location. The creek is used for fishing, crabbing and seasonal prawning. It is also a listed safe harbour offering a protected deep water anchoring location that can be accessed at low tide. Non-fishing boating activity includes smaller vessels and yachts that use the adjacent channel to access in and out of the Narrows.

The proposed Project is located in close proximity to the Gladstone State Development Area (GSDA), which compromises 28,000 ha of land specifically allocated to large scale industrial development, including infrastructure corridors and essential infrastructure (Figure 5-2). A large proportion of the GSDA is currently undeveloped.

Land access to the reclamation site is via Landing Road, which runs off Mount Larcom – Gladstone Road, the major northern access road to Gladstone.

There are various industrial developments in the immediate proximity to the proposed reclamation site and areas to be dredged (Figure 5-2). Current business owners/operators include:

- Users of the Bulk Liquid Wharf;
- Cement Australia;
- Rio Tinto Alcan Yarwun (RTAY) (which has a refinery, wharf and storage facilities);
- Orica Australia (which has a bulk liquid ammonia tank at the existing Fisherman's Landing Reclamation);
- RG Tanna Coal Terminal; and
- Queensland Energy Resources Ltd (QERL) (which has leasehold land directly to the north of the project site and overlapping with the proposed development site as part of the Stuart Oil Shale Project).

Other land uses in close proximity to the proposed Western Basin Reclamation Area include State Forestry, based in Targinie State Forest. The local land area formally accommodated various rural land uses including beef cattle grazing and horticulture, however many of the former landholders have since relocated.

The areas surrounding the dredging footprint include land uses such as the existing Fisherman's Landing Reclamation Area, the RG Tanna Coal Terminal, the proposed Wiggins Island Coal Terminal, the Curtis

Island LNG Precinct and a number of islands, some of which are privately owned and are occupied by residents.

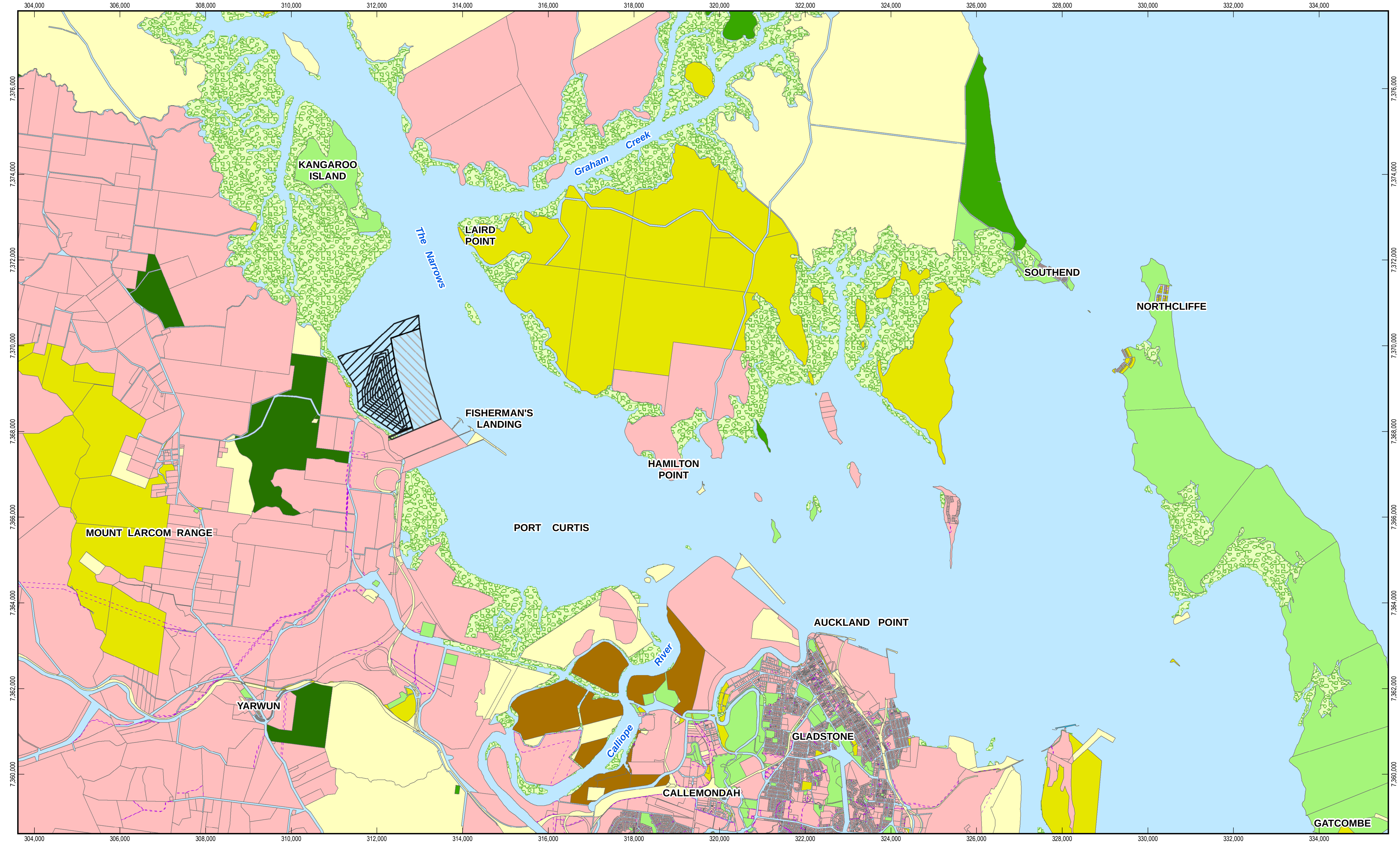
The city of Gladstone is the closest major urban centre and the largest urban and main residential area in the Gladstone region. Gladstone is a major port and industrial hub, and major service centre. Tannum Sands, Boyne Island, Calliope and Mount Larcom are the next largest towns in the Gladstone region in terms of population. There are also various rural residential townships and localities spread throughout the Gladstone region. These smaller towns service the greater regional area, which consists predominantly of rural land uses, particularly beef cattle grazing. Other land uses throughout the region include forestry reserves, mining and conservation lands.

Chapter 9 – Nature Conservation details areas of environmental significance within or adjacent to the Project Area as well as a map showing their location. These areas include:

- The Great Barrier Reef World Heritage Area (GBRWHA) and Great Barrier Reef Marine Park (GBRMP);
- Rodds Bay Dugong Protection Area (DPA);
- The Port Curtis Wetland;
- The Great Barrier Reef Coast Marine Park (including a Habitat Protection Zone under the GBR Coast Marine Park in the Narrows); and
- Colosseum Inlet and Rodds Bay Fish Habitat areas to the south of Port Curtis.

Native Title

There are a number of traditional owner groups in the Port Curtis area. There is a Native Title Claim (QC01/29) over the Gladstone region. Port Curtis Coral Coast Aboriginal Corporation (PCCCAC) is the Claimant. The portion of the project area comprising the waters of the Gladstone Harbour is not subject to a current native title claim or Aboriginal Cultural Heritage Body and has not been subject to a native title claim at the time of or since the introduction of the *Aboriginal Cultural Heritage Act 2003*. As such, pursuant to section 96 of the Act, public notification is required to determine who the Aboriginal Parties are for all areas of the project not located within the external boundaries of the PCCC native title claim. This is discussed further in Chapter 12.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion
- Coastal Wetlands
- Road
- Closed Road (temporary)
- Easement
- Freehold
- Housing Commission Lease
- Commercial / Industrial Development
- Leasehold
- National Park
- Port and Harbour Boards
- Reserve
- Railway
- State Forest
- State Land

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Land Use and Tenure of Sites Surrounding the Project Area

Figure 5-2

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5.2.2 Potential Impacts and Mitigation Measures

The construction of the Reclamation Area will result in a change of land use from marine waters to potential industrial land. This change in land use will prevent the current uses of the area, which are marine habitat and recreational and commercial fishing. The ability of these uses to occur in areas directly adjacent to the Western Basin Reclamation Area may also be reduced.

The construction of the Reclamation Area allows for an expansion of port facilities for import and export of bulk commodities and resources, and as such, is compatible with adjacent land uses.

The dredging activities for the Project will promote shipping access to Curtis Island, which will impact on its land use. However, the Curtis Island LNG Precinct has been established specifically to cater for industrial development. It is also possible that the dredging activities may impact upon recreational uses in the area, however, this impact will be transient.

5.3 Geology

5.3.1 Description of Environmental Values

The ToR for Geology specifies that the chemical properties of surface and subsurface materials, as well as the geo-mechanical and chemical properties of the bund wall rock. These details are provided in Chapter 7 – Coastal Environment and Chapter 2 – Description of Project respectively.

Reclamation Area

According to the 1:100,000 Geological Series – Gladstone Sheet 1950, the geology underlying the Reclamation Area is described as Quaternary Holocene deposits (Qhm) – Mangrove swamps, mudflats and saltpans (Figure 5-4). Immediately landward of the Reclamation Area the geology is described as Quaternary age alluvium (Qha) – Gravel, sand, silt, clay and alluvium (Figure 5-4).

The Western Basin area is located within a coastal plain setting lying to the east of Mount Larcom along the shores of an inlet known as The Narrows. The area used to comprise a broad zone of swampy coastal plains and mangrove flats. The Narrows geology comprises a shallow marine channel, from the mouth of the Calliope River. The Narrows is a half graben (a major fault along only one of the boundaries), with the western limb terminating against the Western Basement Fault. Over the past 60 million years, the graben has been in-filled as subsidence occurred, accumulating close to 1000 m of sediment: the Worthington Formation, the Rundle Formation, and the Curlew Formation (Table 5-1).

Table 5-1 Stratigraphy of The Narrows

Age	Group	Unit
Quaternary	-	*Quaternary Sediments*
Tertiary	The Narrows Beds	*Curlew Formation*
		Rundle Formation
		Worthington Formation
Devonian-Carboniferous	Curtis Island Group	*Doonside Formation*

These Tertiary aged sedimentary units, commonly referred to as The Narrows Beds are interpreted to have been deposited in a fluvial to lacustrine (lake) setting (Noon 1981; Henstridge and Missen 1981). Sediment thickness varies across the graben, attaining a maximum thickness of approximately 1000 m along the western boundary; thinning eastwards to a maximum of about 200 m. Clays within the sediments of The Narrows Beds are dominated by kaolinite, illite, and illite-montmorillonite.

The Curlew Formation is at least 116 m thick and is dominated by a 'greenish-grey to pale grey claystone/mudstone, with interbedded black calcareous and coaly shales with minor arenite and limestone beds.

Quaternary sediment covering the sea floor is dominated by typically grey/brown, brown, grey/orange clay/sandy clay and grey/green mudstone. These sediments overlay semi-consolidated to consolidated sediments of the Curlew Formation.

Figure 5-3 shows a cross section of the geology of the Narrows.

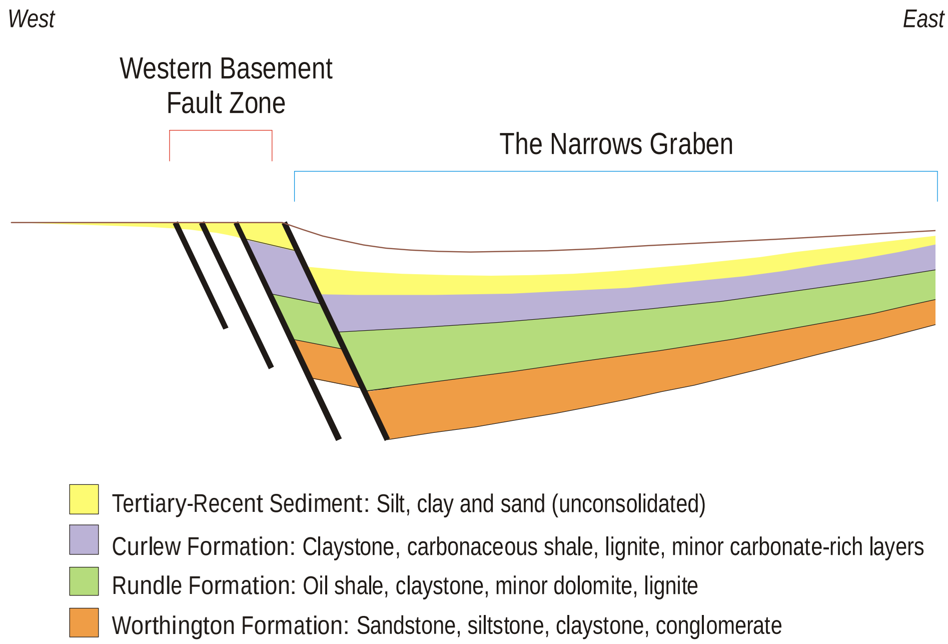
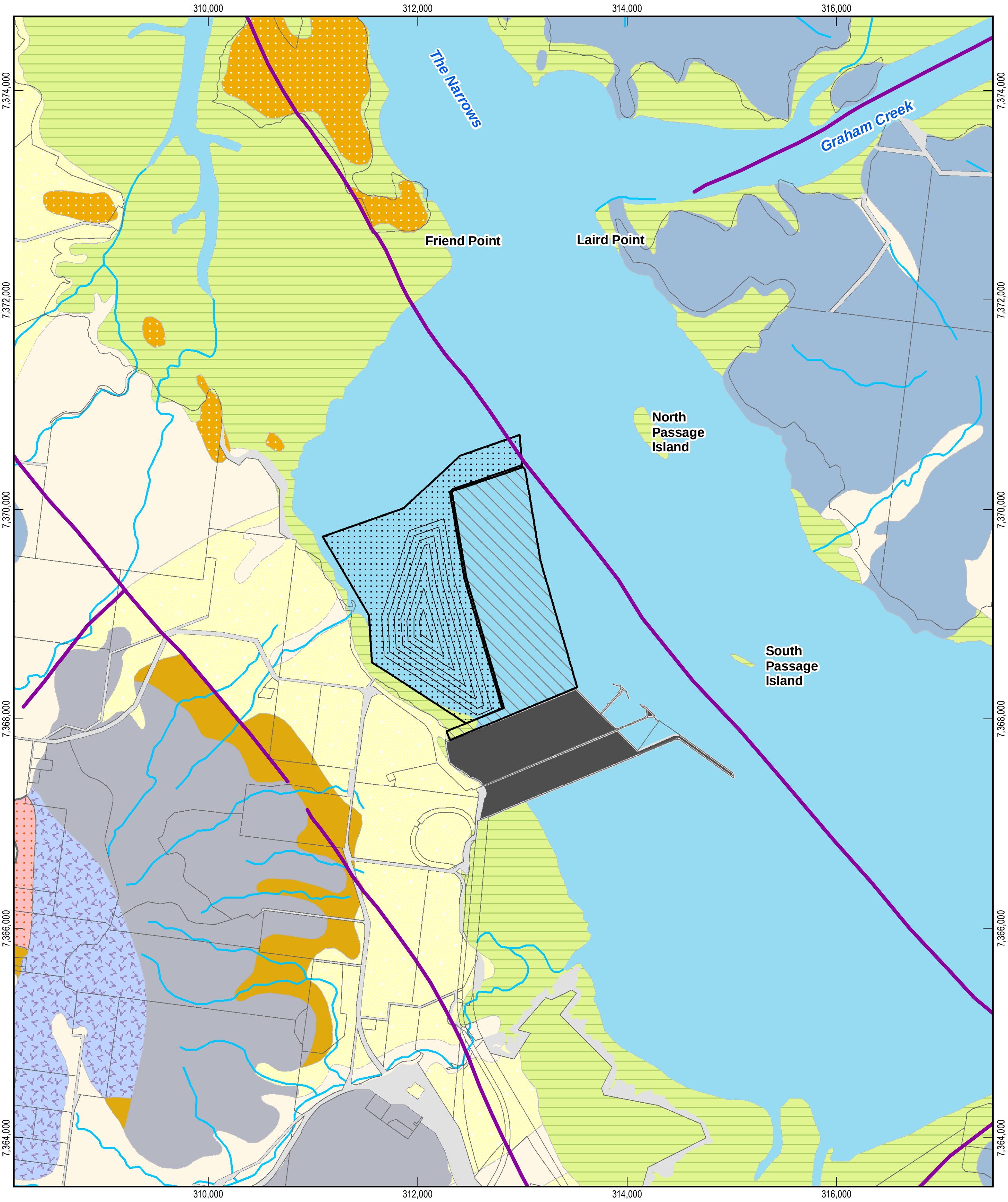


Figure 5-3 Schematic Cross Section of The Narrows

The local geology at the proposed Reclamation Area comprises estuarine clay overlying marine and residual clays. The estuarine clay varies in thickness from 0.5 m to approximately 5.0 m across the site. The underlying soil varies from clay, silty clay or residual clay. The source of the residual clay is siltstone. Some areas may contain gravel and/or sand layers, more commonly in the first 10 m below seabed.

Seismic survey suggests that the area towards the western side of the proposed Reclamation Area has increased seismic velocities (GHD 2009g). The increased seismic velocities could indicate thicker deposits of loose to dense sands. These thicker deposits may result from deposition by stormwater runoff from the natural watercourses coming into the bay at or near that area.



LEGEND

- Fault Lines
- Watercourse
- Western Basin Reclamation Footprint
- Fisherman's Landing Northern Expansion

Geology 100K

- Qhe/m
- Qa
- Qr\s
- Qr\s>Tr
- TQr
- Ts
- PRgta
- DCcw
- DCcd
- DCcd/b
- W

1:50,000 (at A4)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Port of Gladstone
Western Basin Dredging and Disposal Project

Geology of Western Basin Reclamation Area

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 5-4

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Dredging Area

Based on the available information, the stratigraphy within the proposed strategic dredge areas is likely to comprise:

- A marine sediment layer (where present);
- Underlain by alluvial material; and
- Underlain by residual material and the Wandilla Formation.

Stage 1A

Published information on the lithology of the Stage 1A area is limited to the vicinity of China Bay (reported in URS January 2009a) and also further to the east in the vicinity of the Targinie and Clinton Bypass channels (reported in Douglas Partners 2005 and 2006).

Data reported in URS (January 2009a) indicate that marine sediments, described as soft clay and loose sands and gravels with shell fragments, are underlain by residual materials (including layers of sandy clay, clayey sand, gravelly sand and clay) and extremely weathered bedrock of the Wandilla Formation in the vicinity of China Bay. Marine sediments were encountered to between 2.2 m and 11.2 m below the seabed. Cross sections for the investigated locations (URS January 2009a) indicate the marine sediments increase in thickness towards the south west (away from Curtis Island) and towards the north west in the vicinity of China Bay.

Previous investigations by Douglas Partners (2005 and 2006) indicate the presence of interbedded sand, gravel and clay dominated sub-surface materials of variable thickness (typically <0.5 up to around 10 m) within and to the south of the Targinie Channel (within the Wiggins Island Coal Terminal site) and the southern end of the Clinton Bypass Channel. Cross sections presented in Douglas Partners (2006) indicate individual layers can be laterally discontinuous, but can be generalised as alluvium (sand, silty sand, silty clay, thin clay-bound gravel) underlain by clay bound gravel dominated lithologies.

Stage 1B

Published information on the lithology of the Stage 1B area is limited to the investigations conducted by Douglas Partners (2005).

Data indicate that the near surface sediment in the area immediately east of Fisherman's Landing wharves (Targinie Swing Basin) includes stiff to very stiff silty clay with traces of gravel and sand, which is overlain in the south west of the swing basin area by a layer, up to 1 m thick, of very soft to soft sandy silty clay containing some shell fragments. Sand and clayey sandy gravel is indicated to be underlain by stiff silty clay at the western end of the Targinie Channel.

Stage 4

Published information on the lithology of the Stage 4 area is limited to the vicinity of China Bay (reported in URS January 2009a). The lithology is indicated to be similar to that summarised for Stage 1A, i.e. a layer of marine sediments underlain by residual material.

5.4 Soils and Quarry Materials

5.4.1 Description of Environmental Values

This section describes the soils and quarry materials associated with the Reclamation Area, while Chapter 7 – Coastal Environment describes the values for the area to be dredged in greater detail.

The materials to be used in the construction of the bund wall, filling and capping of the Western Basin Reclamation Area include:

- Hard rock (approximately 1,800,000 m^3) from a GPC owned quarry situated at Guerassimoff Road Yarwun consisting of:
  - Bund armour - This material comprises the larger fractions of the quarry materials that may have been separated from the "run of quarry" materials at the quarry. The material is anticipated to be a uniform rock, graded to prescribed engineering specifications; and
  - Bund material - The "run of quarry" material that remains after the armour rock has been removed may also have the smaller particle sizes "scalped" from the "run of quarry". The resulting material to be used for bund construction may have a minimum particle size of 12 mm to assist in the minimisation of fine release into the water column and minimise the turbidity generated from the works.
- Up to 55 million m^3 of dredged material (capital and maintenance dredging); and
- Capping material sourced from quarry overburden.

5.4.2 Potential Impacts and Mitigation Measures

Soil Erosion

Erosion is the wearing away of land by water, wind and general weather conditions. This is a natural process but some land management practices have the potential to greatly increase the rate at which this occurs. During erosion, soil is selectively removed from its current location and may be deposited elsewhere. The amount of erosion occurring is dependent on factors such as rainfall erosivity (rainfall volume and intensity), vegetation coverage and soil erodibility (soil structural stability and texture, soil type).

It is possible that erosion of the surface of the reclamation area may occur during or after construction due to wind and rainfall. The following mitigation measures are to be implemented to minimise this:

- A stormwater drainage system will be constructed on the final reclamation area, which will direct runoff and discharge stormwater from the area. This will reduce soil erosion from water; and
- Vegetation of the final reclamation area with suitable vegetation to prevent wind erosion of the surface of the area.

Quarry Material

An investigation into the quarry resource was undertaken as part of the quarry design process (GHD 2009e). The study identified four main rock types in the quarry:

- Lithic meta-sandstone;
- Pelite (low grade metamorphosed siltstone);

- Rhyo dacite (low grade metamorphism); and
- Trachy andersite (lowest metamorphic grade amongst the four categories).

All rock of resource value was categorised as bluestone, which is not expected to result in impacts on water quality when placed in the marine environment. The quarry was utilised by a previous owner and the remaining faces, which have been exposed for more than 10 years, showed very little weathering, indicating that the material would be able to endure placement in the marine environment without undergoing rapid deterioration (GHD 2009e). The potential for acid production from the rock when it is placed in the marine environment will be tested prior to the commencement of construction. Samples of unweathered material from each rock type will be tested for net acid producing potential and net acid generation. If any of the analysis results suggest uncertainty (i.e. potential for production of acid), then additional sampling would be undertaken and management or mitigation measures considered as appropriate.

The rock will be extracted and screened at the quarry site, including scalping of the fine fraction (<20 mm) to reduce the potential for generation of turbid plumes through the introduction of fines into the harbour.

5.5 Acid Sulphate Soils

5.5.1 Methodology

This section focuses on the description of potential acid sulphate soils underlying the proposed bund wall as well as the acid sulphate soil characteristics of the material to be dredged. A detailed report on the acid sulphate soil investigation that has been completed for the Project and is provided in Appendix I.

An assessment of acid sulphate soils (ASS) has been completed to define areas of the Project Area that contain actual ASS (AASS) or potential ASS (PASS) and to characterise the dredged material in terms of the potential for ASS. This assessment was completed by:

- Reviewing published information and previous investigations;
- Interpretation and analysis of field investigation data and ASS laboratory testing results, provided by QGC, for the Western Basin Dredging and Disposal Project; and
- Assessing the potential impacts and identifying potential mitigation measures.

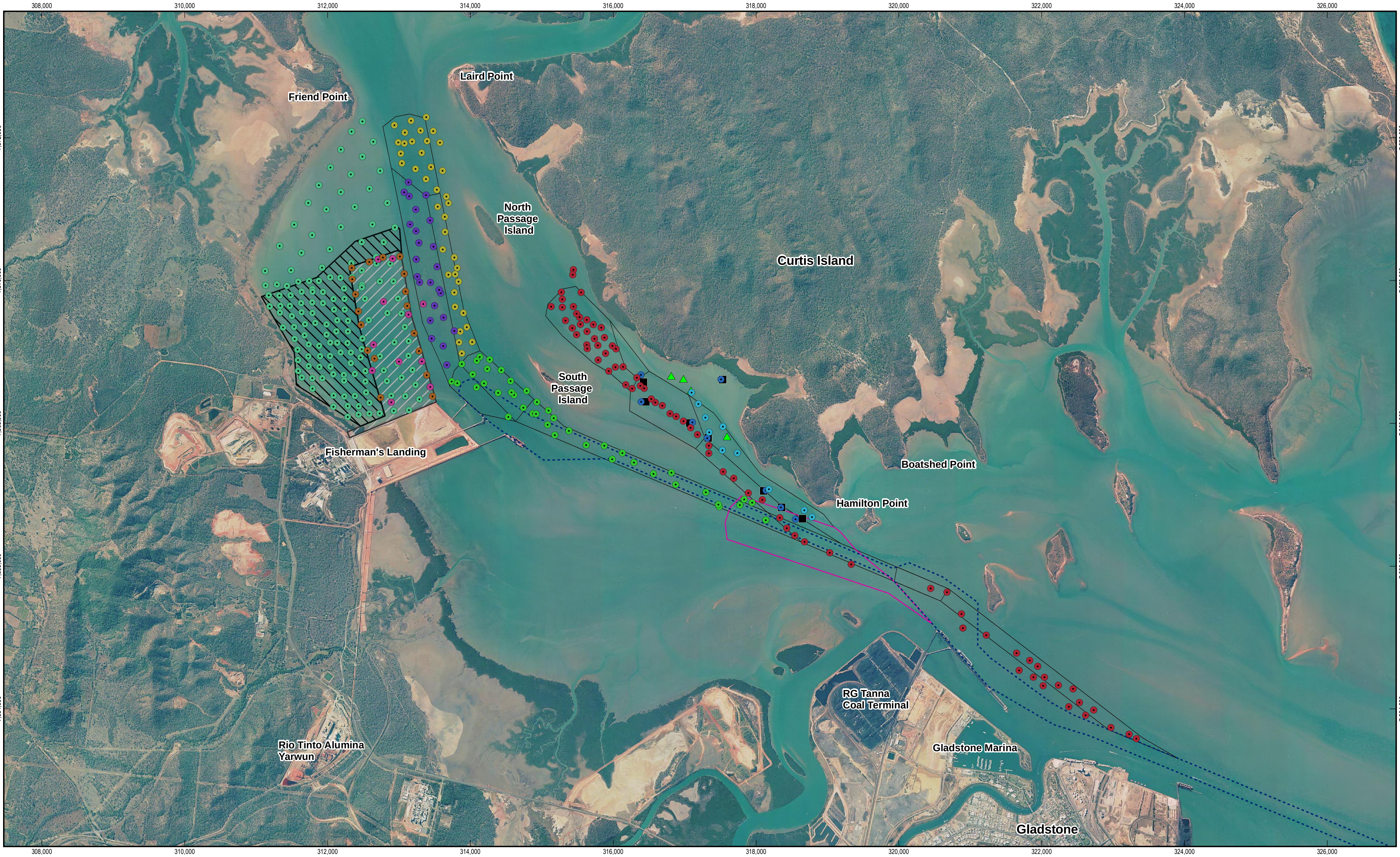
A total of 189 locations were sampled for the Dredging Area, with 100 locations sampled for the Reclamation Area, as shown in Table 5-2.

Table 5-2 Sample Locations

Area	No. Locations	Dredge volume (Mm^3)	Area (Hectare)
Reclamation Area	100	N/A	233
Dredging Stage 1A	76	16	295
Dredging Stage 1B	41	6.1	148
Dredging Stage 2	38	4.5	107
Dredging Stage 3	24	5.5	103
Dredging Stage 4	10	3.9	62

Testing for pH, chromium-reducing sulphur, acid neutralising capacity (ANC) and calculations for net acidity were completed for the samples to indicate the likelihood and location of the occurrence of AASS or PASS. The locations of the ASS investigations are shown in Figure 5-5.

Details regarding the depths of sampling and parameters tested can be found in Appendix I.



1:50,000 (at A3)

0 0.5 1 1.5 2
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Core Location
- Stage 1A
- Stage 1B
- Stage 2
- Stage 3
- Stage 4
- AS
- FL
- GLNG
- GT
- Geocoastal Pty Ltd
- Connell Wagner Pty Ltd

- Existing Channels, Swing Basins, Berths
- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion
- Proposed Dredging
- Wiggins Island Coal Terminal (Approved)

Port of Gladstone
Western Basin Dredging and Disposal Project

Acid Sulphate Soil
Investigation Locations

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Figure 5-5

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5.5.2 Description of Environmental Values

Background

Lowland ASS include both AASS and PASS. These soils generally occur in Quaternary aged (1.8 Ma[1] – Present) marine or estuarine sediments, which are predominantly confined to coastal lowlands below 5 mAHD. Within these sediments, the majority of soils that present an environmental risk are generally confined to the Holocene (<10,000 years) material. When these lowland areas are disturbed, such as by excavation, drainage or displacement and the watertable is lowered, oxygen may get mixed into or enter the soil/sediment profile.

In the presence of water, oxygen in the soil/sediment profile can oxidise sulfide minerals, typically pyrite (FeS_2), to form sulphuric acid (H_2SO_4) and iron oxide (Fe_2O_3). The formation of sulphuric acid causes the pH to fall below neutral (pH 7), with extremely low pH levels possible (pH < 4). Subsequently, the surrounding land (soil) and nearby waterways may become contaminated with acids, and metals leached from the sediments by the acid. Under acidic conditions metals such as aluminium and iron, as well as trace heavy metals (including arsenic) become more soluble and therefore are more easily mobilised by infiltrating waters. This may result in the significant degradation of the surrounding ecosystem.

Under natural conditions, PASS are usually located below the watertable. A decrease in the watertable beyond its natural seasonal fluctuation can expose these soils to oxygen, oxidising the pyritic sediment and producing sulphuric acid. PASS are not usually present above the natural watertable because these materials have been exposed to oxygen long enough to convert all the sulphur-bearing minerals (i.e. pyrite) to acids or AASS. The AASS materials commonly have a mottled appearance (e.g. orange and yellow discolouration).

The 1:50,000-scale acid sulphate soils map for Tannum Sands- Gladstone (DNRM&E 2004) is shown in Figure 5-6 and the acid sulphate soil hazard map for Tannum Sands- Gladstone is shown in Figure 5-6.

The acid sulphate soil map for Tannum Sands- Gladstone (DNRM&E 2004) identifies a narrow strip of land in the vicinity of the mangroves, which parallels the coastline west of the Western Basin reclamation area, as having PASS at less than 0.5 m below the surface. The acid sulphate hazard map identifies this strip of land as medium (southern end) and high (northern end) potential for acid generation. The published 1:100,000-scale geology map for Gladstone (Sheet 9150, Department of Natural Resources and Mines, 2001) shows Holocene-aged estuarine and marine deposits mapped at outcrop along the coastline adjacent to the proposed reclamation area coincide with the mapped PASS. Similar Holocene-aged estuarine and marine deposits are likely to continue beneath the proposed reclamation area and potentially, the channel beyond.

[1] Ma –million years

LEGEND

- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion

Acid Sulphate Soils

- A0S0 - AASS & PASS (0 - 0.5m)
- A1S1 - AASS & PASS (0.5 - 1m)
- S0 - PASS (0 - 0.5m)
- S1 - PASS (0.5 - 1m)
- S1/S2 - PASS (0.5 - 2m)
- SDL - Disturbed land likely to contain ASS. Limited field investigation.
- NA - Land not assessed for sulfidic materials
- NAM - Made land over subtidal flats and sea.
- a2LP - Low probability of ASS. Strong acid field pH may or may not be result of sulfide oxidation.

1:50,000 (at A4)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Acid Sulphate Soil Mapping
for Tannum Sands and Gladstone

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 5-6

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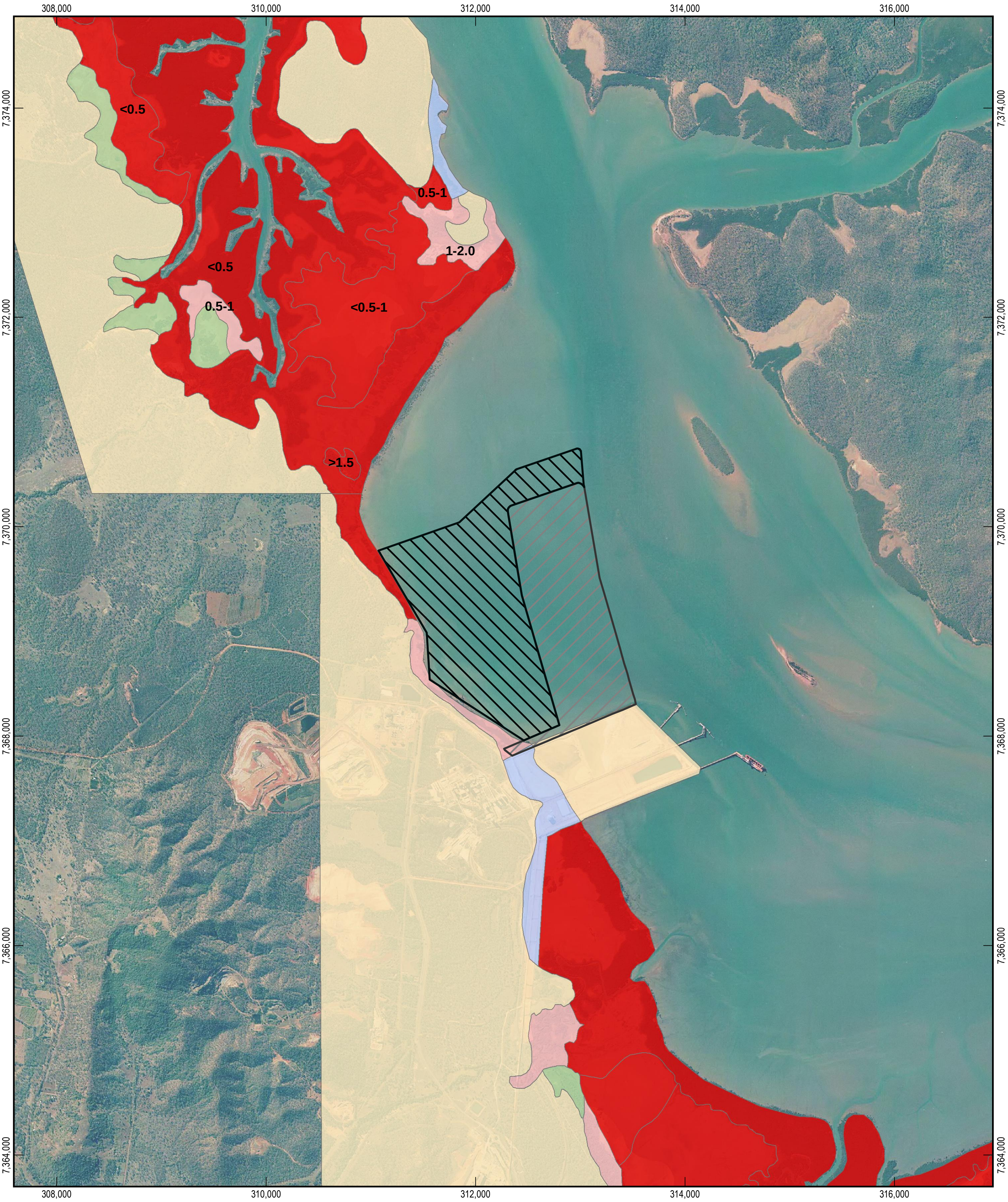

LEGEND

Western Basin Reclamation Area
Fisherman's Landing Northern Expansion

Potential for Acid Generation
- Very Low
- Low
- Moderate
- High
- Not Classified
- Not Assessed

1:50,000 (at A4)

0 0.5 1 1.5 2
Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD GPC

Port of Gladstone
Western Basin Dredging and Disposal Project

Acid Sulphate Soil Hazard Mapping, Gladstone

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 5-7

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Results of ASS Investigations

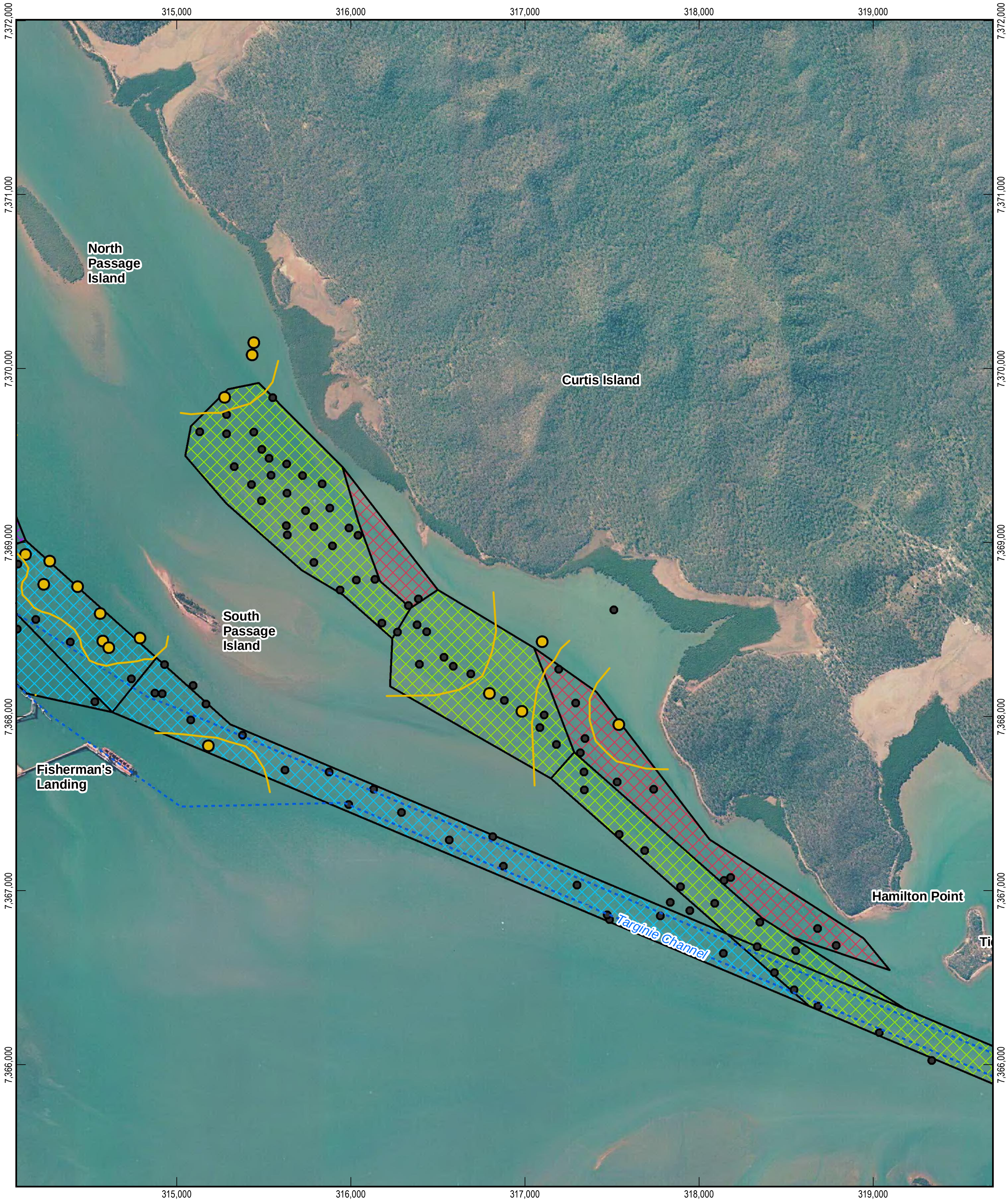
Dredging Area

Based on the laboratory analysis and spatial distribution (detailed in Appendix I), a number of locations within the Dredging Area have been identified as containing elevated amounts of net acidity and will require treatment. These ‘hot spots’ are shown in Figure 5-8. The occurrence of natural neutralising capacity in most samples reduces the number of areas that may cause environmental harm, however the potential acidity should still be considered as an impact. Based on the volume of sediment and the amount of ANC in the samples, it is likely that the majority of the sediments will self neutralise within the Reclamation Area, reducing the potential impact of the acid producing fraction.

However, it is possible that separation of the potential acid-producing fraction (pyritic material) and the neutralising fraction (calcium carbonate) may occur during dredged material placement, leading to accumulation of pockets with insufficient ANC to ensure neutralisation. As a number of samples did not record any potential acidity but did record excess amounts of ANC, it can be assumed this buffering capacity will be available for neutralisation of the potentially acidic materials, further reducing the risk.

Reclamation Area

Figure 5-10 illustrates areas of potential acidity within the Reclamation Area. The majority of the Reclamation Area contains excess sulphur acidity and net acidity at varying depths. It has been assumed that a maximum of 2 m may be disturbed during the construction of the bund wall. Figure 5-10 illustrates the locations of excess acidity within the top 2 m which may heave during placement of the bund wall material and require ASS management. *In-situ*, these samples contain enough buffering capacity to self-neutralise, however it is not known how effective this buffering capacity will be after dredging occurs.



LEGEND

- Core with Net Acidity ≥18 moles H+/tonne
- Core Sample Location
- Area Containing Potential Acid Sulphate Soils
- Existing Channels, Swing Basins and Berths

Proposed Dredge Stages

- Stage 1A - North China Bay LNG Precinct
- Stage 1B - Fisherman's Landing LNG
- Stage 2 - Laird Point LNG
- Stage 3 - Fisherman's Landing
- Stage 4 - Hamilton Point

1:30,000 (at A4)

0 200 400 600 800 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Port of Gladstone
Western Basin Dredging and Disposal Project

Acid Sulphate Soil 'Hot Spots' in Dredging Area
Northern Targinie Channel to Hamilton Point

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 5-8

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LEGEND

- Core with Net Acidity ≥18 moles H+/tonne
- Core Sample Location
- Area Containing Potential Acid Sulphate Soils
- Existing Channels, Swing Basins and Berths

Proposed Dredge Stages

- Stage 1A - North China Bay LNG Precinct
- Stage 1B - Fisherman's Landing LNG
- Stage 2 - Laird Point LNG
- Stage 3 - Fisherman's Landing
- Stage 4 - Hamilton Point

1:30,000 (at A4)

0 200 400 600 800 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Port of Gladstone
Western Basin Dredging and Disposal Project

Acid Sulphate Soil 'Hot Spots' in Dredging Area
Targinie Channel to Clinton Bypass

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 5-9

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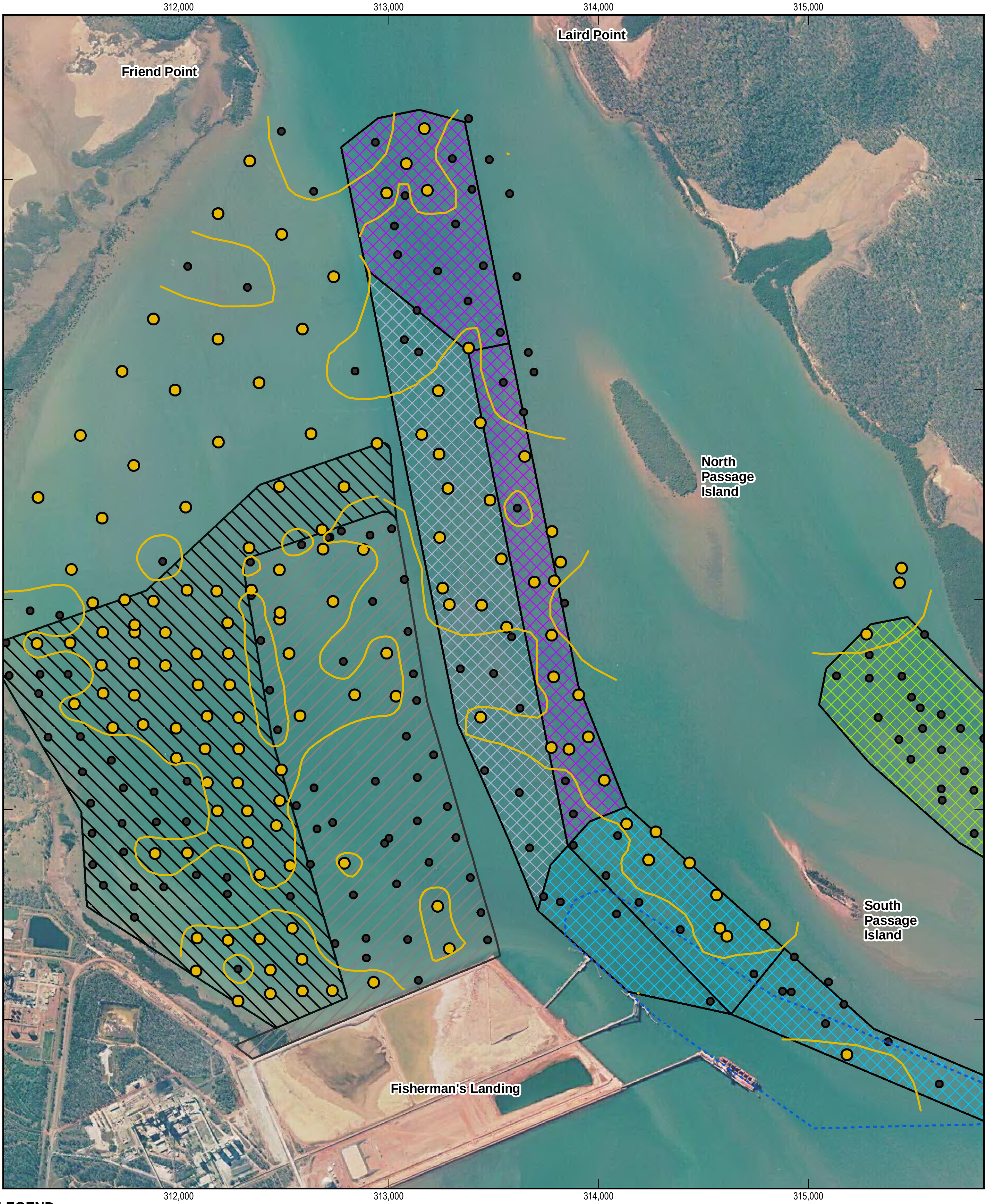

LEGEND

- Core with Net Acidity ≥18 moles H+/tonne
- Core Sample Location
- Area Containing Potential Acid Sulphate Soils
- Existing Channels, Swing Basins and Berths
- Western Basin Reclamation
- Fisherman's Landing Northern Expansion

Proposed Dredge Stages

- Stage 1A - North China Bay LNG Precinct
- Stage 1B - Fisherman's Landing LNG
- Stage 2 - Laird Point LNG
- Stage 3 - Fisherman's Landing
- Stage 4 - Hamilton Point

1:25,000 (at A4)

0 200 400 600 800 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Acid Sulphate Soil 'Hot Spots'
in Reclamation Area

Job Number 42-15386
Revision A
Date 01 Sept 2009

Figure 5-10

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5.5.3 Potential Impacts and Mitigation Measures

Potential Impacts of Acid Sulphate Soils

The potential impacts of ASS may occur during the construction of the bund wall, during dredging activities and during the placement of dredged material into the Reclamation Area.

Bund Wall Construction

Potential impacts from ASS during the construction of the bund wall are:

- Oxidisation of sediments and release of acidic leachate into the receiving environment (harbour) with potential for the transport of heavy metals during placement of the bund materials. This potential impact is related to any AASS or PASS displaced above the mean high water neap level as a result of the creation of a 'mud wave' from lateral movement of soft material due to the weight of rock being placed for the bund wall. The extent of the 'mud wave' cannot easily be estimated given this will depend on the geotechnical properties of sediments which vary throughout the Reclamation Area; and
- Production of acidic leachate and increased concentrations of heavy metals from unconsolidated soft materials entrapped within the core material and bunded area resulting from oxidation of PASS and release of acidity from AASS previously located in anoxic conditions under surface sediments or as a result of reduction in tidal movement.

Dredging Activities

Potential impacts from dredging are:

- The suspension of fine sediments in the water column as a result of rehandling adjacent to the Reclamation Area. This will occur for sediments dredged by a Trailer Suction Hopper Dredger as the dredged material will be rehandled into the Reclamation Area by a small Cutter Suction Dredger. This could result in the re-deposition of PASS in new areas of the harbour if the sediments are transported away from the rehandling area by tidal currents before they are pumped into the Reclamation Area. There is potential for large quantities of PASS to deposit above the intertidal zones in the northern section of the harbour close to the proposed bottom dumping area;
- Potential for the generation of acid from dredged material if saturation of the material is not maintained throughout the dredging process;
- Separation of fines from granular material during the dredging process resulting in the concentration of PASS materials. For example this could occur when dredged material is pumped into a holding vessel and/or when dredged material is placed as fill; and
- Release and redistribution of PASS material into the harbour during the dredging operations from the dredge overflow.

Placement of Dredged Material

Potential impacts from the placement of dredged material within the reclamation area are:

- Oxidation of PASS which are allowed to dry out within the reclamation area and subsequent generation of acidic leachate;

- Migration of acidic groundwater from within the Reclamation Area into the harbour (which could potentially contain elevated concentrations of metals);
- Precipitation of metals including iron, arsenic and manganese out of solution when acidic groundwater from within the Reclamation Area, containing elevated concentrations of iron in solution mixes with sea water, given that the oxidisable sulphur reported in the dredge spoil appears to be inorganic (i.e. likely to be pyritic). The waters from the Reclamation Area will become less acidic on mixing with seawater and can result in precipitation of iron, thus there is the potential this will create extensive red/orange iron staining (rust) in the water, on infrastructure and boats/vessels;
- Iron staining at ground surface within the Reclamation Area if dredged material containing PASS is placed at ground surface, where it will dry out, oxidise, generate acid and mobilise iron from within the sediments and result in the precipitation of iron;
- Algal blooms as a result of increased levels of nutrients produced from reactions within acid sulphate soils and discharge of the nutrient rich water to the sea. The impacts of elevated nutrients are likely to be most significant on the western side of the Reclamation Area where flushing with 'fresh' seawater may be limited and hence, potential for limited dilution of any nutrients discharged to sea;
- Discolouration and noxious odours emitted from open water bodies which are not regularly flushed (e.g. intertidal channel to the west of the Reclamation Area, dredge decant ponds);
- Generation of acid within *in-situ* sediments (identified as PASS) if they are exposed to the atmosphere (and oxidised) such as through dewatering or through excavation during future development of the Reclamation Area;
- Lateral flow of groundwater from within the placed dredged material into existing fill material at Fisherman's Landing, with the potential to change the existing groundwater quality at Fisherman's Landing. The predominant groundwater flow direction is however, likely to be to the north and east;
- Temporary increase groundwater levels in materials adjacent to the Reclamation Area (e.g. Fisherman's Landing and land to the west) when *in-situ* sediments, which include material identified as PASS, are compacted during reclamation (such as placement of fill and bund construction);
- Degradation/corrosion of concrete and steel structures founded in dredge material or founded in material where groundwater has become acidic as a result of oxidation of overlying materials;
- Cracking, shrinking and subsidence of PASS material that are allowed to dry out; and
- Potential health issues for workers that handle and work around PASS, any leachate or groundwater.

Mitigation Measures

Bund Wall Construction

The following mitigation measures have been recommended to reduce the impact of the 'mud wave' effect:

- Excavation of unconsolidated materials forming the 'mud wave' above the mean high water neap level, ensuring that the remaining material is inundated each tidal cycle; and
- Neutralisation treatment and validation of these excavated materials as required; or

- Placement of 'mud wave' material permanently under water within the bunded area, for material where exposure time to the atmosphere has not exceeded the ASSMAC stockpiling guideline limits of Dear *et al.* (2002).

Any unconsolidated material in the 'mud wave' below the mean high water neap level will be managed passively through the natural inundation of water each tidal cycle.

Other mitigation measures to be implemented for the construction of the bund wall are:

- Re-distribution of any material trapped within the bunded area so that it remains permanently under water, within the bunded area. The material is to be re-distributed in compliance with the guidelines for stockpiling of ASS, or placement of the material in the bunded area following treatment with lime and validation sampling;
- Excavation of disturbed, trapped, unconsolidated materials from the western side of the Reclamation Area which are no longer inundated by the mean high water neap tide. Placement of this excavated material permanently below the water table within the bunded area subject to compliance with the ASSMAC ASS material stockpiling guidelines in Dear *et al.* (2002), or placement in the bunded area following treatment with lime and validation sampling.

Dredging Activities

The following mitigation measures will be implemented to reduce the impacts from ASS during dredging activities:

- Temporary rehandling adjacent to the Reclamation Area is not to occur with any dredged material that has TPA, TSA or TAA concentrations above the ASSMAC guidelines without appropriate turbidity/siltation control; and
- During dredging, dredged material is to be kept in a saturated state to reduce the potential impact of oxidising PASS.

Placement of Dredged Material

To mitigate potential impacts from the placement of dredged material in the reclamation area, management during placement of the dredged material will be required.

To reduce the risk of potential impacts on the surrounding environment, active management of sediments during placement within the Reclamation Area is recommended. Additional *in-situ* testing is likely to increase the confidence interval however, it will not negate the need for verification sampling during the operational stage of the dredging. Verification sampling will be conducted to indicate separation of the neutralising fraction and the acid producing fraction does not occur and the sediments do not produce acidity in high enough concentrations to cause environmental harm.

A detailed ASS Management Plan will be required outlining the recommended strategy during placement, after completion and any other excavation works for future developments within the Reclamation Area. The ASS Management Plan should describe the following activities in more detail:

- Strategic placement of dredged material. Dredging of the identified 'hot spot' areas within the early stages of the project to allow strategic placement of sediments identified as having high sulfur levels. These materials should be placed under the permanent watertable within the reclamation area. Figure 5-8 shows the preliminary areas that have been classified as 'Hot spots'.

- Dewatering and lowering of the water table within the reclamation area should be avoided where possible, to allow the maximum volume of sediment stay in a saturated state.
- Preparation of a water management strategy for the reclamation area, to mitigate the potential impacts of contaminated leachate and runoff entering the receiving environment. The strategy should include:
  - Collection of any runoff and any water pumped from excavations;
  - Testing and treatment of any contained water prior to release into the harbour. Any water should be validated to ensure it is of similar or better quality than that of the receiving environment; and
  - Testing and treatment of the decant pond water prior to release into the harbour. All decant water is to be validated prior to release to ensure it is of similar or better quality than that of the receiving environment.
- Lime dosing of dredged sediments as they are pumped into the Reclamation Area to ensure sufficient neutralising agent is available and negate the effect of beaching which may cause the sediments natural buffering capacity to be separated from the pyritic material within reclamation.
- Validation testing of the sediments after placement to confirm sediments have sufficient buffering capacity. If samples located above the permanent water table fail the validation testing then additional sampling will be conducted and the management options will be assessed on a case by case basis.
- Placement of a capping layer of at least 2 m of clean sand or the like over untreated PASS that has been placed up to the mean high water neap level (i.e. is inundated at least once per tide cycle) to ensure materials stay near their optimum moisture content and do not dry out over time. Installation of groundwater monitoring bores to allow early detection of any contamination plumes, fluctuations in groundwater levels and degradation of groundwater quality as a result of oxidation of PASS.
- A groundwater management plan should be developed once the of the Reclamation Area is filled to RL7m, to provide a framework for routine monitoring and data analysis, special event monitoring, due diligence auditing and corrective actions to be taken in the event of a non-compliance.

Maintenance Dredging

The impacts listed for the capital dredging works are the same for the maintenance dredging, however there is an increased likelihood of the oxidation of PASS as the maintenance dredged material is unlikely to be placed below the permanent water table.

To mitigate the potential impacts, an ASS investigation of the areas to be dredged should be conducted prior to commencement of the dredging, but no more than 6 months before the proposed start date. Materials identified as PASS or AASS should be dredged in a way to ensure material is not oxidised during the dredging process and any overflow from the dredge is kept to a minimum. Once the materials are ready to be placed within the Reclamation Area, the same management process used for the capital dredging is to be adopted.

5.6 Land Contamination

5.6.1 Description of Environmental Values

The proposed Western Basin Reclamation Area is currently located under high water mark and is not registered on the DERM's Environmental Management Register (EMR) or Contaminated Land Register (CLR). The site is not currently considered to be contaminated.

Information on sediment quality in the areas to be dredged is provided in Chapter 7 –Coastal Environment and is not discussed in this Section.

5.6.2 Potential Impacts and Mitigation Measures

There is the potential for the Reclamation Area to be contaminated during construction through the spillage of oils and fuels from construction equipment. This will be managed through implementing the following mitigation measures:

- Undertake maintenance and servicing of vehicles at off-site facilities;
- All plant and machinery (particularly hydraulic hoses, fuel lines, etc) will be inspected daily and any defaults or signs of wear and tear reported to the Construction Supervisor for repair as part of a preventative maintenance program;
- Petroleum product spillages will be immediately cleaned up with appropriate absorbent materials along with remediation of the area, if required. The absorbent will be kept in an appropriate container marked 'regulated waste' for a waste contractor licensed to receive such waste;
- In the case of a spill to ground, clean up will be initiated immediately along with advice from a qualified professional to minimise the risk of groundwater contamination;
- Spill kits, including containment and treatment equipment and materials, will be provided at the site, near where equipment is being used;
- In the case of a spill or other accident, monitoring of the receiving environment will be undertaken by an experienced professional; and
- In the case of environmental nuisance or harm the Construction Supervisor will report the incident to DERM and GRC. A report detailing reasons for spills and corrective action will be prepared.

Potential contamination from ASS is discussed in Section 5.5.