Port Expansion Project EIS

Appendix List

AECOM BMT WBM

Appendix List

Port Expansion Project EIS

Appendix A1

Queensland Government Terms of Reference

AECOM BMT WBM

The **Coordinator-General**

Townsville Port Expansion Project

Terms of reference for an environmental impact statement

February 2012

Queensland Government

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Contents

Introduction

The Port of Townsville Limited (PoTL) is the proponent for the proposed expansion of the Port of Townsville Project (the project), located at the mouth of the Ross River in the City of Townsville.

The port expansion has been proposed to address current capacity constraints and accommodate forecast growth in trade at the port over a planning horizon to 2040, and is consistent with the future planning of the port as set out in the Port of Townsville, Land Use Plan (2010).

The Coordinator-General has declared the project to be a 'significant project' requiring an environmental impact statement (EIS) under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act).

The declaration of the project as a 'significant project' does not indicate support for, nor approval of, the project by the Coordinator-General or the Queensland Government. Rather, it is a requirement for the project to undergo a rigorous EIS process.

Terms of reference (TOR) set out the requirements, both general and specific, that the proponent should address in preparing the EIS. These TOR have been prepared having regard to comments and submissions received on the draft TOR released for public comment over the period of 29 October 2011 to 25 November 2011.

The TOR are divided into two parts:

- Part A—General information and administrative procedures (page 2)
- Part B—Contents of the EIS (page 10)

The Australian Government has determined that the project constitutes a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) (reference number EPBC 2011/5979) due to possible impacts on matters of national environmental significance, and is conducting a separate assessment process.

Part A General information and administrative procedures

1. Project summary

PoTL proposes an expansion of the Port of Townsville to accommodate forecast growth in trade at the port and to address current capacity constraints. The key components of the Townsville Port Expansion project include:

- constructing a new deep water outer harbour, by constructing a new breakwater approximately one kilometre seaward of the existing northern breakwater, and deepening the harbour area
- potentially constructing a new western breakwater to protect the outer harbour, depending on the results of further hydrodynamic modelling to be undertaken as part of the EIS
- constructing up to six additional vessel berths in the new harbour
- deepening the existing approach channels (the Sea and Platypus channels)
- widening the approach channel near the outer harbour entrance
- creating approximately 100 hectares of reclaimed land backing the new berths to provide for bulk cargo storage and rail loop, all formed from material reclaimed from the harbour deepening and from mainland sources. This will include internal bunds to facilitate effective land reclamation
- placing unsuitable and excess dredged material at sea in the approved dredge material placement area in Cleveland Bay
- installing new navigational aids
- constructing new road and rail infrastructure within the project footprint and connecting it to the Townsville eastern access corridor (EAC), currently under construction
- installing new services infrastructure.

Further information on the project can be viewed at:
http://projects.industry.qld.gov.au

2. Project proponent

PoTL is a Queensland Government Owned Corporation whose main function is the control and management of the Port of Townsville.

The contact details for the proponent are:

Melinda Louden
Project Manager
Port of Townsville Limited
PO Box 1031
TOWNSVILLE QLD 4810

tel	+61 7 4781 1619
fax	+61 7 4781 1601
email	mlouden@townsville-port.com.au
web	www.townsville-port.com.au

3. Legislative framework

On 23 May 2011, the Coordinator-General declared the project to be a ‘significant project’ under section 26(1)(a) of the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act). This declaration initiates the statutory environmental impact assessment procedure of Part 4 of the SDPWO Act, which requires the proponent to prepare an EIS for the project.

On the 1 July 2011, the delegate for the Commonwealth Environment Minister determined that the project is a ‘controlled action’ under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act), due to the likely potential impacts on matters of national environmental significance. The controlling provisions under the EPBC Act are:

- sections 12 and 15(a) (World Heritage properties)
- sections 15B and 15(c) (National Heritage places)
- sections 16 and 17(b) (wetlands of international importance)
- sections 18 and 18(a) (listed threatened species and communities)
- sections 20 and 20(a) (listed migratory species)
- sections 23 and 24A (Commonwealth marine areas)
- sections 24B and 24C (Great Barrier Reef Marine Park)

The project will therefore require approval from both the state and Australian governments before it can proceed.

On 21 July 2011, the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) advised that a separate assessment process will be undertaken for this project. The proponent will be required to prepare an EIS addressing both state and Commonwealth requirements (as recorded in the state’s TOR and the Australian Government’s Guidelines for an EIS, respectively). Following this, a separate assessment report will be completed by each jurisdiction.

It should be noted that this TOR only lists the Queensland Government’s requirements.

3.1 State EIS process

The Department of Employment, Economic Development and Innovation (DEEDI) is managing the EIS process on behalf of the Coordinator-General. DEEDI has invited relevant Commonwealth, State and local government representatives, and other relevant authorities, to participate in the process as advisory agencies.

The first step in the impact assessment process is to develop TOR for an EIS for the project. The process involves formulating draft TOR and making them available for public and advisory agency comment. In finalising the TOR, the Coordinator-General considers all written comments on the draft TOR and gives copies of the comments to the proponent.

In accordance with section 32(1) of the SDPWO Act, the proponent must provide an EIS that addresses these TOR. The EIS must be acceptable to the Coordinator-General and be provided within two years of these TOR being finalised (unless the Coordinator-General grants an extension in writing, pursuant to section 32(4)(b) of the SDPWO Act).

Once the Coordinator-General accepts the EIS, the proponent must publicly notify its availability in regional and national newspapers, pursuant to section 33 of the SDPWO Act. The notice will state where copies of the EIS can be viewed or purchased, the submission period and where submissions should be sent. After reviewing the EIS, the Coordinator-General may also require the proponent to provide supplementary information to address specific matters raised during the EIS submission period, pursuant to section 35(2) of the SDPWO Act.

At the completion of the EIS phase, the Coordinator-General will prepare a report (Coordinator-General's report) evaluating the EIS and other relevant material, pursuant to section 35 of the SDPWO Act. The Coordinator-General's report will include an assessment and conclusion about the environmental effects of the project and any associated mitigation measures. Material that will be assessed includes:

- the EIS
- properly made submissions
- other submissions accepted by the Coordinator-General
- any other material the Coordinator-General considers relevant to the project (e.g. a supplementary report to the EIS, comments and advice from advisory agencies and other entities and technical reports).

The Coordinator-General's report will be publicly notified by placing it on the website at **http://projects.industry.qld.gov.au** The report will also be presented to the proponent, the assessment manager under the *Sustainable Planning Act 2009* (Qld) (SPA) and the Australian Government Minister for the Environment, if relevant.

If the project requires an application for a development approval under SPA, the Coordinator-General's report may, under section 39 of the SDPWO Act, state for the assessment manager one or more of the following:

- the conditions that must attach to the development approval
- that the development approval must be for part only of the development

- that the approval must be a preliminary approval only.

Alternatively, under section 39(2) of the SDPWO Act, the Coordinator-General's report must state for the assessment manager that:

- there are no conditions or requirements for the project or
- the application for development approval be refused.

Further, the report must:

- give reasons for the statements (above)
- be given to the assessment manager for the application by the Coordinator-General.

Further to SPA approvals noted above, other approvals or resource allocations are likely to be required under the following*: Coastal Protection and Management Act 1995; Environmental Protection Act 1994,Fisheries Act 1994; Land Act 1994;* and the *Transport Operations (Maritime Safety) Act 1994.*

Note: It is the responsibility of the proponent (or its consultants) to address the requirements of new or amended legislation or policies that come into effect after these TOR have been finalised. This requirement applies regardless of whether or not the legislation or policies are covered in these TOR.

4. EIS objectives

The objective of the EIS is to ensure that all potential environmental, social and economic impacts of the project are identified and assessed and that adverse impacts are avoided or mitigated. Direct, indirect and cumulative impacts must be fully examined and addressed. The project should be based on sound environmental protection and management criteria.

4.1 Audience for EIS

The EIS document should provide information for the following persons and groups, as the project stakeholders:

- **for interested bodies and persons—**a basis for understanding the project, prudent and feasible alternatives, affected environmental values, impacts that may occur and the measures to be taken to mitigate all adverse impacts
- **for affected persons—**that is, groups or persons with rights or interests in land, as defined under section 38 of the EP Act, or water as defined under the *Water Act 2000* (Qld)—an outline of the effects of the proposed project
- **for government agencies and referral bodies—**a framework for decision-makers to assess the environmental aspects of the proposed project with respect to legislative and policy provisions, and based on that information, to make an informed decision on whether the project should proceed or not and if so, subject to what conditions, if any
- **for the proponent—**a mechanism by which the potential environmental impacts of the project are identified and understood, including information to support the development of management measures, such as an environmental management

plan (EMP), to mitigate the effects of adverse environmental impacts of the development.

The proponent is required to address the TOR to the satisfaction of the Coordinator-General before the EIS is made publicly available.

5. EIS guidelines

The EIS should be a self-contained and comprehensive document that provides sufficient information for an informed decision on the potential impacts of the project and the management measures employed to mitigate adverse impacts. The main EIS report needs to be supported by appendices containing relevant data, technical reports and other sources of the EIS analysis. In preparing the EIS, the proponent must:

- use scientific and/or specialist studies to predict environmental impacts and provide details of their methodology, reliability, and any relevant assumptions or scientific judgements
- present all technical data, sources or authority and other information used to assess impacts
- describe and evaluate proposed measures to mitigate and manage identified issues
- describe qualitatively (in as much detail as reasonably practicable) the residual impacts that are not quantifiable
- discuss the criteria adopted in assessing the proposed project and its impacts (e.g. compliance with relevant legislation, policies, standards, community acceptance). Reference should be made to Schedule 4 of the Environmental Protection Act 1994 (EP Act).
- ensure the level of investigation of potential/uncertain impacts on the environment is proportionate to both the severity and the likelihood of those events occurring
- adequately address issues that may emerge during the investigations and preparation of the EIS, undertaking the necessary studies and reporting the results
- address all relevant matters concerning environmental values, impacts and proposed mitigation measures for the first time in the main text of the EIS and not in an appendix or the draft EMP
- define, in plain English, any technical terms used
- present adverse and beneficial effects in quantitative and/or qualitative terms as appropriate.

Where possible, information provided in the EIS should be clear, logical, objective and concise, so that non-technical people may easily understand it. Where appropriate, text should be supported by maps and diagrams and factual information in the document should be referenced. Where applicable, aerial photography and/or digital information (e.g. of project site) should be presented.

The terms ‘describe’, ‘detail’ and ‘discuss’ should be taken to include both quantitative and qualitative matters as practical and meaningful. Should the proponent require any information in the EIS to remain confidential, this should be clearly indicated and separate information should be prepared on these matters.

While every attempt has been made to ensure that these TOR address the major issues associated with projects of this type, the final TOR may not be exhaustive. The EIS should also address such matters if either of the following apply:

- environmental or other studies reveal a matter that was not foreseen when the TOR were prepared
- the Coordinator-General directs the proponent (or its consultants), in writing, to address a matter.

Within these TOR, the term ‘project’ includes all activities undertaken on lands covered by the proposed development, channel and other dredging or dredge material disposal, access required for construction purposes and supporting project infrastructure.

6. Stakeholder consultation

The proponent should undertake a comprehensive and inclusive consultation plan with the stakeholder groups identified in Part A, Section 4 (page 5). Consultation with advisory agencies should be the principal forum for identifying legislation, regulations, policies and guidelines relevant to the project and EIS process.

The public consultation plan should identify broad issues of concern to local and regional community and interest groups and address issues from project planning through commencement, project operations and decommissioning. The consultation plan should identify:

- the types of consultation and communication activities to be undertaken
- timing of activities
- how it will target the stakeholder/community representatives
- integration with other EIS activities and the project development process
- consultation responsibilities
- communication protocols
- reporting and feedback arrangements.

The consultation plan should detail how results of consultation will be considered by the proponent and integrated into the EIS process.

7. EIS format and copy numbers

7.1 General requirements

The EIS should be written in plain English and in a format matching the TOR or include guidelines (preferably as an appendix) describing how the EIS responds to the TOR. Where the project is made up of several components, the EIS should make it clear which project component is being discussed, to allow assessment agencies and other readers to differentiate between the components.

The EIS should contain (as part of the executive summary) a one-page table that explains where readers can find categories of information in the report. This should particularly cover subjects that are presented in multiple places in the EIS.

Include maps, diagrams and other illustrative material in the EIS to assist readers to interpret information.

7.2 Specific format and copy requirements

The proponent must publish the EIS as follows:

(1) On a website that is hosted at the proponent's own expense, in both HTML and portable document format (PDF), as follows:

    (a) pages produced in HTML format must meet the *W3C web content accessibility guidelines* (refer to **www.w3.org**). All cross-references to sections elsewhere in the EIS must be hyperlinked; and all external web links must be hyperlinked.

    (b) PDF files must meet the following requirements:

        (i) no larger than two megabytes in size (documents can be uploaded in sections to meet this requirement)

        (ii) text size and graphics files included in the PDF documents should be of sufficient resolution to facilitate reading and enable legible printing

        (iii) produced in accordance with Adobe's PDF accessibility best practice guides available at: **www.adobe.com/accessibility/products/acrobat/training.html** and meet the following minimum accessibility requirements:

            A. document structure tags and proper read order

            B. searchable text

            C. alternative text descriptions

            D. security that does not interfere with assistive technology.

(2) As a single PDF file on a CD-ROM, DVD or other electronic memory device. This PDF file, which will be read by staff from DEEDI and other assessment agencies, must include:

    (a) bookmarks (links) to all sections of the document (down to five heading levels); and the PDF file must be set to open with the bookmarks showing by default

    (b) active (clickable) internal hyperlinks to any pages, sections or diagrams that have been cross-referenced within the EIS

    (c) active (clickable) hyperlinks to any external websites/documents that have been included in the EIS.

(3) Provide a PDF version of the executive summary, no larger than two megabytes in size, on a CD-ROM or DVD. This file will be placed on the DEEDI website; and the PDF file must meet the accessibility requirements listed under point (1)(b) above.

(4) Provide all maps/diagrams/figures in JPG format, on a separate CD-ROM, DVD or other electronic memory device. All JPG files should be a minimum of 300 dpi.

(5) Limited copies of the EIS should be produced on A4-size paper capable of being photocopied, with maps and diagrams of A4 or A3 size (discuss this requirement with DEEDI staff in the early stages of the EIS process).

8. Contact details

For further inquiries about the EIS process for this project, please contact:

EIS Project Manager—Townsville Port Expansion project
Significant Projects Coordination
Office of the Coordinator-General
PO Box 15517
City East Qld 4002
tel + 61 7 3224 2414
fax+ 61 7 3225 8282
email TPE@deedi.qld.gov.au
web http://projects.industry.qld.gov.au

Part B Contents of the EIS

The EIS should follow the format and content outlined in these TOR; however, changes to the structure can be discussed with the EIS project manager.

1. Executive summary

The executive summary should convey the most important aspects and options relating to the project to the reader in a concise and readable form. It should use plain English, avoid using jargon, be written as a stand-alone document and be structured to follow the EIS. It should be easy to reproduce and distribute on request to interested parties who may not wish to read or purchase the whole EIS.

The executive summary should include:

- project title
- proponent's name and contact details
- a discussion of previous projects undertaken by the proponent, if applicable, and their commitment to effective environmental management
- a concise statement of the aims and objectives of the project
- the legal framework, decision-making authorities and advisory agencies
- an outline of the background and need for the project, including the consequences of not proceeding with the project
- an outline of the alternative options considered and reasons for selecting the proposed development option
- a brief description of the project (pre-construction, construction, operational activities and decommissioning) and the existing environment, using visual aids where appropriate
- an outline of the principal environmental impacts predicted and the proposed environmental management strategies and commitments to minimise the significance of these impacts
- a discussion of the cumulative impacts in relation to social, economic and environmental factors of associated infrastructure projects proposed within the region
- detailed maps of the proposed project location and any other critical figures.

2. Glossary of terms

Provide a glossary of technical terms, acronyms, abbreviations and references.

3. Introduction

Clearly explain the function of the EIS, why it has been prepared and what it sets out to achieve. Include an overview of the structure of the document.

3.1 Project proponent

Describe the proponent's experience, including the nature and extent of business activities, experience and qualifications, and environmental record, including the proponent's environmental, health, safety and community policies.

3.2 Project description

Briefly describe the key elements of the project with illustrations or maps. Summarise any major associated infrastructure requirements. Provide detailed descriptions of the project in Part B, Section 4 (refer to page 15).

3.3 Project rationale

Describe the specific objectives and justification for the project, including its strategic, economic, environmental and social implications, technical feasibility and commercial drivers. Discuss the status of the project in a regional, state and national context. Explain the project's compatibility with relevant policy, planning and regulatory frameworks.

3.4 Relationship to other projects

Describe how the project relates to other infrastructure projects (of which the proponent should reasonably be aware) that have been, are being taken or that have been approved in the area affected by the project (including the Townsville Port Marine Precinct project).

Provide details of how proposed future port activities may impact on the project.

As a result of this assessment, there may be opportunities to co-locate existing or proposed infrastructure, enabling efficiency gains and mitigating environmental and property impacts. Where co-location may be likely, outline opportunities to coordinate or enhance impact mitigation strategies. Discuss the opportunities in sufficient detail to enable the reader to understand the reasons for preferring certain options or courses of action and rejecting others.

3.5 Project alternatives

Describe feasible alternatives including conceptual, technological and locality alternatives to the proposed project and the consequences of not proceeding with the project. Detail the criteria used to determine the alternatives including an economic analysis where appropriate and provide sufficient detail to enable the reader to understand why certain options or courses of action are preferred and why others are rejected (including the 'no action' option). Discuss the interdependencies of the project components, particularly in regard to how any infrastructure requirements relate to the viability of the project.

This information is required to assess why the scope of the project is as it is and to ensure that the environmentally sustainable design principles and sustainable development aspects have been considered and incorporated during the scoping of the project.

3.6 The environmental impact assessment process

3.6.1 Methodology of the EIS

Provide an outline of the environmental impact assessment process, including the role of the EIS in the Coordinator-General's decision-making process. Include information on relevant stages of the EIS development, statutory and public consultation requirements and any interdependencies that exist between approvals sought. The information in this section is required to ensure:

- relevant legislation is addressed
- readers are informed of the process to be followed
- stakeholders are aware of any opportunities for input and participation.

3.6.2 Objectives of the EIS

Provide a statement of the objectives of the environmental impact assessment process. The structure of the EIS can then be outlined and used to explain how the EIS will meet its objectives. The purpose of the EIS is to:

- provide public information on the need for the project, alternatives to it and options for its implementation
- present the likely effects of the project on the natural, social and economic environment
- demonstrate how environmental impacts can be avoided, managed or mitigated and the offsets for any residual impacts
- provide information to formulate the project's EMP.

3.6.3 Submissions

Inform the reader how to properly make submissions and what form the submissions should take. Inform the reader how and when properly made public submissions on the EIS will be addressed and taken into account in the decision-making process. Also indicate any implications for submissions in the event of any appeal processes.

3.7 Public consultation process

The public consultation process should provide opportunities for community involvement and education. It may include interviews with individuals, public communication activities, interest group meetings, production of regular summary information and updates (i.e. newsletters), and other consultation mechanisms to encourage and facilitate active public consultation. The public consultation processes (community engagement) for all parts of the EIS should be integrated.

Outline the methodology that was adopted to:

- identify the stakeholders and how their involvement was facilitated
- identify the processes conducted to date and the future consultation strategies and programs including those during the operational phase of the project

- indicate how consultation involvement and outcomes were integrated into the EIS process and future site activities including opportunities for engagement and provision for feedback and action if necessary.

List the stakeholders consulted during the program and provide details of any meetings held, presentations made and any other consultation undertaken for the EIS process. Provide information about the consultation process that has taken place and the results.

3.8 Project approvals

3.8.1 Relevant legislation and approvals

List and describe Commonwealth, state and local legislation and policies relevant to the planning, approval, construction and operation of the project. Identify all approvals, permits, licences and authorities that will need to be obtained for the proposed project. Outline the triggers for the application of each of these and identify relevant approval requirements.

Commonwealth legislation

Relevant Commonwealth legislation may include, but is not limited to:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1994*
- *Environmental Protection (Sea Dumping) Act 1981* (EPSD Act)
- *Environment Protection and Biodiversity Conservation Act 1999*
- *Great Barrier Reef Marine Park Act 1975* (GBRMP Act)
- *Maritime Transport and Offshore Facilities Security Act 2003*
- *Native Title Act 1993.*

Identify and outline relevant Commonwealth obligations such as:

- protection of World Heritage values
- migratory animals (China–Australia Migratory Bird Agreement (CAMBA), Japan–Australia Migratory Bird Agreement (JAMBA), Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) and Bonn Convention)
- biodiversity
- climate
- wetlands of international importance (Ramsar).

Commonwealth approvals

Identify and outline Commonwealth approvals required including, but not limited to:

- approval, under sections 131(1) and 133 of the EPBC Act, of the proposed action for each of the applicable controlling provisions (SEWPaC)
- approval to dredge within the boundary of the Great Barrier Reef Marine Park under the GBRMP Act (Great Barrier Reef Marine Park Authority)
- permit to dispose of dredge material at sea under the EPSD Act (SEWPaC).

Also, identify and outline relevant Commonwealth obligations relating to the protection of World Heritage values, National Heritage values, declared Ramsar wetlands, listed threatened species and ecological communities, migratory animals (China–Australia Migratory Bird Agreement (CAMBA), Japan–Australia Migratory Bird Agreement (JAMBA), Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) and Bonn Convention) and biodiversity.

Queensland legislation

Where relevant, refer to applicable Queensland legislation, which may include but is not limited to:

- *Aboriginal Cultural Heritage Act 2003*
- *Coastal Protection and Management Act 1995* (Coastal Act)
- *Environmental Protection Act 1994*
- *Fisheries Act 1994*
- *Land Act 1994*
- *Land Protection (Pest and Stock Management) Act 2002*
- *Marine Parks Act 2004*
- Maritime Safety Queensland Regulation 2002
- *Mineral Resources Act 1989*
- *Nature Conservation Act 1992*
- *Petroleum and Gas (Production and Safety) Act 2004*
- *Queensland Heritage Act 1992*
- *State Development and Public Works Organisation Act 1971* (SDPWO Act)
- *Sustainable Planning Act 2009*
- *Transport Infrastructure Act 1994*
- *Transport Operations (Marine Pollution) Act 1995*
- *Transport Operations (Marine Safety) Act 1994*
- Transport Operations (Maritime Safety) Regulation 2004
- *Transport Operations (Road Use Management) Act 1995*
- *Transport Planning and Coordination Act 1994*
- *Vegetation Management Act 1999*
- *Waste Reduction and Recycling Act 2011*
- *Water Act 2000.*

Queensland approvals

Key Queensland approvals required, and to be considered in the EIS process include:

- quarry allocation under the Coastal Act
- permit for development within a coastal management district, that is:
  - disposal of dredged spoil or other solid waste material in tidal water—Coastal Act
  - development permit for tidal works—Coastal Act
  - reclaiming land under tidal water—Coastal Act

- development permit for operational work that is the removal, destruction or damage of a marine plant—*Fisheries Act 1994*
- permit for Resource Entitlement under the *Land Act 1994*
- permit to dredge the channel extension area where it falls within the boundary of a State Marine Park (i.e. the Great Barrier Reef Coast Marine Park)—*Marine Parks Act 2004*
- material change of use of a premises for an environmentally relevant activity (ERA)—ERA16: Extractive and screening activities (dredging)—EP Act
- road impact assessment (including transport impact assessment) and road-use management plan for development on land not contiguous to a state-controlled road—TI Act.

Identify the relevant approval agency for each of the approvals required.

Identify existing approvals that are currently held by the Port that relate to those being sought by this development. In particular, clearly identify existing approvals that are referred to for sections of the development and whether amendments will be sought to these existing approvals.

3.8.2 Relevant plans

Outline the project's consistency with the existing national, state, regional and local planning framework that applies to the project location. Refer to all relevant statutory and non-statutory plans, planning policies, guidelines, strategies and agreements.

4. Description of the project

Describe the project through its lifetime of pre-construction, construction, operation and potentially decommissioning. The project description also allows further assessment of which approvals may be required and how they may be managed through the life of the project.

4.1 Overview of the project

Provide an overview of the project to put it into context. Include:

- a rationale explaining the selection of the preferred operating scenario, including details such as cost, environmental impacts, and the operational efficiencies of each option
- a description of the key components of the project including the use of text and design plans where applicable
- a summary of any environmental design features of the project
- the expected cost, timing, and overall duration of the project, including details of and justification for, any staging of the development.

4.2 Location

Describe, using maps at suitable scales, the regional and local context of the project and all associated infrastructure. Provide real property descriptions of the project. Maps should show the precise location of the project area, in particular the:

- location and boundaries of current or proposed land tenures that the project area is or will be subject to, and details of the ownership of that land
- location, size and boundaries of the project footprint, including easement widths and access requirements
- location and size of any proposed buffers surrounding the working areas (for dredging, construction and operation)
- location of infrastructure relevant to the project, including but not limited to, the state-controlled road network, local roads and railways (including the Eastern Access Corridor road and railway alignments), marine infrastructure such as navigation aids and electricity infrastructure
- location of features such as waterways (e.g. rivers, streams, creeks, other water bodies and wetlands) and shorelines, significant vegetation and navigation channels
- location of any proposed site offices and accommodation sites
- extent of strategic port land and future strategic port land
- views to and from the site
- the relationship to World Heritage Areas and State marine waters.

4.3 Construction phase

Provide a detailed staging plan and approximate timeframes for the project’s construction activities.

Provide an estimate of the number and roles of persons to be employed during the construction phase of the project.

Provide the following information on the pre-construction, construction and commissioning of the project including detailed plans, drawings and maps where appropriate. Reference should be made to building and engineering standards for tidal works.

4.3.1 Pre-construction activities

Describe all pre-construction activities, including nature, scale and timing of :

- land acquisitions required, be it in full or as easements, leases etc.
- vegetation clearing
- site access
- earthworks
- interference with watercourses and floodplain areas, including wetlands
- site establishment requirements for construction facilities, including access restriction measures and expected size, source and control of the construction

workforce accommodation, services (water, sewage, communication, power, recreation) and safety requirements

- temporary works
- upgrade, relocation, realignment, deviation of or restricted access to roads and other infrastructure (including electricity infrastructure)
- equipment to be used.

4.3.2 Dredging and reclamation

Describe the location and extent of the proposed reclamation, the source(s) of fill and the likely construction methodologies. Information provided in this section should be in accordance with:

- *Reclaiming land under tidal water* (Department of Environment and Resource Management 2010f)
- *Allocation of quarry material* (Department of Environment and Resource Management 2010a)
- reference to relevant policies of the *Queensland Coastal Plan* (Department of Environment and Resource Management 2012a) relating to reclaiming land
- *Guideline: Disposing of material in tidal water* (Department of Environment and Resource Management 2010b)
- *Guideline: maintenance dredging undertaken by a port authority – ERA 16* (Department of Environment and Resource Management 2010c)
- Operational policy – material change in intensity or scale for an environmentally relevant activity (Department of Environment and Resource Management 2011a).

Address the following requirements for construction and maintenance dredging:

- Describe and map the location, area and volume of dredging required, differentiating capital from historical or current dredge areas. Provide maps and map overlays indicating areas that have been disturbed and those areas that have not been disturbed historically.
- The boundary of land to be reclaimed by metes and bounds, tied to real property boundaries, the location of the line of mean high water spring tide, highest astronomical tide and coastal management district (includes all land contained within erosion prone areas) in relation to the reclamation area.
- Existing levels of the land and proposed final levels of reclamation in relation to the Australian Height Datum (AHD).
- Method of protecting seaward boundary of the reclamation from erosion by the sea.
- Details of estimated commencement, completion, rate of progress and estimated cost of the reclamation.
- Provide details of the grading and composition of likely dredged materials, including potential contaminants and/or indurated (hardened or cemented) layers and the methods and sites for disposal via land or sea.

- Describe proposed disposal methods and locations, including any off-shore options for disposing of maintenance dredge spoil of possibly varying constituencies to be designated dredge spoil disposal/rehandling areas.
- Quantify the expected amount of maintenance dredging required, the expected frequency of maintenance dredging and the expected composition of dredged material.
- Describe provisions for maintenance dredging in the event of a major cyclone, flood or other extreme conditions.
- Provide details of the dredging methods, including timing of capital dredging and dredge material disposal, which would avoid or minimise impacts on, birds, marine mammals, turtles and fish, including migrations and marine plant propagation
- Provide details of the current approved dredged disposal area e.g. capacity and ability of the site to accommodate dredge material from the proposed development.

4.3.3 Structures

Describe the location and extent of the proposed breakwater and the revetment structures and the likely construction methodologies.

Describe all structures, including:

- locations and dimensions of buildings and marine infrastructure associated with the port expansion
- the likely interface of the port expansion infrastructure with the future port road and rail infrastructure
- the likely construction methodologies
- earthworks, including fill and rock that may need to be imported to the project site, and identifying relevant licensed quarries
- pollution control methods that will be used to prevent pollution entering marine areas during the construction
- modifications that may be needed to accommodate climate change and sea level rise
- reference should be made to DERM policies:
  - Assessment of coastal revetment alignment (2010d)
  - Building and engineering standards for tidal works (2010e)

Information provided should address current legislative policy relating to erosion protection structures.

4.3.4 Other construction activities

Describe all the construction elements of the project, providing details of:

- an indicative construction timetable, including expected commissioning and start-up dates and hours of operation
- major work programs for the construction phase, including an outline of construction methodologies

- construction inputs, handling and storage including an outline of potential locations for source of construction materials
- major hazardous materials to be transported, stored and/or used on site, including environmental toxicity data and biodegradability
- clean-up and restoration of areas used during construction, including camp site(s) and storage areas, if applicable.

4.3.5 Other project-specific infrastructure

Describe:

- all other infrastructure required to be constructed, upgraded, relocated or decommissioned for the construction and/or operation of the project, such as resource extraction areas, access roads and haulage routes, power supply, connection to sewerage or water supply
- the design and construction standards to be met (e.g. waterway crossings should be designed to meet the requirements of the *Fisheries Act 1994* (Qld) and in consultation with DEEDI staff)
- alternative approaches or the opportunity to obtain materials from alternative sources.

4.3.6 Commissioning

Describe the commissioning process including the associated environmental impacts.

4.4 Operation phase

Describe the location and nature of the processes to be used and provide supporting maps, diagrams and artist's impressions as required. Provide full details of the operation for all elements of the project, including:

- a description of the nature and description of all key operational activities (including expected plant and equipment)
- the capacity of the project equipment and operations
- maintenance dredging requirements
- a description of arrangements for long-term maintenance of the marine facilities, including details of the responsible parties
- details of the predicted usage of the marine facilities, including opportunities for recreational and public usage
- detailed requirements of vessel operations, including tugs, pilotage, channel closures, quarantine and security arrangements etc.
- estimated numbers and roles of persons to be employed during the operational phase of the project
- opportunities for future expansion.

4.5 Associated infrastructure

Detail, with the aid of concept and layout plans, requirements for new infrastructure or upgrading/relocating existing infrastructure to service the project. Consider infrastructure such as transportation (road/rail/air/ship), water supply, energy supply, telecommunications, stormwater, waste disposal and sewerage.

4.6 Decommissioning and rehabilitation

This section should present general strategies and methods for decommissioning and rehabilitation of the project should it ever be required.

5. Environmental values and management of impacts

Detail the environmental protection and mitigation measures incorporated in the planning, construction, rehabilitation, commissioning, operations and decommissioning of all facets of the project. Measures should prevent, or where prevention is not possible, minimise environmental harm and maximise environmental benefits of the project. Identify and describe preferred measures in more detail than other alternatives.

The protection and enhancement of human health during construction and operation of the project must be described.

The objectives of the following subsections are to:

- describe the existing environmental values of the area that may be affected by the project, using background information and/or new studies to support statements (include reference to all definitions of environmental values set out in relevant legislation, policies and plans)
- describe the potential adverse and beneficial impacts of the project on the identified environmental values and the measures taken to avoid, minimise and/or mitigate those impacts
- describe any cumulative impacts on environmental values caused by the project, either in isolation or in combination with other known existing or planned projects
- present objectives, standards and measurable indicators that protect the identified environmental values
- examine viable alternative strategies for managing impacts (present and compare these alternatives in view of the stated objectives and standards to be achieved)
- discuss the available techniques to control and manage impacts in relation to the nominated objectives.

Where negative impacts of the project cannot be avoided or adequately minimised or mitigated, present proposals to offset impacts in accordance with the Queensland Government Environmental Offsets Policy (Environmental Protection Agency 2008b).

The EIS should follow the format and content outlined in these TOR; however, changes to the structure can be discussed with the EIS project manager. The mitigation measures, monitoring programs etc., identified in this section of the EIS should be used to develop the EMP for the project. Refer to Part B, Section 10 (page 59).

5.1 Climate, natural hazards and climate change

Describe the climatic conditions that may affect management of the project. This includes a description of the vulnerability of the project area to seasonal conditions, extremes of climate (e.g. cyclones) and natural or induced hazards (including bushfires) and climate change. Reference should also be made to the State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (Department of Local Government and Planning & Department of Emergency Services 2003). Provide a risk assessment (as part of the requirements of Part B, Subsection 8.1 of these TOR) and management plan detailing these potential climatic threats to the construction, and operation of the project. Include the following:

- a risk assessment of changing climate patterns that may affect the viability and environmental management of the project
- the preferred and alternative adaptation strategies to be implemented
- commitments to working cooperatively, where practicable, with government, other industry and other sectors to address adaptation to climate change.

Address the most recent information on potential impacts of climatic factors in the appropriate sections of the EIS.

Specific storm surge requirements are addressed in section 5.4 below.

5.1.1 Flood plain management

Due to the location of the site, a comprehensive flood study should be included in the EIS that:

- quantifies flood impacts on properties surrounding and external to the project site from redirection or concentration of flows
- identifies potential variation of increased flood levels, increased flow velocities or increased time of flood inundation as a result of the development.

The flood study should address any requirements of local or regional planning schemes for flood affected areas. The study report should include details of all calculations along with descriptions of base data, any potential for loss of flood plain storage, and triangulated surface meshes produced in terrain modelling software. Reference must be made to any studies undertaken by the local council in relation to flooding.

Reference should be made to Temporary State Planning Policy 2/11: Planning for stronger, more resilient floodplains (Queensland Reconstruction Authority 2011).

5.2 Land

Detail the existing land environment values for all areas associated with the project. Describe the potential for the construction and operation of the project to change existing and potential land uses of the project sites and adjacent areas (on and off Port land).

5.2.1 Scenic amenity and lighting

Description of environmental values

Describe, in general terms, the existing character of the landscape and the general impression that would be obtained while travelling through and around it. Outline existing landscape features, panoramas and views that have, or could be expected to have, value to the community. Include information such as maps and photographs, particularly where addressing the following issues:

- major views, view sheds, outlooks, and features contributing to the amenity of the area, including assessment from private residences
- focal points, landmarks, waterways and other features contributing to the visual quality of the area and the project site(s)
- character of the local and surrounding areas including vegetation and land use.

Reference should be made to the *Queensland Coastal Plan: State Planning Policy for Coastal Protection Guideline* (Department of Environment and Resource Management 2011e) (Annex 3—Determining scenic preference in the coastal zone).

Include any relevant World Heritage and National Heritage values of the area.

Potential impacts and mitigation measures

Describe the potential beneficial and adverse impacts of the project on landscape character and visual qualities of the site and the surrounding area. Address the local and broader visual impacts of the project buildings, other structures, and breakwater. This should include views from:

- places of residence, work, and recreation
- road, cycle and walkways
- the air
- other known vantage points day and night (e.g. Castle Hill)

during all stages of the project as it relates to the surrounding landscape.

Use sketches, diagrams, computer imaging/simulation and photos where possible to portray the near and far views of the completed structures and their surroundings from visually sensitive locations.

Detail the measures to be undertaken to mitigate or avoid identified adverse impacts.

Lighting

Provide an assessment of all potential impacts of the project’s lighting, during all stages, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid, such as:

- the visual impact at night
- night operations/maintenance and effects of lighting on marine and terrestrial fauna and residents

- the potential impact of increased vehicular traffic
- changed habitat conditions for nocturnal fauna and associated impacts.

5.2.2 Topography, geology and soils

Description of environmental values

Provide maps locating the project in state, regional and local contexts. The topography should be detailed with contours at suitable increments, shown with respect to AHD. Include significant features of the landscape and topography, and accompanying comments on the maps.

Provide a description, map and a series of cross-sections of the geology of the project area relevant to the project components. Describe the geological properties that may influence ground stability, occupational health and safety, or the quality of stormwater leaving any area disturbed by the project. In locations where the age and type of geology is such that significant fossil specimens may be uncovered during construction/operations, address the potential for significant finds.

A soil survey of the sites affected by the project must be conducted at a suitable scale, with particular reference to the physical and chemical properties of the materials that will influence erosion potential, stormwater run-off quality, rehabilitation and agricultural productivity of the land. Provide information on soil stability and suitability for construction of project facilities.

Assess the potential for acid sulfate soils in accordance with:

- Queensland Acid Sulfate Soil Technical Manual (refer to: **www.derm.qld.gov.au/land/ass/products.html**)
- State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (Department of Natural Resources and Mines & Department of Local Government and Planning 2002a)
- *State Planning Policy 2/02 Guideline: Acid Sulfate Soils* (Department of Natural Resources and Mines & Department of Local Government and Planning 2002b).

Soils should be described and mapped at a suitable scale and described according to the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al. 2008) and *Australian soil classification* (Isbell & CSIRO 2002). Undertake an appraisal of the depth and quality of useable soil.

Provide a map and description of:

- the location of key tidal planes such as:
  - the Highest Astronomical Tide
  - Mean High Water Spring Tide
  - Mean High Water Neap Tide
  - Mean Sea Level
  - Mean Low Water Neap Tide
  - Mean Low Water Spring Tide
  - Lowest Astronomical Tide.

- the bathymetry of the project area and surrounds
- relevant coastal geomorphology.

Potential impacts and mitigation measures

Provide details of any potential impacts to the topography or geomorphology associated with the project and proposed mitigation measures, including:

- a discussion of the project in the context of major topographic features and any measures taken to avoid or minimise impact to such, if required
- the objectives to be used for the project in any re-contouring or consolidation, rehabilitation, landscaping, and fencing.

Identify the possible soil erosion rate for all permanent and temporary landforms and describe the techniques used to manage the impact. Include an assessment of likely erosion effects, especially those resulting from removing vegetation, and constructing retaining walls both on-site and off-site for all disturbed areas.

Identify all soil types and outline the erosion potential (both wind and water) and erosion management techniques to be used. Provide details of an erosion-monitoring program (including rehabilitation measures for erosion problems identified during construction), and detail acceptable mitigation strategies.

Summarise methods proposed to prevent or control erosion with regard to:

- the *Soil Erosion and Sediment Control—Engineering Guidelines for Queensland Construction Sites* (Institution of Engineers Australia 1996)
- the *Urban Stormwater Quality Planning Guidelines 2010* (Department of Environment and Resource Management 2010h)
- preventing soil loss in order to maintain land capability/suitability
- preventing degradation of local waterways.

Discuss the potential for acid generation through disturbance of acid sulfate soils during earthworks and construction, and propose measures to manage soils and mitigate impacts for all site earthworks and construction activities. Should action criteria be triggered by acid generating potential as a result of testing, outline management measures in an acid sulfate soils management plan prepared in accordance with:

- Queensland Acid Sulfate Soil Technical Manual (refer to: **www.derm.qld.gov.au/land/ass/products.html#guidelines**)
- the requirements of State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (Department of Natural Resources and Mines & Department of Local Government and Planning 2002a)
- *State Planning Policy 2/02 Guideline: Acid Sulfate Soils* (Department of Natural Resources and Mines and Department of Local Government and Planning 2002b).

5.2.3 Land contamination

Description of environmental values

Include:

- mapping of any areas listed on the Environmental Management Register or Contaminated Land Register under the EP Act
- identification of any potentially contaminated sites not on the registers whether or not remediation is required
- a description of the nature and extent of contamination at each site.

Potential impacts and mitigation measures

Discuss the management of any contaminated land and potential for contamination from construction, commissioning and operation, in accordance with the Department of Environment and Resource Management's *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland* (Department of Environment 1998) and the National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cwlth).

Describe strategies and methods to be used to prevent and manage any land contamination resulting from the project, including the management of any acid generation or management of chemicals and fuels to prevent spills or leaks.

State any intentions concerning the classification of land contamination after project completion.

5.2.4 Land use and tenure

Description of environmental situation

Identify, with the aid of maps:

- land tenure, including reserves, tenure of special interest such as protected areas and forest reserves, existing and proposed gas infrastructure, water pipelines, power infrastructure (above and underground) and transport corridors, including local roads, state-controlled roads and rail corridors
- existing land uses and facilities surrounding the project
- distance of the project from residential and recreational areas
- location of the project in relation to environmentally sensitive areas.

Potential impacts and mitigation measures

Detail the potential for the construction and operation of the project to change existing and potential land uses of the project site and adjacent areas. Describe the following:

- impacts on surrounding land uses and human activities and strategies for minimisation, such as:
  - – key resource areas (refer to State Planning Policy 2/07: Protection of Extractive Resources (Department of Mines and Energy 2007a) and *State Planning Policy 2/07 Guideline: Protection of Extractive Resources* (Department of Mines and Energy 2007b))

  - residential and industrial uses
- possible effect on town planning objectives and controls, including local government zoning and strategic plans
- constraints to potential developments and possibilities of rezoning adjacent to the development area
- management of the immediate environs of the project including construction buffer zones
- the potential native title rights and interests likely to be impacted upon by the project and the potential for managing those impacts by an Indigenous land use agreement or other native title compliance outcomes
- proposed land use changes in any areas of high conservation value and information on how easement widths and vegetation clearance in sensitive environmental areas will be minimised
- potential issues involved in proximity and/or co-location of other current or proposed infrastructure services (e.g. rail corridor)
- any land units requiring specific management measures.

5.3 Transport

Present the transport assessment in separate reports for each project-affected mode (road, rail, air and sea) as appropriate. These assessment reports should provide sufficient information to allow an independent assessment of how existing transport infrastructure will be affected by project transport at the local and regional level.

5.3.1 Existing infrastructure

Describe the extent, condition and capacity of the existing transport infrastructure on which the project will depend. Particular mention must be made of the interaction with the Townsville Port Access Transport Corridor. This will include identification and analysis of construction measures for the interface between the port and the access corridor (road and rail). This should also demonstrate how the integrity of the road/rail corridor will be maintained.

Describe the project's impact on local and state-controlled road networks. Include an overview map(s) that shows the project's relationship with current and future local and state-controlled road networks. Include in the map(s) the location of construction activities and access locations (existing and proposed).

Also describe the existing rail network and interaction of the project with the rail corridor and infrastructure with maps at an appropriate scale.

5.3.2 Transport tasks and routes

Describe:

- expected volumes of project inputs and outputs of transported raw materials, wastes, hazardous goods, finished products for all phases of the project
- how identified project inputs and outputs will be moved through the transport network (volume, composition, trip timing and routes)

- traffic generated by workforce personnel including visitors (volume, composition, timing and routes)
- likely heavy and oversize/indivisible loads (volume, composition, timing and routes), highlighting any vulnerable bridges and structures along proposed routes.

5.3.3 Potential impacts and mitigation measures

Impact assessment reports should include details of the adopted assessment methodology (for impacts on roads: the road impact assessment report in general accordance with the *Guidelines for Assessment of Road Impacts of Development* (Department of Main Roads 2006).

Assess project impacts on:

- local and state road networks
- capacity, safety (including level crossing safety in consultation with Queensland Rail), local amenity, efficiency and condition of transport operations, services and assets (from either transport or project operations)
- walking and cycling paths
- possible interruptions to transport operations
- the natural environment within the jurisdiction of an affected transport authority (e.g. road and rail corridors)
- the nature and likelihood of product-spill during transport, if relevant
- driver fatigue for workers travelling to and from regional centres and key destinations
- any existing or proposed strategies for public passenger transport and active transport and address, where relevant, requirements of Part 2A of the *Transport Planning and Coordination Act 1994* (Qld)
- access to transport for people with a disability.

5.3.4 Infrastructure alterations

Detail:

- any proposed alterations or new transport-related infrastructure and services required by the project (as distinct from impact mitigation works)
- construction of any project-related plant and utilities, within or impacting on the jurisdiction of any transport authority.

5.3.5 Transport management strategies

Discuss and recommend how identified impacts will be mitigated so as to maintain safety, efficiency and condition of each mode. These mitigation strategies are to be prepared in close consultation with relevant transport authorities and consider those authorities' works programs and forward planning.

Findings of studies and transport infrastructure impact assessments should be an input into preparing a transport management plan.

Road/rail management planning

Outline:

- consideration of any mitigation works for road/rail corridors, including consultation with relevant road/rail managers and strategies for any associated works
- strategies to minimise the effects of project transport on existing and future public road or rail corridors and rail level crossing safety
- steps to be taken to prevent access from public roads/rail corridors to the project sites
- strategies to maintain safe access to public road/rail reserves to allow road/rail/pipeline maintenance activities
- process for decommissioning any temporary access to road/rail reserves, e.g. stockpile sites

Findings of studies and transport infrastructure impact assessments should be an input into preparing a draft road-use management plan. Conditions of approval for transport management impacts should also be detailed in the EMP.

Shipping management planning

Develop management plans in accordance with the *Maritime Safety Queensland Guidelines for Major Development Proposals* (Department of Transport and Main Roads 2010).

The Regional Harbour Master (RHM) should be consulted on maritime issues relating to the movement and loading of tankers and any barge operations. The EIS should discuss the results of the consultation.

Describe current vessels utilising the port and in the Commonwealth Marine Area, their size, shipping movements, anchorages, access to/from the port and navigational arrangements.

In regard to increased shipping volumes, the following should be specifically addressed:

- potential for introduction of exotic organisms/marine pests from increased shipping and relevant investigation screening methodology
- ballast water management arrangements—including Australian Quarantine and Inspection Service mandatory arrangements and the port’s contingency planning
- management of ship waste, in particular quarantine waste, domestic garbage, oil and sewage
- risk of spills and their management
- potential foreshore damage caused by tanker and tug activities
- potential for increased vessel strike to marine species
- potential impacts on existing shipping activity and navigable channels
- potential use of the Great Barrier Reef World Heritage Area
- routes of ships in transit through port waters and the aligned infrastructure such as navigational aids

- in consultation with Maritime Safety Queensland, the RHM and other relevant agencies as required prepare:
  - an aids to navigational management plan
  - a vessel traffic management plan
  - a ship-sourced pollution management plan and
  - a cyclone contingency plan.

Consider also the potential of the proposal to impact on recreational craft.

5.4 Coastal environment

Describe the existing coastal environment that may be affected by the project in the context of coastal values identified in the Queensland State of the Environment reports and environmental values as defined by the EP Act and environmental protection policies.

Identify actions associated with the project that are assessable development within the coastal zone and will require assessment under the provisions of the *Coastal Protection and Management Act 1995* (Coastal Act).

Assess the project's consistency with the relevant policies of the *Queensland Coastal Plan*, including the State Planning Policy 3/11: Coastal Protection (Department of Environment and Resource Management 2011e) and the State Policy for Coastal Management (Department of Environment and Resource Management 2012b).

5.4.1 Hydrodynamics and sedimentation

Description of environmental values

Assess the physical and chemical characteristics of sediments within the littoral and marine zone of Cleveland Bay adjacent to the project area.

Describe the physical processes of coastal environment related to the project including:

- waves
- currents
- tides
- storm surges
- freshwater flows
- the key influencing factors of cyclones and other severe weather events and their interaction in relation to the assimilation and transport of pollutants entering marine waters from, or adjacent to, the project area.

Describe the environmental values of the coastal resources of the affected area in terms of the physical integrity and morphology of landforms created or modified by coastal processes.

Describe the tidal hydrodynamics of the project area and the adjoining tidal waterways in terms of water levels and current velocities and directions at different tidal states.

Undertake two- and/or three-dimensional modelling. Provide details of water levels and flows associated with historical and predicted storm surges.

Describe the wave climate in the vicinity of the project area and the adjacent beaches including inter-annual variability and details of historical and predicted extreme wave conditions generated by tropical cyclones or other severe storm events.

Describe the hydrology of the area and the adjacent catchments of the rivers and the associated freshwater flows within the study area and the adjoining tidal waterways in terms of water levels and discharges. Detail the interaction of freshwater flows with different tidal states, including storm tides. Describe inter-annual variability and details of historical and predicted floods including extent, levels and frequency. Flood studies should include a range of annual exceedence probabilities for affected waterways, where data permits.

Describe the amount of beach sand movement and or loss, adjacent to the project area that may be affected by the project.

Potential impacts and mitigation measures

Describe the potential changes to the hydrodynamic processes and local sedimentation within Cleveland Bay and adjoining waterways resulting from the construction and operation of the project. This should include:

- impacts on tidal flows and water levels
- changes to sediment transport patterns, including the potential of the proposal to impact on bank erosion and/or bed degradation within adjacent waterways
- Any additional effects of climate change and sea level rise

This assessment should also discuss the potential impacts associated with extreme events such as storm tide flooding which may result from changes to bathymetry and coastline as a result of the project. This must include an assessment of the vulnerability of the project to storm tide flooding and the potential of the project to affect vulnerability to storm tide flooding on adjacent properties.

Describe the impact and relevant strategies of long swell wave energy reflection on dredging and breakwater protection.

Predict the likely changes to hydrodynamics (including water levels, currents, wave conditions and freshwater flows) and sedimentation in the project area (including Cleveland Bay and the banks of the Ross River) due to climate change.

When assessing the hydrodynamics of the area and movement of sediment along the coast, consider coastal processes such as erosion and accretion at adjacent locations including The Strand, Rowes Bay and Pallarenda. Determine the potential sand loss and the amount to renourish beaches adjacent to the project area quantified in terms of tonnes per annum.

Discuss any impacts on upstream flood risk in the Ross River and any mitigation measures that may be required.

5.4.2 Water quality

Description of environmental values

Provide baseline information on water quality of coastal waters. This information should include (but is not necessarily be limited to) general physical chemical water quality parameters such as dissolved oxygen, pH, heavy metals, nutrients, temperature, salinity, oil in water and turbidity. For coastal areas potentially affected by sediment run-off or dredging, suspended solids concentration and turbidity should also be included.

Discuss the interaction of freshwater flows from the Ross River and Ross Creek with coastal waters and the significance of this in relation to marine flora and fauna adjacent to the project area.

Baseline water quality values should be collected at site-specific locations with the precinct. The description of baseline water quality should include a discussion on blue green algae (*Trichdesmium sp.*) blooms, their frequency within the bay as well as causal factors.

Describe the environmental values of coastal waters in the affected area in terms of:

- variability associated with the local wind climate, seasonal factors, freshwater flows and extreme events
- values identified in the EPP (Water) 2009
- reference should be made to the draft water quality objectives, as identified in the *Black Ross (Townsville) Water Quality Improvement Plan* (Townsville City Council 2010).

Potential impacts and mitigation measures

Define and describe the water quality objectives and practical measures for protecting, mitigating or enhancing coastal environmental values. This includes how nominated quantitative standards and indicators may be achieved, and how the achievement of the water quality objectives will be monitored, audited and managed. The potential environmental harm caused by the project on coastal resources and processes shall be described in the context of controlling such effects. Refer to the following:

- State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (Department of Natural Resources and Mines & Department of Local Government and Planning 2002a)
- *Queensland Coastal Plan* (Department of Environment and Resource Management 2012a)
- *Restoration of fish habitats: Fisheries guidelines for marine areas— Fish Habitat Guideline FHG 002* (Hopkins, White & Clarke 1998).

Specific issues to be addressed include:

- the water quality objectives used (including how they were developed), and how predicted activities will meet these objectives (refer to the *Queensland Water Quality Guidelines 2009* (Department of Environment and Resource Management 2009) and *The Australian and New Zealand Guidelines for Fresh and Marine Water*

Quality (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000)

- potential threats to the water quality and sediment quality of the coastal environment within the project footprint, specifically associated with constructing and operating the facilities
- reference should be made to the draft water quality objectives, as identified in the *Black Ross (Townsville) Water Quality Improvement Plan* (Townsville City Council 2010).

This assessment shall consider, at minimum:

- dredging and dredge material disposal, including disturbance of fine-grained sediments and contaminated material
- impacts of construction of the breakwater and revetment structures
- potential accidental discharges of contaminants during construction and operation of the marine precinct
- release of contaminants from marine structures and vessels, including potential for introducing marine pests
- stormwater run-off from the marine precinct facilities and associated infrastructure
- flooding of Ross River and Ross Creek
- other extreme events.

Describe strategies for protecting Ramsar wetlands; and discuss any obligations imposed by state or Commonwealth legislation or policy, or international treaty obligations (i.e. JAMBA, CAMBA and ROKAMBA).

5.4.3 Sediment quality and dredging

Provide baseline information on marine sediments and sediment quality in the area likely to be disturbed by dredging or vessel movements, including contaminants (such as heavy metals, nutrients and pesticides), the presence of fines and/or indurated layers and acid sulfate potential. Present this information as a map of sediment types based on their physical and chemical properties and include depth profiles.

Assessment of marine sediments should be undertaken in accordance with the *National Assessment Guidelines for Dredging* (Commonwealth of Australia 2009).

Detail specific measures to maintain sediment quality to nominated quantitative standards within the project and surrounding areas, particularly where future maintenance dredging may be required.

Comment on the choice of the disposal site in relation to coastal management outcomes, having regard to the nature of the spoil, cost of alternatives and potential impacts on coastal resources and their values.

Describe provisions for dredge material disposal and associated impacts on sediment quality. Discuss disposal options for contaminated material, if required. This must include a description of the arrangements to be put in place for long-term (20 years) dredge material disposal including details of proposed material placement areas.

5.5 Nature conservation

Detail the existing nature conservation values that may be affected by the proposal. Describe the environmental values in terms of:

- integrity of ecological processes, including habitats of rare and threatened species
- conservation of resources
- biological diversity, including habitats of rare and threatened species
- integrity of landscapes and places including wilderness and similar natural places
- aquatic and terrestrial ecosystems.

Survey effort should be sufficient to identify, or adequately extrapolate, the floral and faunal values over the range of seasons, particularly during and following a wet season. The survey should account for the ephemeral nature of watercourses traversing the proposal area, and seasonal variation in fauna populations.

Wherever possible, seek the involvement of the local Indigenous community in conducting field observations and survey activities to identify the traditional and contemporary Indigenous uses of species.

Also outline the proposed strategies to avoid, or minimise and mitigate, impacts on the identified values within the project's footprint.

Identify key flora and fauna indicators for ongoing monitoring.

5.5.1 Sensitive environmental areas

Description of environmental values

Identify areas that are environmentally sensitive in proximity to the project on a map of suitable scale. This should include areas classified as having national, state, regional or local biodiversity significance, or flagged as important for their integrated biodiversity values. Refer to both Queensland and Commonwealth legislation and policies on threatened species and ecological communities.

Areas regarded as sensitive with respect to flora and fauna have one or more of the following features and should be identified and mapped:

- important habitats of species listed under the *Nature Conservation Act 1992* (Qld) (NC Act) and/or EPBC Act as presumed extinct, endangered, vulnerable or rare
- regional ecosystems listed as 'endangered' or 'of concern' under state legislation, and/or ecosystems listed as presumed extinct, endangered or vulnerable under the EPBC Act
- good representative examples of remnant regional ecosystems or regional ecosystems that are described as having 'medium' or 'low' representation in the protected area estate as defined in the Regional Ecosystem Description Database (REDD), available at **www.derm.qld.gov.au**
- sites listed under international treaties such as Ramsar wetlands and World Heritage areas
- sites containing near-threatened or bio-regionally significant species or essential, viable habitat for near-threatened or bio-regionally significant species

- sites in, or adjacent to, areas containing important resting, feeding or breeding sites for migratory species of conservation concern listed under the Convention of Migratory Species of Wild Animals, and/or bilateral agreements between Australia and other countries
- sites adjacent to nesting beaches, feeding, resting or calving areas of species of special interest (e.g. marine turtles, dugongs and cetaceans)
- sites containing common species that represent a distributional limit and are of scientific value or that contain feeding, breeding, resting areas for populations of echidna, koala, platypus and other species of special cultural significance
- sites of high biodiversity that are of a suitable size or with connectivity to corridors/protected areas to ensure survival in the longer term; such land may contain:
  - natural vegetation in good condition or other habitat in good condition (e.g. wetlands)
  - degraded vegetation or other habitats that still support high levels of biodiversity or act as an important corridor for maintaining high levels of biodiversity in the area
- a site containing other special ecological values (e.g. high habitat diversity and areas of high endemism) including seagrass beds
- ecosystems that provide important ecological functions such as:
  - wetlands of national, state and regional significance
  - coral reefs
  - riparian vegetation
  - important buffer to a protected area or important habitat corridor between areas
- declared fish habitat areas and sites containing protected marine plants under the *Fisheries Act 1994* (Qld)
- sites of palaeontologic significance such as fossil sites
- sites of geomorphological significance, such as lava tubes or karst
- protected areas that have been proclaimed under the NC Act and *Marine Parks Act 2004* (Qld) or are under consideration for proclamation
- areas of major interest, or critical habitat declared under the NC Act
- remnant vegetation listed under the *Vegetation Management Act 1999* (Qld) (VM Act) as containing endangered and of concern regional ecosystems where clearing is likely to result in land degradation and a loss of ecosystem function and biodiversity.

Areas of special sensitivity include the marine environment and wetlands, wildlife breeding or roosting areas, any significant habitat or relevant bird flight paths for migratory species, bat roosting and breeding caves including existing structures such as adits and shafts, and habitat of threatened plants, animals and communities.

Potential impacts and mitigation measures

Discuss the impact of the project on species, communities and habitats of local, regional or national significance in sensitive environmental areas as identified above. Include human impacts and the control of any domestic animals introduced to the area.

Demonstrate how the project would comply with the following hierarchy:

- avoiding impact on areas of remnant vegetation and other areas of conservation value including listed species and their habitat
- mitigating impacts through rehabilitation and restoration including, where relevant, a discussion of any relevant previous experience or trials of the proposed rehabilitation
- measures to be taken to replace or offset the loss of conservation values where avoiding and mitigating impacts cannot be achieved.

Explain why the measures above would not apply in areas where loss would occur.

Discuss the boundaries of the areas impacted by the project within or adjacent to an endangered ecological community, including details of footprint width. If the project area will impact upon a threatened community, include reasons for the preferred alignment and the viability of alternatives.

Address any actions of the project or likely impacts that require an authority under the NC Act, and/or would be assessable development for the purposes of the VM Act.

Outline how these measures will be implemented in the overall EMP for the project.

Provide details about the approvals that will be required under the NC Act and the VM Act for development made assessable under SPA. The overall EMP for the project should address the performance requirements of the relevant policies and regional vegetation management codes published by DERM.

For vegetation management policies, refer to: **www.derm.qld.gov.au/services_resources/item_list.php?category_id=215&topic_id=39**

For vegetation management codes, refer to:
www.derm.qld.gov.au/vegetation/regional_codes.html

Where relevant, this section should discuss environmental offset requirements in accordance with the Queensland Government Environmental Offsets Policy (Environmental Protection Agency 2008b) and take into account the applicable specific-issue offset policies, as follows:

- Policy for Vegetation Management Offsets (Department of Environment and Resource Management 2011b)
- Queensland Biodiversity Offset Policy (Department of Environment and Resource Management 2011c)
- *Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss* (Fish Habitat Management Operational Policy FHMOP 005) (Dixon & Beumer 2002).

Describe any departure from no net loss of ecological values.

5.5.2 Terrestrial flora

Description of environmental values

Provide vegetation mapping for all relevant project sites. Adjacent areas should also be mapped to illustrate interconnectivity. Mapping should also illustrate any larger scale interconnections between areas of remnant or regrowth vegetation where the project site includes a corridor connecting those other areas. Discuss any variances between site mapping and mapping produced by the Queensland Herbarium.

Describe the terrestrial vegetation communities within the affected areas at an appropriate scale (maximum 1:10 000), with mapping produced from aerial photographs and ground-truthing, showing the following:

- location and extent of vegetation types using the regional ecosystem type descriptions in accordance with the REDD
- location of vegetation types of conservation significance based on regional ecosystem types and occurrence of species listed as protected plants under the Nature Conservation (Wildlife) Regulation 1994 (Qld) and subsequent amendments, as well as areas subject to the VM Act
- the current extent (bioregional and catchment) of protected vegetation types of conservation significance within the protected area estate (national parks, conservation parks, resource reserves, nature refuges and conservation reserves under the *Land Act 1994* (Qld))
- any plant communities of cultural, commercial or recreational significance
- the location of any horticultural crops in the vicinity of the project area
- location and abundance of any exotic or weed species.

Highlight sensitive or important vegetation types, including any marine littoral and subtidal zone and riparian vegetation, and their value as habitat for fauna and conservation of specific rare floral and faunal assemblages or community types. The description should contain a review of published information regarding the assessment of the significance of the vegetation to conservation, recreation, scientific, educational and historical interests.

For each significant natural vegetation community likely to be impacted by the project, vegetation surveys should be undertaken at an appropriate number of sites, allowing for seasonal factors, and satisfying the following:

- the relevant regional vegetation management codes
- site data should be recorded in a form compatible with the Queensland Herbarium CORVEG database
- the minimum site size should be 10 × 50 metres
- a complete list of species present at each site should be recorded
- the surveys to include species structure, assemblage, diversity and abundance
- the relative abundance of plant species present to be recorded
- any plant species of conservation, cultural, commercial or recreational significance to be identified

- any plant species of conservation, cultural, commercial or recreational significance to be identified
- specimens of species listed as protected plants under the Nature Conservation (Wildlife) Regulation, other than common species, are to be submitted to the Queensland Herbarium for identification.

Existing information on plant species may be used instead of new survey work, provided that the data is derived from previous surveys at the site consistent with the above methodology. The methodology used for flora surveys should be specified in the appendices to the report.

Potential impacts and mitigation measures

Describe the potential environmental harm to the ecological values of the area arising from the construction, operation and decommissioning of the project including clearing, salvaging or removing vegetation. Discuss the indirect effects on remaining vegetation. Consider short- and long-term effects and comment on whether the impacts are reversible or irreversible.

With regard to all components of the project, include:

- a description of the potential impacts that clearing vegetation will have on listed species and communities in the extent of the proposed vegetation clearing
- any management actions to minimise vegetation disturbance and clearance
- a discussion of the ability of identified vegetation to withstand any increased pressure resulting from the project and any measures proposed to mitigate potential impacts
- a description of the methods to ensure rapid rehabilitation of disturbed areas following construction, including the species chosen for revegetation, which should be consistent with the surrounding associations
- details of any post construction monitoring programs
- a discussion of the potential environmental harm on flora due to any alterations to the local surface and groundwater environment with specific reference to impacts on riparian vegetation or other sensitive vegetation communities
- a description of any foreseen impacts which increase the susceptibility of ecological communities and species to the impacts of climate change.

Outline how these measures will be implemented in the overall EMP for the project. Weed management strategies are required for containing existing weed species (e.g. parthenium and other declared plants) and ensuring no new declared plants are introduced to the area. Refer to the local government authority’s pest management plan and any strategies and plans recommended for the project area by Biosecurity Queensland. Discuss the strategies in accordance with provisions of the *Land Protection (Pest and Stock Route Management) Act 2002* (Qld) in the main body of the EIS and in the pest management plan within the EMP for the project.

5.5.3 Terrestrial fauna

Description of environmental values

Describe the terrestrial and riparian fauna occurring in the areas affected by the proposal, noting the broad distribution patterns in relation to vegetation, topography and substrate. The description of the fauna present or likely to be present in the area should include:

- species diversity (i.e. a species list) and abundance of animals of recognised significance
- any species that are poorly known but suspected of being rare or threatened
- habitat requirements and sensitivity to changes, including movement corridors and barriers to movement
- the existence of feral or introduced animals including those of economic or conservation significance
- existence (actual or likely) of any species/communities of conservation significance in the study area, including discussion of range, habitat, breeding, recruitment feeding and movement requirements, and current level of protection (e.g. any requirements of protected area management plans or threatened species recovery plans)
- habitat requirements and sensitivity to changes, including movement corridors and barriers to movement
- an estimate of commonness or rarity for the listed or otherwise significant species
- use of the area by coastal/marine birds, migratory birds, nomadic birds and terrestrial fauna.

Identify any species listed by the EPBC Act and the NC Act occurring in the project area. Identify any species listed by the DERM 'Back on Track' species prioritisation methodology (refer to **www.derm.qld.gov.au/wildlife-ecosystems/wildlife/back_on_track_species_prioritisation_framework/index.html**).

Indicate how well any affected communities are represented and protected elsewhere in the bio-region where the project occurs. Specify the methodology used for fauna surveys. Provide relevant site data to DERM in a format compatible with the Wildlife Online database for listed threatened species (refer to **www.derm.qld.gov.au/wildlife-ecosystems/wildlife/wildlife_online/index.html**).

Potential impacts and mitigation measures

The assessment of potential impact should consider impacts the project may have on terrestrial fauna, relevant wildlife habitat and other fauna conservation values, including:

- impacts due to loss of range/habitat, food supply, nest sites, breeding/recruiting potential or movement corridors or as a result of hydrological change
- impacts on native species, particularly species of conservation significance
- cumulative effects of direct and indirect impacts
- threatening processes leading to progressive loss

- a description of any foreseen impacts which increase the susceptibility of ecological communities and species to the impacts of climate change.

Describe strategies for protecting rare or threatened species, and discuss any obligations imposed by state or Commonwealth endangered species legislation or policy or international obligations (i.e. JAMBA, CAMBA and ROKAMBA).

Address any actions of the project or likely impacts that require an authority under the NC Act. Provide the following information on mitigation strategies:

- measures to avoid and mitigate the identified impacts. Any provision for buffer zones and movement corridors, nature reserves or special provisions for migratory animals should be discussed and coordinated with the outputs of the flora assessment
- details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works, and if accidental injuries should occur, the methodologies to assess and handle injuries
- strategies for complying with the objectives and management practices of relevant recovery plans.

Outline how these measures will be implemented in the overall EMP for the project. Rehabilitation of disturbed areas should incorporate, where appropriate, provision of nest hollows and ground litter.

Address feral animal (including pest) management strategies and practices. The study should develop strategies to ensure that the project does not contribute to increased encroachment of a feral animal species. Refer to the local government authority's pest management plan and any strategies and plans recommended for the project area by Biosecurity Queensland. Discuss the strategies in accordance with the provisions of the Land Protection (Pest and Stock Route Management) Act in the main body of the EIS and in the pest management plan within the EMP for the project.

5.5.4 Aquatic ecology

Description of environmental values

General

Describe the aquatic flora and fauna present, or likely to be present, in the areas affected by the proposal, noting the patterns and distribution in the waterways and any associated wetlands. Include:

- fish species, mammals, reptiles, amphibians, crustaceans and aquatic invertebrates occurring in the waterways within the affected area (as defined under section 5 of the *Fisheries Act 1994*)
- any rare or threatened marine species
- a description of the habitat requirements and the sensitivity of aquatic species to changes in flow regime, water levels and water quality in the project areas
- aquatic plants including native and exotic/weed species
- aquatic and benthic substrate

- habitat downstream of the project or potentially impacted due to currents in associated lacustrine and marine environments
- aquatic substrate and stream type, including extent of tidal influence and common levels such as highest astronomical tide and mean high water springs.

Describe any wetlands listed by DERM as areas of national, state or regional significance and detail their values and importance for aquatic flora and fauna species.

Flora

Define the nature and extent of existing marine features such as littoral and sub-littoral lands, waterways, affected tidal and subtidal lands and marine plants vegetation (e.g. aquatic plants, salt couch, seagrass and mangroves) within the proposed area of development and in the areas adjacent to the project.

Conduct field assessments for plant species, preferably in both pre- and post-wet season conditions, as follows:

- record site data in a form compatible with the Queensland Herbarium CORVEG database
- record a complete list of species present at each site, including those species defined and protected under the Fisheries Act
- record the relative abundance of plant species present
- identify any plant species of conservation, cultural, commercial or recreational significance
- submit specimens of species listed as protected plants under the Nature Conservation (Wildlife) Regulation (other than common species) to the Queensland Herbarium for identification and entry into the HERBRECS database.

Fauna—megafauna

Describe the aquatic fauna, such as dugongs, dolphins, whales, sea snakes and rays that may be impacted by the proposed development.

Fauna—turtles

Describe the turtle species that may be using beaches in proximity to the proposed development area. The proponent should monitor turtle nesting along beaches near the proposed project area for the duration of the turtle nesting seasons, for turtle species occurring in the area.

Undertake a desktop review of information on the turtle communities of the study area, particularly the green, hawksbill, loggerhead, olive ridley and flatback turtles, paying specific attention to any anecdotal or recorded information on turtle populations frequenting the port area and any known nesting sites.

Refer to studies of the turtle populations and consult DERM on historical data for the area, particularly in relation to previously conducted nesting surveys.

The proponent shall use this information to establish the basis for recommendations in relation to the most appropriate management measures to be adopted to minimise the risk of turtle injury or death. Particular reference should be given to the protection of turtles from boat strike, given the potential increase in boat traffic closer to feeding grounds than the existing port channel.

Benthic macro invertebrates

Benthic macro invertebrate communities likely to be directly or indirectly impacted by the project should be characterised for the assessment of the potential impacts of proposed capital works. Consider the effect of ongoing maintenance activities, including dredging, on benthic fauna.

Reef communities

Describe the reef communities that may be impacted by the proposed development.

Potential impacts and mitigation measures

Discuss the potential impacts of the project on the aquatic ecosystems, including:

- loss of tidal flats on juvenile and adult aquatic species leading to loss of productivity in fish, crustaceans etc
- loss of seagrasses in relation to the extent and regional significance of seagrass communities and associated impact on fisheries, dugongs, turtles etc
- potential impacts associated with dredging and dredge material disposal (e.g. impacts of seagrass, mangroves, corals and benthic fauna)
- potential impact of marine structures (whether temporary during construction or permanent) that may impair the movement of fish. Where waterway barrier works are proposed, these are to be described and mapped and will require approval under the Fisheries Act
- benefits and/or disadvantages to recreational and commercial fishers resulting from provision of infrastructure or other aspects of the proposal
- the impact of creating the reclaimed area and the likely colonisation of the marina and marine structures, including the breakwaters that may partially offset the adverse impacts of the development on marine biodiversity. Discuss the design of the reclamation area and breakwater in relation to *Fisheries Guidelines for Fish-Friendly Structures—Fish Habitat Guideline 006* (Derbyshire 2006) and, where appropriate, demonstrate fish-friendly design features of the proposed infrastructure
- potential impacts from climate change and the project’s potential to increase the susceptibility of aquatic ecological communities and species, e.g. coral bleaching.

Describe proposed mitigation actions, including:

- proposed location, type and design of waterway barrier works (both temporary and permanent) that would impact on aquatic resources, particularly fish movement; and provide an appropriately scaled map
- potential mechanism to ensure adequate fish passage is provided at proposed waterway barriers
- strategies for protecting any rare or threatened species
- measures to reduce the impacts on the Australian snubfin dolphin, Indo-Pacific humpback dolphin, turtles and dugongs related to increased commercial use (i.e. boat strike, degraded water quality)

- measures to avoid fish spawning periods, such as seasonal construction of waterway crossings and measures to facilitate fish movements through water crossings
- offsets proposed for unavoidable, permanent loss of fisheries habitat in accordance with *Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss* (Fish Habitat Management Operational Policy 005) (Dixon & Beumer 2002).
- methods to minimise the potential for introducing or spreading weed species or plant disease
- monitoring aquatic biology health, productivity and biodiversity in areas subject to direct discharge
- measures to prevent direct impacts on marine fauna and flora by any dredging works.

Address any actions of the project or likely impacts that require an authority under the relevant legislation including the NC Act and/or the Fisheries Act. Outline how these measures will be implemented in the overall EMP for the project.

5.6 Water resources

5.6.1 Description of environmental values

Describe the existing water resources that may be affected by the project in the context of environmental values, as defined in such documents as:

- the EP Act
- Environmental Protection (Water) Policy 2009 (EPP (Water))
- *Australia and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000)
- *Queensland Water Quality Guidelines 2009* (Department of Environment and Resource Management 2009).

Provide an indication of the quality and quantity of water resources in the vicinity of the project area, describing:

- existing surface and groundwater in terms of physical, chemical and biological characteristics
- existing surface drainage patterns, flows, history of flooding including extent, levels and frequency and present water uses.

Describe the environmental values of the surface waterways (including Ross River and Ross Creek) and groundwater of the affected area in terms of:

- values identified in the EPP (Water)
- physical integrity, fluvial processes and morphology, including riparian zone vegetation and form, if relevant
- any impoundments (e.g. dams, levees, weirs etc.)
- hydrology of waterways and groundwater

- sustainability, including both quality and quantity
- dependent ecosystems
- existing and other potential surface and groundwater users
- water resource plans relevant to the affected catchments.

If the project is likely to use or affect local sources of groundwater, describe groundwater resources in the area in terms of:

- geology/stratigraphy
- aquifer type—such as confined, unconfined
- depth to and thickness of the aquifers
- depth to water level and seasonal changes in levels
- groundwater flow directions (defined from water level contours)
- interaction with surface water
- possible sources of recharge
- potential exposure to pollution
- current access to groundwater resources in the form of bores, springs and ponds (including quantitative yield of water and locations of access).

The groundwater assessment should also be consistent with relevant guidelines for the assessment of acid sulfate soils including spatial and temporal monitoring to accurately characterise baseline groundwater characteristics.

5.6.2 Potential impacts and mitigation measures

Assess the potential impacts of the project on water resource environmental values identified in the previous section. Also, define and describe the objectives and practical measures for protecting or enhancing water resource environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of objectives will be monitored, audited and managed. Include the following:

- potential impacts on the flow and the quality of surface and groundwater from all phases of the project, with reference to their suitability for the current and potential downstream uses and discharge licences
- an assessment of all likely impacts on groundwater depletion or recharge regimes
- potential impacts of surface water flow on existing infrastructure, with reference to the EPP (Water) and the *Water Act 2000*
- chemical and physical properties of any wastewater (including stormwater at the point of discharge into natural surface waters), and the toxicity of effluent to flora and fauna
- potential impacts on other downstream receiving environments, if it is proposed to discharge water to a riverine system
- the results of a risk assessment for uncontrolled releases to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and list strategies to prevent, minimise and contain impacts

- an assessment of the potential to contaminate surface and groundwater resources and measures to prevent, mitigate and remediate such contamination.

Strategies should be adequately detailed to demonstrate best practice management and that environmental values of receiving waters will be maintained to nominated water quality objectives. Describe the monitoring programs that will assess the effectiveness of management strategies for protecting water resources during the construction, operation and decommissioning of the project. Outline how these strategies are incorporated into appropriate sections of the EMP.

5.7 Air quality

5.7.1 Description of environmental values

Describe the existing air quality that may be affected by the project in the context of environmental values as defined by the EP Act and Environmental Protection (Air) Policy 2008 (EPP (Air)) and State Planning Policy 5/10: Air, Noise and Hazardous materials (Department of Environment and Resource Management 2010g).

Discuss the existing air shed environment, both local and regional, including:

- background levels and sources of particulates, gaseous and odorous compounds and any major constituent
- pollutants, including greenhouse gases, that may be generated by the project
- baseline monitoring results, sensitive receptors
- data on local meteorology and ambient levels of pollutants should be gathered to provide a baseline for later studies or for the modelling of air quality environmental harms.

Parameters should include air temperature, wind speed and direction, atmospheric stability, mixing depth and other parameters necessary for input to the models.

5.7.2 Potential impacts and mitigation measures

Consider the following air quality issues and their mitigation:

- an inventory of air emissions from the project expected during construction and operational activities
- ‘worst case’ emissions that may occur during operation. If these emissions are significantly higher than those for normal operations, it will be necessary to separately evaluate the worst-case impact to determine whether the planned buffer distance between the facility and neighbouring sensitive receptors will be adequate
- ground level predictions should be made at any site that includes the environmental values identified by the EPP (Air), including any sites that could be sensitive to the effects of predicted emissions
- dust generation from construction activities, especially in areas where construction activities are adjacent to existing road networks or are in close proximity to sensitive receivers
- climatic patterns that could affect dust generation and movement

- vehicle emissions and dust generation along major haulage routes both internal and external to the project site
- human health risk associated with emissions from the facility of all hazardous or toxic pollutants
- impacts on terrestrial flora and fauna.

Detail the mitigation measures together with proactive and predictive operational and maintenance strategies that could be used to prevent and mitigate impacts.

Discuss potential air quality impacts from emissions, with reference to the National Environmental Protection (Ambient Air Quality) Measure 2003 (Cwlth) and the EPP (Air). If an emission is not addressed in these legislative instruments, the emission should be discussed with reference to its risk to human health, including appropriate health-based guidelines/standards.

5.8 Greenhouse gas emissions

5.8.1 Description of environmental situation

Provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO_2 equivalent' terms for the following categories:

- Scope 1 emissions—means direct emissions of greenhouse gases from sources within the boundary of the facility and as a result of the facility's activities
- Scope 2 emissions—means emissions of greenhouse gases from the production of electricity, heat or steam that the facility will consume, but that are physically produced by another facility

Briefly describe method(s) by which estimates were made.

Use the *National Greenhouse Accounts (NGA) Factors* (Commonwealth of Australia 2010) as a reference source for emission estimates, supplemented by other sources where practicable and appropriate. As a requirement of the NGA factors, estimates should include the loss of carbon sink capacity of vegetation due to clearing and impoundment.

5.8.2 Potential impacts and mitigation measures

Discuss the potential for greenhouse gas abatement measures, including:

- the proposed measures (alternatives and preferred) to avoid and/or minimise direct greenhouse gas emissions
- how the preferred measures minimise emissions and achieve energy efficiency
- any opportunities to further offset greenhouse gas emissions through indirect means including sequestration and carbon trading.

5.9 Noise and vibration

5.9.1 Description of environmental values

Describe the existing noise and vibration environment that may be affected by the project in the context of the environmental values defined by the Environmental

Protection (Noise) Policy 2008*.* The *Noise Measurement Manual* (Environmental Protection Agency 2000) should be considered and references should be made to the *EPA Guideline: Noise and vibration from blasting* (Environmental Protection Agency 2006) and *Guideline: Planning for noise control* (Environmental Protection Agency 2004).

Identify sensitive noise receptors adjacent to all project components and estimate typical background noise and vibration levels based on surveys at representative sites. Discuss the potential sensitivity of such receptors and nominate performance indicators and standards.

5.9.2 Potential impacts and mitigation measures

Describe the impacts of noise and vibration generated during the construction and operational phases of the project. Noise and vibration impact analysis should include:

- the levels of noise and vibration generated, including noise contours, assessed against current typical background levels, using modelling (such as Environmental Noise Model or SoundPLAN) where appropriate
- impact of noise, including low frequency noise (noise with components below 200 Hz) and vibration at all potentially sensitive receivers (e.g. residences, social and public infrastructure, such as health, recreational and educational facilities, roads, etc) compared with the performance indicators and standards nominated above
- impact on terrestrial and aquatic fauna
- proposals to minimise or eliminate these effects, including details of any screening, lining, enclosing or bunding of facilities, or timing schedules for construction and operations that would minimise environmental harm and environmental nuisance from noise and vibration
- options for sensitive receivers that are otherwise unable to achieve a satisfactory internal noise level for the preservation of health and wellbeing as identified within the EPP (Noise).

Night-time works

Provide details of any night-time work that may be undertaken. Specifically include:

- the reasons why night-time work may be undertaken (e.g. to avoid peak traffic periods, or to undertake work in a rail corridor)
- the likely duration of work (if known)
- the proposed hours of the work
- the nature of the work to be undertaken
- the likely impact on residents and the associated mitigation measures to be undertaken by the proponent
- the methods that will be used to communicate with affected residents.

5.10 Waste

5.10.1 Waste generation

Identify and describe all sources, likely volumes and quality (where applicable) of waste associated with construction, operation and decommissioning of all aspects of the project. Reference is to be made to the *Waste Reduction and Recycling Act 2011* (Qld). Describe:

- waste generated by delivery of material to site(s)
- all chemical and mechanical processes conducted on the construction sites that produce waste
- the amount and characteristics of solid and liquid waste produced on site by the project
- hazardous materials to be stored and/or used on site, including environmental toxicity data and biodegradability.

5.10.2 Waste management

Assess the potential impact of all wastes generated during construction and operation, with regard for best practice waste management strategies in accordance with the Waste Reduction and Recycling Act. Provide details of each waste in terms of:

- the options available for avoidance/minimisation
- operational handling and fate of all wastes including storage
- on-site treatment methods proposed for any wastes
- methods of disposal (including the need to transport wastes off site for disposal) proposed to be used for any trade wastes, liquid wastes and solid wastes
- the potential level of impact on environmental values
- measures to ensure stability of the waste storage areas and impoundments
- methods to prevent seepage and contamination of groundwater from stockpiles and/or storage areas and impoundments
- measures to minimise attraction of vermin, insects and pests
- options available for using recycled materials
- market demand for recyclable waste (where appropriate)
- decommissioning of the construction site.

5.11 Indigenous cultural heritage

Identify areas covered by applications for native title claims or native title determinations, providing boundary descriptions of native title representative body(ies), and whether it is necessary to notify the representative body(ies) or if there is evidence that native title does not exist.

5.11.1 Description of existing Indigenous cultural heritage values

Describe the existing Indigenous cultural heritage values that may be affected by the project and the environmental values of the cultural landscapes of the affected area in terms of the physical and cultural integrity of the landforms.

Also describe how, in conjunction with the appropriate Indigenous people, the cultural heritage values were ascertained. This could include:

- the results of any Aboriginal cultural heritage survey undertaken
- the DERM Aboriginal Cultural Heritage Register and Database
- any existing literature relating to Indigenous cultural heritage in the project area.

5.11.2 Potential impacts and mitigation measures

Define and describe the objectives and practical measures for protecting or enhancing Indigenous cultural heritage environmental values. Describe how nominated quantitative standards and indicators may be achieved for cultural heritage management, and describe how the achievement of the objectives will be monitored, assessed and managed.

To the greatest extent practicable, significant cultural heritage areas should be avoided by the project. The EIS should provide an assessment of likely effects on sites of Indigenous cultural heritage value, including but not limited to the following:

- description of the significance of artefacts, items or places of conservation or cultural heritage values likely to be affected by the project and their values at a local, regional and national level
- recommended means of mitigating any negative impact on cultural heritage values and enhancing any positive impacts.

As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care.

During the EIS process, the proponent should initiate a native title agreement (NT agreement), as defined under the *Aboriginal Cultural Heritage Act 2003* (Qld) (ACH Act) that includes management and protection strategies for Indigenous cultural heritage or a cultural heritage management plan (CHMP) under the ACH Act. An NT agreement or an approved CHMP, in a form which complies with Part 7 of the ACH Act, will ensure that the project meets the Aboriginal cultural heritage duty of care imposed by the ACH Act.

If an NT agreement is not finalised or a CHMP has not been approved when the EIS is submitted to the Coordinator-General, the following must be provided:

- an outline of the draft CHMP or draft plan within the NT agreement that addresses management and protection strategies for cultural heritage, subject to any confidentiality provisions, outlining the position of the relevant parties
- details of the proposed steps and timeframes for finalising the CHMP or NT agreement.

An NT agreement or CHMP should be negotiated between the proponent and the appropriate native title/Indigenous parties and should address and include the following:

- a process for including Indigenous people associated with the development areas in protection and management of Indigenous cultural heritage
- processes for mitigating, managing and protecting identified cultural heritage sites and objects in the project areas, including associated infrastructure developments, during both the construction and operational phases of the project
- provisions for managing the accidental discovery of cultural material, including burials
- a clear recording process to assist initial management and recording of accidental discoveries
- a cultural heritage induction for project staff
- developing a cultural heritage awareness program to be incorporated into the contractor/employee manual and induction manual. This is to be in the form of a plain language, short document that is easy for contractors and staff ‘on the ground’ to understand
- a conflict resolution process.

5.11.3 Native title

Identify areas covered by applications for native title claims or native title determinations, providing boundary descriptions of native title representative body(ies), and whether it is necessary to notify the representative body(ies) or if there is evidence that native title does not exist.

Identify the potential for native title rights and interests likely to be impacted upon by the project and the potential for managing those impacts by an Indigenous land use agreement or other native title compliance outcomes.

5.12 Non-Indigenous cultural heritage

5.12.1 Description of existing non-Indigenous cultural heritage values

Include a cultural heritage study that describes non-Indigenous cultural heritage sites and places, and their values. Any such study should be conducted by an appropriately qualified cultural heritage practitioner and should include the following:

- review of:
  - the Australian Heritage Places Inventory
  - the Queensland Heritage Register and other information regarding places of potential non-Indigenous cultural heritage significance
  - any local government heritage register
  - any existing literature relating to the heritage of the affected areas
- liaison with relevant community groups/organisations (e.g. local historical societies) concerning places of non-Indigenous cultural heritage significance located or identified

- locations of culturally and historically significant sites, shown on maps, that are likely to be impacted by the project
- a constraints analysis of the proposed development area to identify and record non-Indigenous cultural heritage places.

5.12.2 Potential impacts and mitigation measures

Provide an assessment of any likely effects on sites of non-Indigenous cultural heritage values, including but not limited to the following:

- description of the significance of artefacts, items or places of conservation or non-Indigenous cultural heritage value likely to be affected by the project and their values at a local, regional, state and national level
- recommended means of mitigating any negative impacts on non-Indigenous cultural heritage values and enhancing any positive impacts
- strategies to manage places of historic heritage significance, taking account also of community interests and concerns.

As a minimum, investigation, consultation, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care, including those under the EPBC Act and *Queensland Heritage Act 1992*.

6. Social values and management of impacts

6.1 Description of existing social values

Conduct a social impact assessment and consider:

- the social and cultural area, which should include the suburbs intersected by and adjacent to the project
- community engagement
- a social baseline study
- a workforce profile
- potential impacts and mitigation measures
- management strategies.

6.1.1 Social and cultural area

Define the project's social and cultural area of influence, including the local, district, regional and state level as relevant, taking into account the:

- potential for social and cultural impacts to occur
- location of other relevant proposals or projects
- location and types of physical and social infrastructure, settlement and land use patterns
- social values that might be affected by the project (e.g. integrity of social conditions, visual amenity and liveability, social harmony and wellbeing, and sense of community)

- Indigenous social and cultural characteristics, such as native title rights and interests, and cultural heritage
- use of the harbour/port area for commercial and recreational boating and fishing.

6.1.2 Community engagement

Consistent with national and international good practice, and with regard to local and regional strategies for community engagement, the proponent should engage at the earliest practical stage with likely affected parties to discuss and explain the project, and to identify and respond to issues and concerns regarding social impacts.

Describe the community engagement processes used to conduct open and transparent dialogue with stakeholders. Such processes should include, but not limited to, the use of community reference group forums. Include the project's planning and design stages and future operations including affected local and state authorities. Engagement processes will involve consideration of social and cultural factors, customs and values, and relevant consideration of linkages between environmental, economic, and social impact issues.

Discuss engagement strategies and processes, including how complaint resolution will be addressed, for all stages of the project.

6.1.3 Social baseline study

Include a targeted baseline study of the people residing in the project's social and cultural area is required to identify the project's critical social issues, potential adverse and positive social impacts, and strategies and measures developed to address the impacts. The social baseline study should be based on qualitative, quantitative, and participatory methods. It should be supplemented by community engagement processes, and reference relevant data contained in Local and State Government publications, reports, plans, guidelines and documentation, including regional plans and, where available, community plans.

Describe:

- the current social infrastructure including community and civic facilities (e.g. Townsville Yacht Club), services and networks—for definition see *South East Queensland Regional Plan 2005–2026: Implementation Guideline No.5: Social infrastructure planning* (Department of Infrastructure 2007)
- settlement patterns including the names, locations, size, history and cultural aspects of settlement in the social and cultural area
- the identity, values, lifestyles, vitality, characteristics and aspirations of communities in the social and cultural area, including Indigenous communities
- land use and land ownership patterns including:
  - the number of properties directly affected by the project
  - the number of families directly and indirectly affected by the project including Indigenous traditional owners and their families, property owners, and families of workers either living on the property or workers where the property is their primary employment.

- use of the social and cultural area for fishing, recreation, business and industry, tourism, aquaculture, and Indigenous cultural use of flora and fauna.

6.1.4 Workforce profile

Include a profile of the workforce that describes the:

- number of personnel to be employed, the skills base of the required workforce and the likely sources (i.e. local, regional or overseas) for the workforce during the construction and operational phases for each component of the project
- estimated number of people to be employed during construction and operation, and arrangements for their transport to and from the project areas, including proposed use of regional or charter air services.

Estimates should be provided according to occupational groupings and variations in the workforce numbers for the duration of the project and show anticipated peaks in worker numbers during the construction and operation phase of the project.

Provide an outline of recruitment schedules and policies for recruiting workers, addressing recruitment of local and non-local workers including Indigenous workers, people from culturally and linguistically diverse backgrounds and people with a disability

Provide information on the location of other major projects or proposals under study within the social and cultural area, together with workforce numbers.

6.2 Potential impacts

Assess and describe the type, level and significance of the project's social impacts (both beneficial and adverse) on the local and cultural area, based on outcomes of community engagement processes and the social baseline study. Furthermore:

- describe and summarise outcomes of community engagement processes including the likely response of the affected communities, including Indigenous people and other interest groups such as port and marina users including the Townsville Yacht Club
- include sufficient data to enable affected local and state authorities to make informed decisions about the project's effect on their business and plan for the provision of social infrastructure in the project's social and cultural area
- address direct, indirect and secondary impacts from any existing projects and the proposed project including an assessment of the size, significance, and likelihood of these impacts at the local and regional level. Consider the following:
    - key population/demographic shifts; disruptions to existing lifestyles, the health and social wellbeing of families and communities; social dysfunction including alcohol and drugs, crime, violence, and social or cultural disruption due to population influx
    - the needs of vulnerable groups including women, children and young people, the aged and people with a disability
    - Indigenous peoples including cultural property issues

  - local, regional and state labour markets, with regard to the source of the workforce. Present this information according to occupational groupings of the workforce. Detail whether the proponent, and/or contractors, is likely to employ locally or through other means and whether there are initiatives for local employment business opportunities
  - proposed new skills and training related to the project including the occupational skill groups required and potential skill shortages anticipated
  - how much service revenue and work from the project would be likely to flow to the project's social and cultural area
  - impact of additional marine transport on recreational boating and fishing
  - impacts of construction and operational workforces, their families, and associated contractors on housing and accommodation availability and affordability, land use and land availability. Discuss the capability of the existing housing and rental accommodation, to meet any additional demands created by the project, including direct impacts on Indigenous people.

Evaluate and discuss the potential cumulative social impacts resulting from the project including an estimation of the overall size, significance and likelihood of those impacts. In this context, 'cumulative impacts' is defined as the additional impacts on population, workforce, accommodation, housing, and use of community infrastructure and services, from the project, and other proposals for development projects in the area, which are publicly known or communicated by DEEDI, if they overlap the proposed project in the same timeframe as its construction period.

Discuss the concept of longitudinal cumulative impacts, or 'project fatigue', where the community in the study area has been subjected to a number of large-scale construction projects in recent years.

6.2.1 Mitigation measures and management strategies

For identified social impacts, social impact mitigation strategies and measures should be presented to address the:

- recruitment and training of the construction and operational workforces and the social and cultural implications this may have for the host community, including if any part of the workforce is sourced from outside the social and cultural area
- housing and accommodation issues, in consultation with relevant local authorities and State Government agencies, with proposals for accommodating the project workforce and their families that avoid, mitigate or offset any short- and medium-term adverse effects on housing affordability and availability, including the rental market, in the social and cultural area
- demographic changes in the profile of the region and the associated sufficiency of current social infrastructure, particularly health and welfare, education, policing and emergency services
- adequate provision of education, training and employment for women, people with a disability, and Indigenous peoples via an Indigenous Participation Plan.

Describe any consultation about acceptance of proposed mitigation strategies and how practical management and monitoring regimes are proposed to be implemented.

7. Economics and management of impacts

7.1 Economics

7.1.1 Description of affected local and regional economies

Describe the existing economy in which the project is located and the economies materially impacted by the project. Include:

- a map illustrating the local and regional economies (local government areas) that could be potentially affected by the project
- gross regional product or other appropriate measure of annual economic production
- population
- labour force statistics
- economic indicators
- the regional economy's key industries and their contribution to regional economic income
- sufficient baseline economic data to underpin a comprehensive assessment of the direct, indirect, cumulative, costs and impacts of the project
- the key regional markets relevant to the project:
  - labour market
  - housing and land markets
  - construction services and building inputs market
  - regional competitive advantage and expected future growth.

With regard to the region's key industries and factor prices, provide information on:

- current input costs (wage rates, building costs, housing rent etc.)
- land values in the region by type of use.

7.1.2 Potential impacts and mitigation measures

The potential impacts should consider local, regional, state and national perspectives as appropriate to the scale of the project.

An assessment should use a Regional General Equilibrium Model analysis tool or similar model to measure impacts.

The analysis should describe both the potential and direct economic impacts including estimated costs, if material, on industry and the community, assessing the following:

- property values
- industry output (e.g. large construction projects)
- employment
- commercial fishing

- the indirect impacts likely to flow to other industries and economies from the development of the project. This should also consider the implications of the project for future development
- the distributional effects of the proposal including proposals to mitigate any negative impact on disadvantaged groups.

Strategies for local participation

The assessment of economic impacts should outline strategies for local participation, including:

- strategies for assessing the cost effectiveness of sourcing local inputs from the regional economy during the construction, operation and rehabilitation phases of the project
- employment strategies for local residents including members of Indigenous communities and people with a disability, including a skills assessment and recruitment and training programs to be offered
- strategies responding to relevant government policy, relating to:
  - the level of training provided for construction contracts on Queensland Government building and construction contracts, with regard to the Queensland Government Building and Construction Contracts Structured Training Policy (the 10 per cent policy) (see **http://training.qld.gov.au/industry/10percent-policy.html**)
  - Indigenous employment opportunities, with regard to the Indigenous Employment Policy for Queensland Government Building and Civil Construction Projects—the 20 per cent policy (Department of Employment, Economic Development and Innovation 2008a)
  - development of a Local Industry Participation Plan and other reports in accordance with the Local Industry Policy (Department of Employment, Economic Development and Innovation 2010) in conjunction with the DEEDI Office of Advanced Manufacturing to embrace the use of locally sourced goods and services.

7.2 Sustainable development

Provide a comparative analysis of how the project conforms to the objectives for ‘sustainable development’—see the *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee 1992).

Consider the cumulative impacts (both beneficial and adverse) of the project from a life-of-project perspective, taking into consideration the scale, intensity, duration and frequency of the impacts to demonstrate a balance between environmental integrity, social development and economic development.

This information is required to demonstrate that sustainable development aspects have been considered and incorporated during the scoping and planning of the project.

8. Hazard and risk

8.1 Hazard and risk assessment

Describe the potential hazards and risks to people and property that may be associated with the project, which may include but are not restricted to:

- identifying potential hazards, accidents, spillages and abnormal events that may occur during all stages of the project, including possible frequency of occurrence
- identifying all hazardous substances to be used, stored, processed or produced and the rate of usage
- potential wildlife hazards, natural events (reference should also be made to the SPP 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (Department of Local Government and Planning & Department of Emergency Services 2003)) and implications related to climate change
- terrorist attack (refer sections 8.4.1 and 8.5).

Undertake a preliminary risk assessment for all components of the project, as part of the EIS process in accordance with *Australia/New Zealand AS/NZS ISO 31000:2009 Risk management—Principles and guidelines* (Standards Australia & Standards New Zealand 2009)*.* With respect to risk assessment, the EIS should:

- deal comprehensively with external and on-site risks including transport risks
- assess risks during the construction, operational and decommissioning phases of the project
- include an analysis of the consequences of each hazard on safety in the project area, examining the likelihood of both individual and collective consequences, involving injuries and fatalities to workers and to the public
- present quantitative levels of risks from the above analysis.

Provide details on the safeguards that would reduce the likelihood and severity of hazards, consequences and risks to persons, within and adjacent to the project area(s).

Present a comparison of assessed and mitigated risks with acceptable risk criteria for land uses in and adjacent to the project area(s).

Provide a risk management plan.

Cross-reference to sections 8.4.1 and 8.5 below.

8.2 Cumulative risk

The risk analysis is to address the potential impacts that may occur on the normal on-site day-to-day activities during the construction and/or operation of the facilities. Furthermore, determine the level of change that may affect the risk contours of other relevant existing or proposed industrial facilities in the area, as a result of the proposed project (where details of such proposed facilities are provided by DEEDI or otherwise published). Individual risk criteria should be used to limit risks to individual workers and members of the public. Societal risk criteria should be used to limit risk to the affected population as a whole.

Identify and adopt, where appropriate, any changes to operating or storage procedures that would reduce the possibility of these events occurring, or reduce the severity of the events should they occur.

8.3 Health and safety

8.3.1 Description of public health and safety community values

Describe the existing health and safety values of the community, workforce, suppliers and other stakeholders in terms of the environmental factors that can affect human health, public safety and quality of life, such as air pollutants, odour, lighting and amenity, dust, noise and water.

8.3.2 Potential impact and mitigation measures

Define and describe the objectives and practical measures for protecting or enhancing health and safety community values. Describe how nominated quantitative standards and indicators may be achieved for social impacts management, and how the achievement of the objectives will be monitored, audited and managed.

Assess the cumulative effects on public health values and occupational health and safety impacts on the community and workforce from project operations and emissions. Recommend any practical monitoring regimes in this section.

Include relevant consultation with the appropriate regional health service providers.

8.4 Emergency management plan

Present preliminary information on the design and operation of proposed safety/contingency systems to address significant emergency issues delineated in the risk assessment, together with at least the following areas of emergency:

- terrorist attack
- marine collision minimisation
- fire prevention/protection
- leak detection/minimisation
- release of contaminants
- emergency shutdown systems and procedures.

In addition, undertake an assessment of businesses that may be affected in the event of an emergency, including strategies to mitigate the impact on these businesses.

In regard to fires, outline strategies to manage the provision of:

- fire management systems to ensure the retention on site of fire water or other fire suppressants used to combat emergency incidents
- building fire safety measures for any construction or permanent accommodation

- details of any emergency response plans and bushfire mitigation plans under the State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (Department of Local Government and Planning & Department of Emergency Services 2003)
- on-site firefighting equipment provided and the level of training of staff who will be tasked with emergency management activities
- detailed maps showing the plant outline, potential hazardous material stores, incident control points, firefighting equipment, etc
- an outline of any dangerous goods stores associated with the plant operations, including fuel storage and emergency response plans.

Present outlines of emergency planning and response strategies to deal with relevant incidents above, which have been determined in consultation with state and regional emergency service providers, and which show integration of emergency services into the plans.

Present plans for emergency medical response and transport and first aid matters with involvement of the relevant state agencies (such as the Queensland Ambulance Service, Queensland Fire and Rescue Service and Emergency Management Queensland).

8.4.1 Maritime security plan

The emergency management plan is to include a maritime security plan which meets the security requirements included in the:

- *Maritime Transport and Offshore Facilities Security Act 2003* and Maritime Transport and Offshore Facilities Security Regulation 2003 (Cwlth)
- *Transport Security (Counter Terrorism) Act 2008* and Regulations (Qld)
- International Ship and Port Facility Security Code (International Maritime Organization 2003).

A maritime security plan should be submitted as a separate confidential document to the Coordinator-General at the time of submission of the EIS.

8.5 Counter-terrorism and critical infrastructure protection

The Port of Townsville is deemed to be critical infrastructure as defined by the *Queensland Plan for the Protection of Critical Infrastructure from Terrorism* (State of Queensland, 2005), that is:

> Those physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would significantly impact on the social or economic well-being of Queensland.

Provide information on the design and operation of proposed safety and contingency systems to address the National and Queensland counter-terrorism and critical infrastructure protection legislation, policies and arrangements including:

- *National Counter-Terrorism Plan* (National Counter-Terrorism Committee 2005)

- *Critical Infrastructure Protection National Strategy* (Trusted Information Security Network 2004)
- *Critical Infrastructure Emergency Risk Management and Assurance: Handbook* (Emergency Management Australia 2004)
- *Queensland Counter-Terrorism Strategy 2008–2010* (Department of the Premier and Cabinet 2007)
- *Queensland Infrastructure Protection and Resilience Framework* (Department of the Premier and Cabinet 2005)
- *Queensland Government Information Security Classification Framework* (Department of Public Works 2010)
- *Transport Security (Counter Terrorism) Act 2008* and Regulations
- *Australia/New Zealand AS/NZS ISO 31000:2009 Risk management—Principles and guidelines* (Standards Australia & Standards New Zealand 2009)
- *Handbook: Security Risk Management* (HB 167:2006) (Standards Australia & Standards New Zealand 2006)
- *Business Continuity Management* (HB 221:2004) (Standards Australia & Standards New Zealand 2004)
- *A Practitioners Guide to Business Continuity Management* (HB 292-2006) (Standards Australia 2006a)
- *Executive Guide to Business Continuity Management* (HB 293-2006) (Standards Australia 2006b).

Provide information on the design and operation of the port's operational security plan.

Such information should be provided as a separate confidential document to the Coordinator-General at the time of submission of the EIS.

9. Cumulative impacts

Summarise the project's cumulative impacts and describe these impacts in combination with those of existing or proposed project(s) publicly known or advised by DEEDI to be in the region (including the Townsville Port Marine Precinct project), to the greatest extent practicable. Assess cumulative impacts with respect to both geographic location and environmental values. Explain the methodology used to determine the cumulative impacts of the project, detailing the range of variables considered (including relevant baseline or other criteria upon which the cumulative aspects of the project have been assessed, where applicable).

10. Environmental management plan

Detail the EMPs for both the construction and operation phases of the project. The EMP should be developed from, and be consistent with, the information in the EIS. The EMP must address discrete project elements and provide life-of-proposal control strategies. It must be capable of being read as a stand-alone document without reference to other parts of the EIS.

The EMP must comprise the following components for performance criteria and implementation strategies:

- the proponent's commitments to acceptable levels of environmental performance, including environmental objectives, performance standards and associated measurable indicators, performance monitoring and reporting
- impact prevention or mitigation actions to implement the commitments
- corrective actions to rectify any deviation from performance standards
- an action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to:
  - continuous improvement
  - environmental auditing
  - monitoring
  - reporting
  - staff training
  - a rehabilitation program for land proposed to be disturbed under each relevant aspect of the proposal.

The recommended structure of each element of the EMP is:

Element/issue	Aspect of construction or operation to be managed (as it affects environmental values).
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Measurable performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies, tasks or action program (to nominated operational design standards) that would be implemented to achieve the performance criteria.
Monitoring	The monitoring requirements to measure actual performance (e.g. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements to demonstrate implementation of agreed construction and operation environmental management strategies and compliance with agreed performance criteria.
Reporting	Format, timing and responsibility for reporting and auditing of monitoring results.
Corrective action	The action (options) to be implemented in case a performance requirement is not reached and the person(s) responsible for action (including staff authority and responsibility management structure).

The proponent's commitments to environmental performance, as described in the EMP, may be included as Coordinator-General's conditions to ensure the commitments are met. Therefore, the EMP is a relevant document for project approvals, environmental authorities and permits, and may be referenced by them.

11. Conclusions and recommendations

Make conclusions and recommendations with respect to the project, based on the studies presented, the EMP and conformity of the project with legislative and policy requirements.

12. References

All references consulted should be presented in the EIS in a recognised format.

13. Appendices

Final TOR for this EIS

Include a copy of the final TOR in the EIS.

TOR cross-reference table

Provide a cross-reference table that links the requirements of each section/subsection of the TOR with the corresponding section/subsection of the EIS, where those requirements have been addressed

Project approvals

Provide a list of the project approvals required by the project.

Consultation report

The report should include the methodology used in the public consultation plan including:

- criteria for identifying stakeholders and the communication methods used (the consultation plan)
- a list of stakeholders identified, including the Commonwealth, Queensland and local government agencies, and/or the affected parties (as defined by the EP Act)
- a summary of the issues raised by stakeholders and the means by which the issues have been addressed
- plans for ongoing consultation to be outlined and included in the EMP.

Study team

List the relevant qualifications and experience of the key study team members and specialist sub-consultants.

Glossary of terms

Provide a glossary of technical terms.

Specialist studies

All reports generated on specialist studies undertaken as part of the EIS are to be included as appendices. These may include, but are not limited to:

- air pollution, noise and vibration
- groundwater and surface water hydrology
- geology and geomorphology
- economic studies and/or cost-benefit analyses
- transport studies
- cultural heritage
- hazard and risk studies
- land use and land capability studies.

Corporate environmental policy

Attach a copy of the proponent's corporate environmental policy and planning framework document.

List of proponent commitments

Provide a list of all commitments made by the proponent in the EIS, together with a reference to the relevant section in the report.

Acronyms and abbreviations

Acronym/ abbreviation	Definition
ACH Act	*Aboriginal Cultural Heritage Act 2003* (Qld)
AHD	Australian height datum
AS/NZS	Australian standard/New Zealand standard
CAMBA	China–Australia Migratory Bird Agreement
CHMP	cultural heritage management plan
CLR	Contaminated Land Register
Coastal Act	*Coastal Protection and Management Act 1995* (Qld)
DEEDI	Department of Employment, Economic Development and Innovation, Queensland
DERM	Department of Environment and Resource Management, Queensland
EIS	environmental impact statement
EMP	environmental management plan
EP Act	*Environmental Protection Act 1994* (Qld)
EPA	former Queensland Environmental Protection Agency
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
EPP	Environmental Protection Policy (water, air, waste, noise)
ERA	environmentally relevant activity
GBRMP Act	*Great Barrier Reef Marine Park Act 1974* (Cwlth)
HTML	hyper text markup language
JAMBA	Japan–Australia Migratory Bird Agreement
NC Act	*Nature Conservation Act 1992* (Qld)
NGA	National Greenhouse Accounts
NT agreement	native title agreement
PDF	portable document format
PoTL	Port of Townsville Limited
QASSMAC	Queensland Acid Sulfate Soils Management Advisory Committee
QASSIT	Queensland Acid Sulfate Soils Investigation Team
REDD	Regional Ecosystem Description Database
RIA	road impact assessment (report)
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SDPWO Act	*State Development and Public Works Organisation Act 1971* (Qld)
SEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities
SIA	social impact assessment
SPA	*Sustainable Planning Act 2009* (Qld)
The proponent	Port of Townsville Limited
TMR	Department of Transport and Main Roads, Queensland
TOR	terms of reference

VM Act	*Vegetation Management Act 1999* (Qld)

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Port Expansion Project EIS

Appendix A2

Commonwealth Government Guidelines for an EIS

AECOM BMT WBM

Australian Government

Department of Sustainability, Environment, Water, Population and Communities
Great Barrier Reef Marine Park Authority

Environment Protection and Biodiversity Conservation Act 1999

Great Barrier Reef Marine Park Act 1975

GUIDELINES FOR AN ENVIRONMENTAL IMPACT STATEMENT FOR THE PORT OF TOWNSVILLE PORT EXPANSION PROJECT, QUEENSLAND

PORT OF TOWNSVILLE LTD
(EPBC 2011/5979 / GBRMPA G34429.1)

April 2012

Contents

1 PREAMBLE

Port of Townsville Ltd (hereafter referred to as the proponent) proposes to expand the Port of Townsville in Cleveland Bay, Queensland. The proposal is a staged development expected to take approximately 20 years to complete.

The main components of the proposed development include:

- The construction of a new outer harbour formed by the construction of a new breakwater approximately one kilometre seaward of the existing northern breakwater and deepening of the harbour area;
- Potential construction of a new western breakwater;
- The construction of up to six additional vessel berths in the new harbour;
- Deepening of the existing approach channels;
- Widening of the approach channel near the outer harbour entrance;
- Creation of approximately 100 hectares of reclaimed land backing the new berths to provide for bulk cargo storage and rail loop, all formed from material reclaimed from the harbour deepening. This will include external and internal bunds to facilitate land reclamation;
- Placement of unsuitable and excess dredge materials at sea in the existing dredge material placement area in Cleveland Bay;
- Installation of new navigation aids;
- Construction of new road and rail infrastructure within the project footprint and connection to the Eastern Access Corridor currently under construction;
- Installation of new service utilities infrastructure;
- The project involves ten million cubic metres of dredging: five million cubic metres is proposed for offshore disposal and five million cubic metres is proposed for disposal in the reclamation; and
- Other project components described in the referral EPBC 2011/5979.

The proposal was referred for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 26 May 2011. The assessment process commenced following a determination on 1 July 2011 by a delegate of the Minister for Sustainability, Environment, Water, Population and Communities that the proposed development was a controlled action under the provisions of the EPBC Act. The controlling provisions for the proposal under the EPBC Act are:

a) World Heritage properties (sections 12 & 15A);

b) National Heritage places (sections 15B & 15C);

c) Wetlands of international importance (sections 16 & 17B);

d) Listed threatened species and communities (sections 18 & 18A);

e) Listed migratory species (sections 20 & 20A);

f) Commonwealth marine areas (sections 23 & 24A); and

g) Great Barrier Reef Marine Park (sections 24B & 24C).

On 21 July 2011, a delegate of the Minister for Sustainability, Environment, Water, Population and Communities, determined that an Environmental Impact Statement (EIS) would be required for the proposal. The EIS Guidelines identify the issues that the Australian Government requires the proponent to address in the EIS.

As a component of the proposal involves an activity that requires a permission under the *Great Barrier Reef Marine Park Regulations 1983* (GBRMP Regulations) the referral under the EPBC Act is taken to be an application under the GBRMP Regulations. A single integrated assessment will be undertaken to support decisions under both the EPBC Act and *Great Barrier Reef Marine Park Act 1975* (GBRMP Act).

2 ENVIRONMENTAL ASSESSMENT AND APPROVAL PROCESS

2.1 PURPOSE OF GUIDELINES

This document is intended to set the scope of environmental, social, cultural, heritage and economic studies required in the EIS to allow for an assessment and decision on the appropriateness of the construction and operation of the Port of Townsville Port Expansion Project. These Guidelines have been jointly developed by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) and the Great Barrier Reef Marine Park Authority (GBRMPA) to address assessment requirements specified in Section 97 of the EPBC Act and Schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000* (EPBC Regulations) (refer to Attachment 1) and GBRMP Regulations 88Q and 88R (refer to Attachment 2).

3 DESCRIPTION OF THE PROJECT

3.1 THE PROPOSED PROJECT AREA

The proposed development is located in Cleveland Bay at the Port of Townsville in Townsville, Queensland. The project footprint is located wholly within the Great Barrier Reef World Heritage Area, the Great Barrier Reef National Heritage place, and partially in the Great Barrier Reef Marine Park. Magnetic Island is a continental island, eight kilometres off shore from the city of Townsville and is in close proximity to the proposal.

3.2 DESCRIPTION OF PROPOSED ACTIVITIES AND TIMEFRAMES

The proponent intends to construct the project components (described in the preamble) over a 20 year period. The proponent proposes to commence construction in 2014 subject to the receipt of all necessary approvals. Construction will be staged, with Stage 1 expected to comprise construction of a breakwater and reclamation bunding, first stage channel deepening, partial harbour dredging and reclamation filling, and construction of two berths. Stage 2 is expected to comprise additional harbour dredging, reclamation filling and the construction of one berth. Stages 3, 4 and 5 are expected to comprise the final channel deepening, complete harbour dredging, reclamation filling and berth construction.

4 INFORMATION AND ADVICE RELATED TO THE PREPARATION OF THE ENVIRONMENTAL IMPACT STATEMENT

4.1 THE OBJECTIVES OF AN ENVIRONMENTAL IMPACT STATEMENT

Environmental impact assessment depends on adequately defining those elements of the environment that may be affected by a proposed development, and on identifying the significance, risks and consequences of the potential impacts of the proposal. The EIS will be a significant source of information on which the public and government decision-makers will assess the potential environmental impacts of the proposal.

It is expected that additional ecological and socio-economic investigations will be required to be undertaken to provide sufficient information for the EIS. The nature and level of investigations must be related to the likely extent and gravity of the potential impacts (likelihood, consequence, magnitude, extent and scale of impacts, including worst case scenarios). All potential impacts of the proposal on social, cultural, heritage and environmental values are to be investigated and analysed, and commitments to avoid, mitigate and offset any adverse impacts are to be detailed in the EIS.

This document provides Guidelines (or terms of reference) for the drafting of the EIS based on the formal requirements for the contents of an EIS provided in:
Section 102 of the EPBC Act and Schedule 4 of the EPBC Regulations; and
Sections 88Q and 88R of the GBRMP Regulations.

In preparing the EIS the proponent must consider the following aims of the EIS and public review process: To provide a source of information from which interested individuals and groups may gain an understanding of the proposal, the need for the proposal, the alternatives, the environment[1] which it could potentially affect, the impacts that may occur and the measures proposed to be taken to avoid and minimise these impacts; to provide a forum for public consultation and informed comment on the proposal; and to provide a framework in which decision-makers can consider the environmental aspects of the proposal including biophysical, cultural, social, heritage, economic, technical and other factors.

The proponent must ensure that the EIS discusses compliance with the objectives of the EPBC Act and GBRMP Act, and the principles of ecologically sustainable development as set out in the EPBC Act and GBRMP Act (Attachment 3).

The draft EIS prepared by the proponent must be approved for publication by the Minister prior to it being published in accordance with the EPBC Regulations. An invitation for anyone to provide comments relating to the draft report within the period specified must also be published. After the period for comment, the proponent must take account of the comments received in finalising the EIS, which is then provided to the Minister. A recommendation report for the controlled action is then prepared by DSEWPAC. GBRMPA will also prepare an assessment report for components of the proposal requiring a permission under the GBRMP Regulations. Following this, in accordance with Part 9, Division 1 of the EPBC Act, the Minister will decide whether to approve the proposal and attach any conditions required. GBRMPA cannot grant a permission for actions requiring a permission under the GBRMP Regulations if the Minister has not decided to approve the taking of that component of the proposal under the EPBC Act.

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[1] The definition for ‘environment’ is as stipulated under section 528 of the EPBC Act and should be considered when any reference to the 'environment' is made in the EIS.

It is the responsibility of the proponent preparing the EIS to identify and address, as fully as possible, all matters relevant to this proposal and its potential impacts.

The EIS must provide a description of the existing environment in the area affected by the proposal and any decommissioning of existing infrastructure, construction and operations proposed. All potential impacts on the environment are to be investigated and analysed. The EIS must present an evaluation of the potential environmental impacts using an accepted risk-based methodology and describe proposed measures to avoid, minimise or offset the expected, likely, or potential impacts. Particular attention must be given to potential impacts on the environment and listed values of the Great Barrier Reef World Heritage Area and National Heritage place, the Great Barrier Reef Marine Park, listed threatened species and communities, listed migratory species, Wetlands of international importance and the Commonwealth marine environment under the EPBC Act. Any prudent and feasible alternatives must be discussed in detail and the reasons for selection of the preferred option must be clearly given.

These EIS Guidelines are not necessarily exhaustive and should not be interpreted as excluding from consideration currently unforeseen matters that emerge as important from environmental studies or otherwise during the course of the preparation of the EIS.

The specific requirements to be addressed in the EIS are provided in Section 5. It is on these requirements that public comment is sought, with the earlier sections of this document providing the context.

4.2 GENERAL ADVICE

The EIS must be a stand-alone document. It must contain sufficient information from any studies or investigations undertaken to avoid the need to refer to previous or supplementary reports. The EIS is to address both the Australian Government Guidelines and the Queensland Government Terms of Reference. A cross referencing table should be provided in an Appendix to enable cross referencing of information provided in the EIS with Australian and State Government requirements. Headers and/or footers should be used on every page to denote which section the page relates to (i.e. based on the table of contents).

The EIS must enable interested stakeholders and the assessing agencies to understand the environmental consequences of the proposed development. Information provided in the EIS must be objective, clear, succinct and, where appropriate, be supported by maps, plans, diagrams or other descriptive detail. The body of the EIS is to be written in a style that is easily understood by the general reader. Technical jargon must be avoided wherever possible and a full glossary included. Cross-referencing should be used to avoid unnecessary duplication of text.

If it is necessary to make use of material that is considered to be of a confidential nature, the proponent should consult with the Department on the preferred presentation of that material, before submitting it to the Minister for approval for publication.

Detailed technical information, studies or investigations necessary to support the main text must be included as appendices issued with the EIS. Any additional supporting documentation and relevant studies, reports or literature not normally available to the public from which information has been extracted must be made available at appropriate locations during the period of public display of the EIS.

An executive summary must be provided in the EIS and made available as a stand-alone document for public information.

The EIS must state the criteria adopted in assessing the proposal and its potential impacts, such as: compliance with relevant legislation, policies, standards and best practice; community acceptance; maximisation of environmental benefits (if any); and minimisation of risks and harm.

Any and all unknown variables or assumptions made in the assessment must be clearly stated and qualified. The extent to which the limitations, if any, of available information may influence the conclusions of the environmental assessment must be discussed.

The proponent must ensure that the personnel providing information to address this EIS have the relevant qualifications and experience in their relevant fields.

The EIS must comprise three elements:

a) The executive summary;

b) The main text of the document, written in a clear and concise manner so as to be readily understood by general readers; and

c) Appendices containing:

    i. a table cross referencing Australian Government and State EIS requirements (by section number and page number(s)) with an EIS table of contents;

    ii. a copy of these Guidelines; and

    iii. detailed technical information.

Part 5 of these Guidelines details the Australian Government requirements for the EIS and has been set out in a manner that may be adopted as the format for the EIS. This format need not be followed where the required information can be more effectively presented in an alternative way. However, all requirements set out in the EPBC Act and Regulations and GBRMP Act and Regulations must still be addressed.

The EIS must be written so that any conclusions reached can be independently assessed. To this end all sources must be appropriately referenced.

5 SPECIFIC CONTENT REQUIREMENTS

An extract of Schedule 4 of the EPBC Regulations 2000, which sets out the matters that must be addressed in an EIS, is provided at Attachment 1. An extract of the GBRMP Regulations 88Q and 88R, which set out considerations for deciding whether or not to grant a permission, is provided at Attachment 2. The following content requirements are based on these matters and considerations, with the addition of directions specific to the proposed action and the receiving environment. Requirements on presentation and consultation, that have proven valuable in communicating with members of the public and specific interest groups, are also included.

5.1 EXECUTIVE SUMMARY

An executive summary that outlines the key findings of the EIS must be provided. The executive summary must briefly:

a) State the background and the need for the proposal;

b) Discuss alternatives and the reasons for selecting the preferred option and rejecting the alternatives;

c) Summarise the pre-construction, construction and operational activities associated with putting the proposal into practice;

d) State the proposed schedule for each key component of the proposal, the relationships and interdependencies between each stage, the expected duration of each stage and the proposal as a whole;

e) Provide an overview of the existing regional and local environments, summarising the features of the physical, biological, social, cultural and economic environment relating to the proposal and associated activities;

f) Summarise stakeholder consultation undertaken in preparing the EIS;

g) Describe the expected, likely and potential impacts of the proposal on matters of National Environmental Significance, the physical, biological, social, cultural and economic environment during pre-construction activities, construction, operational and post-operational phases;

h) Summarise the environmental protection measures and safeguards, mitigation measures, offsets and monitoring to be implemented for the proposal; and

i) Provide an outline of the environmental record of the proponent.

5.2 OBJECTIVE

The objectives of the EIS must be clearly stated and include specific reference to EPBC Act and GBRMP Act legislative requirements.

5.3 GENERAL INFORMATION

The EIS is to provide the background of the proposed development. This is to include:

a) The title of the proposal;

b) The full name and postal address of the designated proponent;

c) A clear outline of the proposal;

d) The location of the proposal;

e) The background to the development of the proposal;

f) How the proposal relates to any other developments (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region;

g) The current status of the proposal;

h) Prudent and feasible alternatives to the proposed action, including scale, configuration and staging options;

i) The consequences of not proceeding with the proposal or components of the proposal and/or the consequences of other projects (that this action relies upon) not proceeding;

j) A brief explanation of the scope, structure and legislative basis of the EIS;

k) The specific EPBC Act and GBRMP Act matters affected by the proposal; and

l) A description of government planning policies, statutory controls and agreements which will influence the proposal. All applicable jurisdictions and areas of responsible authorities within the area (both terrestrial and marine) must be listed and shown on maps at appropriate scales.

5.4 THE PROPOSAL DESCRIPTION

This section must describe the proposal in sufficient detail to allow an understanding of all stages (including interdependencies between stages) and components of the proposal, and determine potential environmental impacts associated with the proposal. Those elements with potential implications for matters protected under Part 3 of the EPBC Act must be highlighted.

All pre-operational construction, operational and decommissioning components of the action (short and long term) must be described in detail. This includes, but is not limited to, the date or time period over which construction will take place, details of the locations of each component of the proposal (i.e. preferably the precise location (including coordinates) of all works to be undertaken and/or the footprint area(s)), dimensions of structures/vessels to be built and materials, equipment to be used as well as construction access requirements, lay down/set down areas and elements of the action that may have impacts on matters of National Environmental Significance.

A discussion of the assumptions underlying the predicted operation of the proposal and associated changes in the activities undertaken in the surrounding environment must be provided.

Details of proposed monitoring and enforcement programs to help limit the impacts of the ongoing operations, including but not limited to dredging and increased vessel activity in the area, on matters of National Environmental Significance, must also be addressed.

5.5 PROJECT DETAILS

The description of the proposal must cover:

a) The environmental principles on which the development will be managed;

b) All the components of the proposal including:

    i. site selection including the choice of region for the project and site within that region, an analysis of prudent and feasible alternative sites and why this site is likely to have the least impact on matters of National Environmental Significance;

    ii. describe all feasible, economic alternative site options for the proposal (e.g. through a multi-criteria analysis);

    iii. development options, including an explanation of prudent and feasible alternatives;

    iv. associated infrastructure, including transport networks/corridors (both land, estuarine and marine);

    v. construction, including dredging and dredged material disposal requirements and mooring and anchoring requirements;

    vi. commissioning;

    vii. operation, including details of the expected vessel numbers for each stage of the proposed development; and

    viii. related maintenance activities, both long and short term including but not limited to dredging and dredged material disposal requirements.

c) Describe the local and regional economic, social and built context, including historical and future trends (e.g. Australian Bureau of Statistics and *Great Barrier Reef Outlook Report 2009*) in which this project is proposed;

d) Future development areas that are currently "greenfield" in the region and the likely nature and timing of development, (including but not limited to strategic port development lands, state development areas);

e) Describe the overall planning context in which proponents' decisions for this project have been made (including the overarching plan in which this project sits within);

f) A detailed description of social and economic impacts and drivers for the proposal;

g) The precise location of works to be undertaken (including specific footprint area(s)), structures to be built or other elements of the proposal that may have impacts on the environment. Aerial photographs, maps, figures and diagrams must be incorporated where appropriate;

h) A general location map that includes the location of other known or potential future developments occurring at the Port of Townsville;

i) The following maps and figures must be provided in relation to the Great Barrier Reef Marine Park and Great Barrier Reef World Heritage Area:

    i. a detailed map showing the boundary of the Great Barrier Reef Marine Park, in relation to the proposed development footprint of the project, including the dredge footprint, offshore dredged material disposal ground, breakwaters, reclamation area; berths and other components of the project;

    ii. a detailed map showing the Great Barrier Reef Zoning adjacent to the project footprint This map or figure must include an explanation of the basis for the zoning in this area[2];

    iii. a map showing the location of the proposal in relation to the Great Barrier Reef World Heritage Area and National Heritage place;

    iv. a map showing the boundary of the Bowling Green Bay Ramsar Site;

    v. a map showing shipping lanes within the Great Barrier Reef Marine Park and Great Barrier Reef World Heritage Area in relation to the project footprint as described in (i); and

    vi. simulated viewfields of the proposal showing its visual impact from the adjacent coastline, nearby inhabited islands and the Great Barrier Reef World Heritage Area.

j) Reference must be made to detailed technical information in appendices where relevant;

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[2] http://www.gbrmpa.gov.au/__data/assets/pdf_file/0016/6172/gbrmpa_report_on_zoning.pdf

k) How the works are to be undertaken and design parameters for all aspects of the structures or elements of the proposal. This must include:
    i. an explanation of the anticipated timetable for pre-construction, construction and operation;
    ii. details of construction and operational equipment to be used;
    iii. details of the environmental parameters (incorporating predictions of climate change and 'worst case scenarios') the structures are designed to withstand, based on the expected life of asset; and
    iv. a summary of the design aspects that will be employed to minimise impacts on environmental, social, cultural and heritage values.

5.6 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

In relation to matters of National Environmental Significance listed as controlling provisions for the proposal an inventory of surveys, whether office-based or field-based, must be provided. These may be provided as appendices, but must at least be fully referenced and must be made publicly available unless DSEWPAC is furnished with compelling reasons not to do so. Any anticipated future surveys to be conducted in relation to matters of National Environmental Significance, whether office-based or field-based, must also be discussed.

Output from the protected matters search tool (accessible from DSEWPAC's website) must be also included as an appendix. The results, indicating the presence of matters of National Environmental Significance, must also be provided. Any species or values considered likely or known to occur in areas impacted by the controlled action must be addressed. The description of matters of National Environmental Significance should focus on, but not be limited to the following controlling provisions:

a) World Heritage properties (sections 12 & 15A);
b) National Heritage places (sections 15B & 15C);
c) Wetlands of international importance (sections 16 & 17B);
d) Listed threatened species and ecological communities (sections 18 & 18A);
e) Listed migratory species (sections 20 & 20A);
f) Commonwealth marine areas (sections 23 & 24A); and
g) Great Barrier Reef Marine Park (sections 24B & 24C).

5.7 ALTERNATIVES TO THE PROPOSAL

This section must describe, to the extent reasonably practicable, any prudent and feasible alternatives to the proposal. For each alternative listed the proponent should provide the project details, impacts (positive and negative), location, scale, configuration and staging options. Sufficient detail must be provided to make clear why any alternative is preferred to another. This section must describe, but not be limited to the following:

a) The alternative of taking no action or not proceeding with components of the proposal;
b) Potential alternative locations for different components of the proposal;
c) Potential alternative configuration or scale options for key components of the proposal;

d) Describe options for integrating operations with existing infrastructure where they exist to mitigate impacts on the general environment, ecosystems and matters of National Environmental Significance;

e) A comparative description of the adverse and beneficial impacts of the development as a whole, each component of the development, and location on the matters protected by the controlling provisions for the proposal;

f) A description of how each stage would be affected if one or more of the stages does not occur or is significantly modified;

g) The reasons for choosing the preferred location and option for the development as a whole, and each key component of the proposal, must be explained. The explanation must include a comparison of the adverse and beneficial effects used for selecting the preferred location and option, and compliance with the objectives of the EPBC Act and GBRMP Act (including the principles of ecologically sustainable development and use);

h) The advantages and disadvantages of alternatives when considered against relevant matters protected under the EPBC Act and GBRMP Act, including critical issues identified in the *Great Barrier Reef Outlook Report 2009*, must be specifically addressed; and

i) Short, medium and long-term advantages and disadvantages of the options must be considered.

5.8 CONSULTATION

The proponent is required to consult with all stakeholders, with a particular focus on individuals/sectors that may be affected by the proposal (affected parties), as part of the EIS process. Details of any consultation about the action must be provided. This is to include:

a) Any consultation that has already taken place including details on the frequency, forum and timeframes provided for consultation;

b) Proposed consultation about relevant impacts of the action;

c) If there has been consultation about the proposed action, details of the issues discussed, including the views of the affected and any documented response to, or result of, the consultation;

d) Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views;

e) Details on how affected parties comments received during consultations have been addressed in the EIS; and

f) Any further proposed consultation about potential impacts of the action.

5.9 THE EXISTING ENVIRONMENT

This section must provide a description of the project area including baseline condition and trends of Cleveland Bay’s coastal and marine environments, including hydrology, sediment flows, geography, flora and fauna, cultural and heritage values, and all relevant socio-economic considerations. This section must link to the proposal description, potential impacts, and proposed avoidance, mitigation, adaptive management measures and/or offset measures throughout the life of the project including pre-construction, construction and operation. This section is to also identify and reference any relevant (published and unpublished) studies undertaken in the area which will assist in describing patterns and trends in the environment.

A description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information:

a) Listed migratory species and listed threatened species and ecological communities that are likely to be present in the vicinity of the site, including but not limited to marine turtles, inshore dolphins, cetaceans, dugong and migratory birds including shorebirds;

b) At a minimum the following details must be included:

   i. details of the scope, timing (survey season/s) and methodology for studies or surveys used to provide information on the listed species/community/habitat at the site (and in areas that may be impacted by the project).

   ii. include a summary of the location, size and breeding status of threatened and migratory species listed under the EPBC Act which are likely to occur in the area affected by the proposal.

c) Information on listed threatened and migratory species, including foraging, roosting, resting and nesting habitats, must include but not be limited to:

   i. describe and map critical habitat for threatened species, ecological communities and migratory species;

   ii. the importance of habitat in a local, regional, national and international context;

   iii. the status of the population (e.g. abundance) in the area likely to be affected by the proposed development relative to other areas outside the area likely to be affected;

   iv. genetic diversity;

   v. the viability of the local, regional and overall populations;

   vi. local and regional representation;

   vii. conservation and biodiversity values;

   viii. economic, social and cultural values of species;

   ix. the extent (in hectares) of any areas of important or unique habitat; and

   x. seasonality influences.

d) Identify the desired conservation outcomes that the project has for matters of National Environmental Significance;

e) Describe the biophysical/regional conditions that are required for matters of National Environmental Significance to be maintained and that are required to reach articulated conservation objectives for matters of National Environmental Significance;

f) Identify factors that influence matters of National Environmental Significance including human-induced and natural factors e.g. climate change and flooding;

g) Describe and quantify natural variability of matters of National Environmental Significance where adequate data is available or can be sourced;

h) Describe the extent to which the general environment, ecosystems and matters of National Environmental Significance are already stressed by natural and anthropogenic effects;

i) Identification of the World Heritage and National Heritage values expressed in the vicinity of the proposed development, including an evaluation of the contribution that the values expressed at this location make to the overall values for the Great Barrier Reef World Heritage Area and National Heritage place;

j) A description of the ecological character of the Bowling Green Bay Ramsar site;

k) A description of the Commonwealth marine environment and identification of those aspects of the Commonwealth marine area potentially affected by the proposal, including but not limited to baseline data on listed threatened species, migratory and marine species and any other species of conservation significance, including cetaceans;

l) Provide a description of biota/biotic habitats, including a map of marine/intertidal habitats (including information on seasonal fluctuations e.g. seagrass prevalence), likely to be affected by the proposed development;

m) Identify, describe and map environments important to the health of the Great Barrier Reef Marine Park, including terrestrial and intertidal habitats, that are likely to be affected by the proposed development;

n) Identify, describe and map reef communities[3] and those species supported by reef communities in areas likely to be affected by the proposed development, including information on species diversity and abundance;

o) Identify, describe and map seagrass communities in areas likely to be affected by the proposed development, including information on species diversity, seasonality and abundance;

p) Identify, describe and map soft sediment fauna communities (e.g. infauna, benthic invertebrates) in areas likely to be affected by the proposed development, including information on species diversity, seasonality and abundance;

q) Describe oceanographic conditions in the region, especially those which may have a bearing on the proposal. Include information on seasonal variation, waves, tides, currents, water salinity, clarity, temperature and depths. Discuss the frequency and severity of weather conditions such as storms and cyclones, for two, ten and 100 year conditions; and

r) Identify and describe the existing uses of the area and nearby areas that may be affected by the proposed action (for example; tourism, commercial and recreational fishing, research and traditional use activities).

All habitat maps must be produced at a sufficiently fine scale and as accurately as possible, considering their primary purpose and end use. (for example: to evaluate habitat loss and inform locations of monitoring and reference sites).

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[3] A reference to reef communities includes all Great Barrier Reef ecosystem components including corals, algae, mangroves, soft sediment habitats etc (as per the Great Barrier Reef Outlook Report 2009).

5.10 RELEVANT IMPACTS

The EIS must include a description of all of the relevant impacts[4] of the action. Relevant impacts (both direct and indirect) are impacts that the action will have or is likely to have on a matter protected by a controlling provision (as listed in the preamble of this document). This section must provide clear linkages with the existing environmental values described in section 5.9 and proposed avoidance, safeguards, management and mitigation measures described in section 5.11. Impacts during both the pre-operational construction, operational and (if relevant) the decommissioning phases of the project must be addressed. This section must include:

a) A description of the framework used to assess impacts, including risk assessment processes, based on an approved standard;

b) A detailed assessment of the nature, extent, likelihood and consequence of the likely short-term and long-term impacts including but not limited to: description of the risks and potential impacts (acute and chronic) from the release of cargo material (such as dust from the handling of mineral ores) from the proposed action to the environment; description of the risks and potential impacts of related activities including blasting and pile driving and the impacts of increased marine underwater noise on marine species including the impacts from noise at varying distances from each project component (considering the environmental variables e.g. depth, wave height and bottom profile); impacts of the proposal on air quality; specific guidance is provided for dredging and dredged material disposal impacts and impacts from increased shipping;

c) A statement whether any relevant impacts are likely to be unknown, unpredictable, irreversible or sub-lethal (reversible over time) and what confidence level is placed on the predictions of relevant impacts;

d) Analysis of the significance of the relevant impacts;

e) Any technical data, including modelling, and other information used or needed to make a detailed assessment of the relevant impacts;

f) A risk assessment of changing climate patterns that may affect the proposal and surrounding environment and a description of the preferred and alternative adaptation strategies to be implemented;

g) In discussing potential impacts, consider how the interaction of extreme environmental events (e.g. cyclones, coral bleaching, flood events) and any related cumulative impacts may impact on the proposal and the environment (both independently and cumulatively);

h) Consideration of potential impacts throughout the life of the proposal – from pre construction, construction through to operation;

i) Downstream impacts of the proposed action on water quality and adjacent reef communities and island communities;

j) Impacts to the sea floor through anchoring and/or direct placement of material/infrastructure, sediment disturbance. The GBRMP zone of likely seabed disturbance must be identified;

k) Impacts of anticipated light illumination on marine fauna particularly seabirds, marine turtles and other migratory species, including impacts on nesting and disorientation;

l) Impacts on the existing use of the area and nearby areas that may be affected by the proposed action;

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[4] Please refer to section 527E of the EPBC Act for the meaning of impact.

m) Impacts on amenity (including from the mainland, air, vessels and surrounding islands); and

n) A description of anticipated positive and negative social, cultural and/or economic impacts of the proposal on key stakeholder groups and individuals. This should include a consideration of anticipated changes in the social, cultural and heritage values of the Marine Park.

5.10.1 IMPACTS TO LISTED MIGRATORY SPECIES, THREATENED SPECIES AND ECOLOGICAL COMMUNITIES

The EIS must provide an assessment of all potential and likely impacts to listed migratory species, threatened species and ecological communities from the construction and on-going operation of the development.

5.10.2 IMPACTS TO LISTED VALUES OF THE GREAT BARRIER REEF WORLD HERITAGE PROPERTY

Provide an assessment of all potential and likely impacts to the World Heritage values of the Great Barrier Reef World Heritage property that have been identified as being expressed in the vicinity of the proposal during construction, operation and (if applicable) decommissioning of the proposal. This assessment must include an analysis of the impact of the proposal on the expression of the values at this location and how this in turn impacts on the overall values of the Great Barrier Reef World Heritage property.

Provide an analysis of direct, indirect and relevant impacts of the proposal on the integrity and Outstanding Universal Value of the Great Barrier Reef World Heritage Area.

5.10.3 IMPACTS TO LISTED VALUES OF THE GREAT BARRIER REEF NATIONAL HERITAGE PLACE

Provide an assessment of all potential and likely impacts to the National Heritage values of the Great Barrier Reef National Heritage place that have been identified as being expressed in the vicinity of the proposal during construction, operation and (if applicable) decommissioning of the proposal. This assessment must include an analysis of the impact of the action on the expression of the values at this location and how this in turn impacts on the overall values of the Great Barrier Reef National Heritage place.

5.10.4 IMPACTS TO THE BOWLING GREEN BAY RAMSAR SITE

Provide an assessment of all potential and likely impacts to the ecological character of the Bowling Green Bay Ramsar site during construction, operation and (if applicable) decommissioning of the proposal.

5.10.5 IMPACTS TO THE COMMONWEALTH MARINE ENVIRONMENT

Provide an assessment and discussion of the potential direct, indirect and consequential impacts of the proposed development on the Commonwealth marine environment.

5.10.6 IMPACTS TO THE GREAT BARRIER REEF MARINE PARK

Provide an assessment and discussion of the potential direct, indirect and consequential impacts of the proposed development on the environment and values of the Great Barrier Reef Marine Park.

5.10.7 CUMULATIVE IMPACTS OF THE PROPOSED DEVELOPMENT

The EIS should identify and address cumulative impacts[5], where potential project impacts are in addition to existing impacts of other activities (including known current and future expansions or developments by the proponent and other proponents in the region and vicinity).

The EIS should also address the potential cumulative impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment should also be considered in the assessment of ecosystem resilience. Where relevant to the potential impact, a risk assessment should be conducted and documented.

The risk assessment should include known future expansions or developments by the proponent and other proponents and known impacts on ecosystem resilience and matters of National Environmental Significance. Information on cumulative impacts may include as appropriate, but not be limited to:

a) Description of existing, planned or potential developments (including construction status) of a similar type and scale to the proposed development, that have been approved within the last five years or are still under assessment with emphasis on those in the region that have, will have or are likely to have impacts on the same matters of National Environmental Significance;

b) Description of existing, planned or potential developments (including construction status) of a similar type and scale to the proposed development, that have been approved within the last five years that have, will have or are likely to have impacts on the same matters of National Environmental Significance;

c) Description of any current or likely development precincts or zones in the region, their relationship to the proposed development and the likely cumulative impacts on the general environment, ecosystems and matters of National Environmental Significance as all projects are developed to capacity;

d) Discussion of the impacts of other tourism, residential, industrial and infrastructure projects both directly and indirectly related to the proposal in a regional context;

e) Discussion of the range of developments which will be facilitated or impacted (either positively or negatively) by the proposal and if the project will result in an intensification of development in the region;

f) Discussion and analysis of the cumulative impacts of this proposal on the integrity and Outstanding Universal Value of the Great Barrier Reef World Heritage Area;

g) Discussion of known impacts on ecosystem resilience, including reference to issues identified in the *Great Barrier Reef Outlook Report 2009*;

h) Discussion of any potential future changes to the development which are likely to change the nature or scale of environmental impacts;

i) Outline if existing impacts on the environment in general and matters of National Environmental Significance will be amplified by the action in combination with impacts of other projects;

j) Discussion of the developments and activities which are likely to be facilitated by the proposal;

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[5] Please refer to section 527E of the EPBC Act for the meaning of impact.

k) Identify if the resulting impacts on the general environment, ecosystems and matters of National Environmental Significance could be unacceptable;

l) Identify if these impacts on the general environment, ecosystems and matters of National Environmental Significance could be permanent. If the impacts on matters of National Environmental Significance are not permanent, describe how long it will take before recovery from the effect;

m) Describe how the proposed project will impact on the reproductive capacity and/or survival of listed threatened and migratory species;

n) Explain how much recovery of a matters of National Environmental Significance population, habitat, ecosystems and the environment in general could occur, with and without mitigation (e.g. complete, partial, none);

o) Describe how soon restoration of habitat could be achieved to reinstate ecosystem function for matters of National Environmental Significance;

p) Where possible, identify how much likely change to matters of National Environmental Significance exceeds natural variability in the region;

q) Describe how this project will contribute to the desired conservation objectives for matters of National Environmental Significance; and

r) In conducting the risk assessment, key information sources and indicators for assessing change and impact must be described.

5.10.8 CONSEQUENTIAL IMPACTS

Provide a detailed assessment of any likely impacts that this development may facilitate on the following (at the local, regional, state, national and international scale)[6]:

a) The World Heritage values of the Great Barrier Reef World Heritage Area;

b) The National Heritage values of the Great Barrier Reef National Heritage place;

c) Wetlands of international importance;

d) The environment of the Great Barrier Reef Marine Park;

e) Listed threatened species and ecological communities;

f) Listed migratory species; and

g) The Commonwealth marine environment.

5.10.9 DREDGING AND DREDGED MATERIAL DISPOSAL RELATED IMPACTS

The EIS must provide an assessment of the dredging and dredged material disposal related elements of the project and its impacts, including but not limited to the following:

a) Review of the historical use of the dredge disposal ground/s used by the Proponent, including but not limited to;

    i. location, volume, timing, nature of material and equipment used;

    ii. identification of direct and indirect impacts of dredge material disposal over time; and

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[6] Please refer to section 527E of the EPBC Act for the meaning of impact.

    iii. an assessment of alternatives to the current dredge disposal ground.

b) Detailed evaluation of all potential disposal options in accordance with the *National Assessment Guidelines for Dredging 2009* (NAGD 2009) and Annex 2 of the *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972* (as amended in 2006) (London Protocol), identification of the preferred disposal option(s) and explanation of how the preferred option was selected;

c) The amount to be dredged and a map of the dredge footprint and locations for proposed disposal. The map should also indicate the proposed staging of dredging activities;

d) The type and method of dredging proposed with the expected length and timing of the dredging activities;

e) Discussion of proposed dredging equipment and methodology;

f) Other uses of the dredged material including any re-use, recycling or possible future use;

g) Assessment of sediment according to the NAGD 2009 this must include an assessment of the suitability of this material for land deposition and reclamation and offshore disposal at any proposed dredged material disposal ground;

h) Assessment of the risk and potential impacts of acid sulfate soils (ASS) and potential acid sulfate soils (PASS);

i) Consideration of potential impacts of mobilised sediments (e.g. metal or contaminant release);

j) Details of future maintenance dredging requirements over the life of the project;

k) Details of any previous sea dumping permits applied for including dates and volumes and whether the permit was for capital dredging or maintenance dredging;

l) Detailed descriptions of potential impacts on the marine habitats and species within the proposed dredge footprint and disposal areas, including but not limited to assessment of seagrass and species that depend on it, including any marine flora and fauna protection measures proposed;

m) The characteristics of the dredged material disposal area(s) proposed including the history of the site and the predicted fate of the material after disposal and over time and the potential zone of impact;

n) Detailed descriptions of both the direct and indirect impacts along with an assessment of the reversibility of those impacts are to be included in predictions of impacts associated with the activity of dredging and disposal on marine habitats and species[7];

o) Predictive, fully three dimensional modelling of indirect impacts of dredge generated sediments must include:

    i. hydrodynamic modelling;

    ii. sediment transport modelling where the range of particle fractions (sand, silt and clay) are all modelled;

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[7] The Environmental Assessment Guideline for Marine Dredging Proposals, September 2011, prepared by the Environmental Protection Authority, Western Australia, is an example of a document that presents guidance on predicted impacts of dredging activities on benthic communities and habitats.

    iii. modelling must include all types of resuspension possibilities including currents and wave-induced bottom shear stresses as well as wave induced mud fluidisation. If not modelled a justification as to why this phenomena was not relevant for that site.

    iv. ecological impact predictions. Lethal and sub lethal thresholds used for the ecological impact predictions must be clearly indicated and substantiated with relevant scientific peer reviewed articles;

    v. testing the sensitivity of ecological impact predictions to different pressure thresholds and considering seasonal effects must also be undertaken to understand the likely range of prediction outcomes;

    vi. proponent to provide results of modelling in a suitable electronic format (i.e.shapefiles); and

    vii. the modelling must represent the conditions at the time of year in which the dredging will actually occur. If this is not known then modelling must be undertaken for all seasons (i.e. summer conditions, winter conditions, transitional conditions) depending on prevalent oceanographic conditions.

p) Modelling must include likely dispersion and resuspension from both dredging operations and dredge material disposal during a range of probable hydrodynamic conditions, weather events and expected dredge equipment scenarios;

q) Site selection of dredge disposal site (even if a historic site) must be justified and compared to other possible sites with a prediction for resuspension and possible direction and distance of the migration of the dredged material under different current conditions;

r) Model outputs must use a spatially based scheme that provides for a clear and consistent way of describing and presenting the extent, severity and duration of predicted impacts of dredging and dredged material disposal and must include likely "best case" and likely "worst case" scenarios;

s) Modelling must be independently peer reviewed. Information relating to the peer review, including the Terms of Reference and the peer reviewer's report must be included as part of the EIS documentation;

t) Impacts to benthic habitat, in particular benthic primary producer habitat (BPPH), must be described. The benthic habitat must be mapped and the potential impacts must be described, taking into consideration the sediment plume monitoring. Cumulative impacts of the entire dredge operation and likely maintenance dredging requirements must be described; and

u) Identify the potential vectors and risks of introducing marine invasive species through vessels involved in dredging operations; and how these risks will be appropriately managed. Must include but not be limited to ballast water, entrainment of mud and sediment and biofouling in dredge equipment and ancillary fitting, niche areas, internal seawater systems, vessel history, previous work locations and maintenance history.

5.10.10 RECLAMATION AND LAND BASED DISPOSAL

a) Describe any prudent and feasible alternatives to the proposed reclamation (e.g. re-use). For each alternative listed the proponent should detail the impacts (positive and negative), location, scale, and configuration;

b) describe the impact of the proposed reclamation in Cleveland Bay on seagrass, and on hydrodynamics and coastal processes;

c) A plan of the proposed land to be reclaimed, drawn to an appropriate scale, showing the following information:

    i. the boundary of the land to be reclaimed, tied to real property boundaries;

    ii. the location of the line of mean high water spring tide and highest astronomical tide in relation to the area of reclamation;

    iii. existing levels of the land and proposed final levels of reclamation in relation to the lowest astronomical tide (LAT) or Australian Height Datum (AHD);

    iv. location of marine plants and species habitat within the land to be reclaimed and existing and proposed bund area;

    v. typical cross section across the land to be reclaimed showing the proposed finished levels and method of protecting the seaward boundary of the reclamation from erosion;

    vi. discussion of how the land reclamation may affect the current erosion and deposition patterns in terms of changes to the low water mark of the World Heritage Area boundary;

    vii. discussion of the impacts to the roosting sites (sand bars) at the mouth of the Ross River due to potential hydrological changes from dredging and land reclamation; and

    viii. three dimensional modelling of the impacts of the land reclamation on the current sediment transport and hydrodynamic patterns within Cleveland Bay.

d) The method, location and issues associated with the disposal of dredged material must be described including:

    i. for land-based dredged material disposal, a detailed description of potential methods, location issues/risks must be presented.

    Consideration must be given to:

    i. quantities and quality of tail water likely to be generated from dredging activities and the rate of their discharge;

    ii. the settling rate of fine sediments from all dredge material types;

    iii. the residence time within settling ponds prior to discharge (related to dredge pumping rate, ratio of solids to water in the dredged material, settling rates, available capacity of the disposal and settling areas, potential bulking factor, intensity and duration of rainfall events with consideration given to the worst case scenario for these factors);

    iv. source of material for bunds and bund wall stability.

5.10.11 INCREASED SHIPPING

a) In relation to the projected increase in shipping, at a minimum, details of the following must be discussed:
   i. describe current vessel numbers and type utilising the port, their speed, their size, shipping movements, anchorages, access to/from the port and navigational arrangements;
   ii. describe projected total vessel movements at each stage of the project, including at the completion of the project. Include a comparison with total shipping movements through the Great Barrier Reef World Heritage Area and National Heritage place, Great Barrier Reef Marine Park; and
   iii. shipping routes to be used by vessels beyond the port in Commonwealth marine waters. These should be indicated on a map in relationship to the Great Barrier Reef World Heritage area and National Heritage place, Great Barrier Reef Marine Park and to the main shipping channels and any other navigational arrangements.

b) In regard to increased shipping volumes, the following should be specifically addressed:
   i. potential for introduction of marine invasive species from increased shipping rates;
   ii. potential increase in ship groundings and related impacts;
   iii. potential increased risk of vessel collisions and related impacts;
   iv. potential for increased vessel strike to marine species;
   v. ballast water management arrangements - including Australian Quarantine and Inspection Service (AQIS) mandatory arrangements and agency contingency planning;
   vi. management of ship waste, in particular quarantine waste, domestic garbage, oil and sewage;
   vii. potential risk of spills and their management, including stochastic modelling of potential worst case potential spill scenarios;
   viii. potential impacts on existing shipping activity;
   ix. the potential use of the Great Barrier Reef World Heritage Area and Great Barrier Reef Marine Park for the offshore anchorage of ships and the associated impacts of anchorages, including impacts on other users of large areas of the Great Barrier Reef Marine Park potentially being set aside (almost exclusively) as designated anchorage areas; and
   x. additional marine transport issues that should be considered include the potential of the proposal to impact on domestic commercial and recreational vessels.

5.10.12 OTHER USES OF THE AREA AND NEARBY AREAS

The EIS must identify the potential impacts of the proposed action on other uses of the area identified in section 5.9, including but not limited to the following:

a) Social, cultural and heritage values for each stage of the proposal;

b) Current and projected commercial, recreational and scientific use, including any changes in visitation patterns;

c) Heritage and social values, including sites of historic or archaeological significance;

d) Commercial and recreational fishing; and

e) Traditional use activities.

5.11 PROPOSED SAFEGUARDS, MANAGEMENT AND MITIGATION MEASURES

The EIS must provide information on avoidance measures, proposed safeguards and mitigation measures to deal with the impacts of the action. Specific and detailed descriptions of proposed measures must be provided and substantiated, based on best available practices / standards and must include the following elements:

a) Identify the level of risk associated with potential impacts identified in section 5.10 and those that require mitigation, monitoring or management to avoid or reduce impacts to an acceptable level;

b) A consolidated list of measures proposed to be undertaken to avoid, prevent, minimise or manage the impacts of the action, including:

    i. a description of proposed avoidance measures, safeguards and mitigation measures to deal with impacts of the action, including measures proposed to be taken by State governments, local governments or the Proponent;

    ii. assessment of the expected or predicted effectiveness of the measures;

    iii. any statutory or policy basis for the mitigation measures;

    iv. the cost of the associated with the implementation of the mitigation measures; and

    v. the resulting risk level for that impact post- avoidance, mitigation and/or management.

c) Particular focus must be given to:

    i. determining factors in the planning of the proposal so as to avoid damage to the environment;

    ii. measures to avoid or minimise damage to the Great Barrier Reef World Heritage Area and estuary environment;

    iii. measures to avoid or minimise damage to the National Heritage Values of the Great Barrier Reef;

    iv. measures to avoid or minimise damage to the environment of the Great Barrier Reef Marine Park;

    v. articulating conservation objectives for individual matters of National Environmental Significance with a focus on receptors;

    vi. describing how this project is likely to contribute to protection of matters of National Environmental Significance;

    vii. outline how any avoidance, safeguards, management and mitigation measures will increase resilience of the environment, ecosystems and matters of National Environmental Significance within the region;

    viii. demonstrate how impact management and mitigation measures would ensure that matters of National Environmental Significance in the affected region are maintained or improved;

ix. characterise, quantify and address uncertainties that may affect the effectiveness of management measures and therefore on the confidence that biodiversity values would be maintained (or improved) during and after the project;

x. measures to avoid or minimise disturbance to fauna and flora found around and within the proposal area (particularly listed threatened species and communities and listed migratory species);

xi. management of the dredged material during the loading of the dredged material;

xii. management of the dredged material disposal area(s) during disposal operations;

xiii. management strategies for dredging, loading and dredged material disposal, including trigger levels for management actions linked to quantitative measurements of water quality and Benthic Primary Producer Habitat (BPPH) based on baseline data;

xiv. proposed monitoring before, during and after dumping including turbidity, water quality parameters that are likely to be affected and BPPH monitoring. Water quality parameters being monitored should include but may not be restricted to dissolved oxygen, nutrients, pH, turbidity, light attenuation, metals and metalloids and toxicants. Baseline water quality data that includes values for these parameters needs to be included in the EIS. This section should also include the likely impacts on turbidity and water quality from dredging and dredge dredged material disposal and establish the triggers for management actions and specify proposed management actions;

xv. for reclamation based dredge dredged material disposal proposed management must be presented. This must include how water quality will be monitored and managed to ensure that water quality objectives for this area are achieved and the environmental values of the connected surface water and groundwater are maintained. Reference should be given to the National Water Quality Management Strategy including the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), Queensland Water Quality Guidelines 2009, Water Quality Guidelines for the Great Barrier Reef 2010 and) the Australian Monitoring and Reporting Guidelines (2000). Any toxicants that may occur in the sediments must be identified and must be managed appropriately;

xvi. measures to limit channelling and sediment re-suspension in settling ponds;

xvii. measures to limit erosion and sediment re-suspension in discharge channels;

xviii. monitoring of water quality and operational performance monitoring;

xix. disposal of tail waters or overflow due to climatic conditions (such as rain or flooding) to the receiving environment;

xx. contingency measures in the event that discharge limits are exceeded; and

xxi. staff training, including training in relation to environmental issues.

d) An outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the impacts of the action, including any provisions for independent environmental auditing; and

e) The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.

5.12 OFFSETS

Environmental offsets broadly mean measures to compensate for the adverse residual impacts of an action on the environment. More specifically, offsets are measures to compensate for environmental impacts that cannot be adequately reduced through avoidance or mitigation. Offsets do not reduce the impacts of an action. Instead they provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures. These remaining impacts are termed 'residual impacts'[8].

Offsets are not intended to make proposals with unacceptable impacts acceptable. They simply provide an additional tool that can be used during project design and the Environmental Impact Assessment process.

This section of the EIS must outline plans to offset the remaining residual impacts of the proposal. Environmental offsets may be appropriate when they:

a) Are necessary to protect or repair impacts to a protected matter – i.e. a matter of national environmental significance or the environment more broadly;

b) Relate specifically to the matter (for example, species) being impacted; and

c) Seek to ensure that the health, diversity and productivity of the environment are maintained or enhanced.

5.13 MONITORING AND REPORTING

Appropriate baseline data requirements are to be provided as part of the EIS to form the basis for baseline measurement and ongoing monitoring of environmental parameters. It must be demonstrated that the proposed methods for baseline measurements and subsequent monitoring are based on current best practice, scientifically robust and statistically sound to enable diligent and systematic data collection that will deliver unbiased and sound responses to EIS Guideline requirements. This section must identify parameters to be monitored, the performance indicators to be used to evaluate accuracy of predicted impacts and effectiveness of mitigation measures and offsets, and management response trigger values and response activities.

This section is to also identify and describe monitoring programs, procedural and compliance audit programs and reporting requirements and arrangements which will demonstrate the effectiveness of proposed management measures and monitoring.

The proponent must, in addition to outlining proposed programs, clearly identify what is to be monitored and why. Monitoring programs must be designed to provide objective evidence regarding activities associated with the proposal and if these activities are adversely impacting on the environment in the short, medium and long term. Monitoring programs must demonstrate an understanding and consideration of:

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[8] Further information on offsets can be found in the Australian Government's framework on the use of environmental offsets ('offsets') under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Titled "Consultation Draft, Environmental Offsets Policy August 2011"

a) Ecosystems and habitats, climatic or seasonal variations, flora and fauna (particularly listed threatened species/ecological communities and listed migratory species), and water quality issues affected by the proposed development;

b) Measuring the effectiveness of mitigation and/or environmental offset measures;

c) Documenting the difference between predicted and actual impacts;

d) Methods for identification of non-predicted impacts and appropriate reporting and remedial measures;

e) Application and effectiveness of emergency and contingency plans; and

f) Review of consultation and management arrangements with regulatory authorities and the community.

A diagram showing monitoring and reporting arrangements must be included in the EIS.

5.14 OTHER APPROVALS AND CONDITIONS

The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:

a) Details of any local or State Government planning scheme, or plan or policy under any local or State Government planning system that deals with the proposed action, including:

    i. what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and

    ii. how the scheme provides for the prevention, minimisation and management of any relevant impacts;

b) A description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the EPBC Act), including any conditions that apply to the action;

c) A statement identifying any additional approval that is required; and

d) A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

5.15 ENVIRONMENTAL RECORD

The EIS must include the environmental record of the proponent. This must include:

a) Reference to the GBRMP Regulations 88R(j) which includes the applicant's history in relation to environmental matters (for example compliance with Marine Park permits and environmental management plans) and any outstanding charges; and

b) Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against the person proposing to take the action. If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must be provided.

Information relating to the persons' environmental record must also include any accreditations (for example ISO 14001), environmental awards, and other recognition for environmental performance.

5.16 ADDITIONAL SOCIAL AND ECONOMIC MATTERS

Section 136(1)(b) of the EPBC Act requires the Minister to consider economic and social matters when deciding whether to grant approval to the proposed action under Part 9 of the EPBC Act. The or requirements under s136(1)(b) encompass a broader range of matters that may be considered than those addressed during the assessment of the potential impacts of a controlled action. Accordingly, information must be provided in the EIS on the broad social and economic impacts (positive or negative) of the proposal for the purposes of the Part 9 decision on approval.

As the matters protected by the controlling provisions for this action include "the environment", there is the potential for an overlap between the information provided in response to this, and the information requested in the main body of the Guidelines in relation to social, economic and cultural aspects within the definition of the environment. The latter set of information need not be repeated if it will be contained in the body of the EIS.

A table cross-referencing information relevant to 5.16 should be provided identifying relevant text in the body of the EIS.

5.17 CONCLUSION

An overall conclusion as to the environmental acceptability of the proposal must be provided, including discussion on compliance with the objectives and requirements of the EPBC Act and the GBRMP Act including the principles of ESD (see Attachment 3). Reasons justifying undertaking the proposal in the manner proposed must also be outlined. The conclusion must highlight measures proposed or required to avoid, mitigate or offset any unavoidable impacts on the environment.

5.18 INFORMATION SOURCES

Information sources used in the formulation of the EIS are to be provided. This section will describe consultations and studies undertaken in the course of proposal formulation and preparation of the draft EIS, and sources of information and technical data. The following details must be provided for information used in developing the EIS:

a) The source of the information;
b) How recent the information is;
c) How the reliability of the information was tested; and
d) What uncertainties and/or gaps (if any) are in the information.

A copy of all data and the sampling methodologies must be made available to the DSEWPAC and GBRMPA for the purpose of peer review on receipt of a written request from the DSEWPAC or GBRMPA. In making this statement, the sampling methodology (including time samples were collected, replication, size of samples etc) should be specified in the relevant sections where data has been collected.

Any further or ongoing consultations or studies must be outlined here.

5.19 REFERENCE LIST AND BIBLIOGRAPHY

The reference list and bibliography provided in the EIS is to be accurate and concise and include the address of any internet pages used as data sources.

5.20 APPENDICES AND GLOSSARY

Detailed technical information studies or investigations necessary to support the main text of the EIS, but not suitable for inclusion in the main text must be included as appendices; for example, detailed technical or statistical information, maps, risk assessment, baseline data, supplementary reports etc. A copy of the Guidelines must also be included. A glossary defining technical terms and abbreviations used in the text must be included to assist the general reader.

ATTACHMENT 1: Matters that must be addressed in an EIS (Schedule 4 of the *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION Regulations 2000*)

1. General information

1.01 The background of the action including:

- (a) the title of the action;
- (b) the full name and postal address of the designated proponent;
- (c) a clear outline of the objective of the action;
- (d) the location of the action;
- (e) the background to the development of the action;
- (f) how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;
- (g) the current status of the action; and
- (h) the consequences of not proceeding with the action.

2. Description

2.01 A description of the action, including:

- (a) all the components of the action;
- (b) the precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts;
- (c) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;
- (d) relevant impacts of the action;
- (e) proposed safeguards and mitigation measures to deal with relevant impacts of the action;
- (f) any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action;
- (g) to the extent reasonably practicable, any feasible alternatives to the action, including:
  - (i) if relevant, the alternative of taking no action;
  - (ii) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action;
  - (iii) sufficient detail to make clear why any alternative is preferred to another;
- (h) any consultation about the action, including:
  - (i) any consultation that has already taken place;
  - (ii) proposed consultation about relevant impacts of the action;
  - (iii) if there has been consultation about the proposed action — any documented response to, or result of, the consultation;
- (i) identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.

3. Relevant impacts

3.01 Information given under paragraph 2.01 (c) must include:

- (a) a description of the relevant impacts of the action;
- (b) a detailed assessment of the nature and extent of the likely short term and long term relevant impacts;
- (c) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;
- (d) analysis of the significance of the relevant impacts; and
- (e) any technical data and other information used or needed to make a detailed assessment of the relevant impacts.

4. Proposed safeguards and mitigation measures

4.01 Information given under paragraph 2.01 (d) must include:

- (a) a description, and an assessment of the expected or predicted effectiveness of, the mitigation measures;
- (b) any statutory or policy basis for the mitigation measures;
- (c) the cost of the mitigation measures;
- (d) an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing;
- (e) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program; and
- (f) a consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the proponent.

5. Other Approvals and Conditions

5.01 Information given under paragraph 2.01 (e) must include:

- (a) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:
  - (i) what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy;
  - (ii) how the scheme provides for the prevention, minimisation and management of any relevant impacts;
- (b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;
- (c) a statement identifying any additional approval that is required; and
- (d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

6. Environmental record of person proposing to take the action

6.01 Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

(a) the person proposing to take the action; and

(b) for an action for which a person has applied for a permit, the person making the application.

6.02 If the person proposing to take the action is a corporation — details of the corporation's environmental policy and planning framework.

7. Information sources

7.01 For information given the EIS must state:

(a) the source of the information; and

(b) how recent the information is; and

(c) how the reliability of the information was tested; and

(d) what uncertainties (if any) are in the information.

ATTACHMENT 2: CONSIDERATION OF APPLICATIONS UNDER THE *GREAT BARRIER REEF MARINE PARK REGULATIONS 1983*

Division 2A.4 Consideration of applications

88Q Consideration of applications — mandatory considerations

In deciding whether or not to grant a permission in relation to an application, and whether or not to impose any conditions on the permission, the Authority must consider the following:

(a) the potential impacts of the conduct proposed to be permitted by the permission (the ***proposed conduct***) on the environment and on the social, cultural and heritage values of the Marine Park or a part of the Marine Park;

(b) options for monitoring, managing and mitigating the potential impacts of the proposed conduct;

(c) if the proposed conduct will take place in an area to which a zoning plan applies — the objectives of the zone as set out in the zoning plan;

(d) if the proposed conduct also requires an approval or permit under the *Environment Protection and Biodiversity Conservation Act 1999*:

  (i) whether the approval or permit has been, or is likely to be, granted and, if granted, the terms and conditions of it being granted; and

  (ii) any relevant assessment documentation (within the meaning given by subsection 133 (8) of that Act) in relation to the approval or permit;

(e) any written comments received about the application in response to the public advertisement published in accordance with regulation 88D;

(f) any other matters relevant to the orderly and proper management of the Marine Park.

Note Subsection 7 (3) of the *Great Barrier Reef Marine Park Act 1975* provides that the Authority must, in managing the Marine Park and performing its other functions, have regard to, and seek to act in a way that is consistent with, the objects of the Act, the principles of ecologically sustainable use and the protection of the world heritage values of the Great Barrier Reef World Heritage Area.

88R Consideration of applications — discretionary considerations

In deciding whether or not to grant a permission in relation to an application, and whether or not to impose any conditions on the permission, the Authority may consider the following:

(a) the requirement in section 37AA of the Act for users of the Marine Park to take all reasonable steps to prevent or minimise harm to the environment in the Marine Park that might or will be caused by the user’s use or entry;

(b) the effect that the grant of the permission will have on public appreciation, understanding and enjoyment of the Marine Park;

(c) the impact of the conduct proposed to be permitted under the permission in the context of other conduct in the relevant area or nearby areas, or in the Marine Park, that is being undertaken, is planned, is in progress, or is reasonably foreseeable at the time of the Authority’s consideration of the application, whether or not related to or a consequence of the proposed conduct;

(d) any policies or guidelines issued by the Authority about the management of the Marine Park or the performance of the Authority's functions under the Act and these Regulations;

(e) if the application for the permission relates to an undeveloped project the cost of which will be large — the capacity of the applicant to satisfactorily develop and manage the project;

(f) if the proposed conduct also requires an approval or a permission under a law of Queensland — whether the approval or permission has been, or is likely to be, granted and, if granted, the terms and conditions of it being granted; and

(g) any international Convention to which Australia is a signatory, or any agreement between the Commonwealth and a State or Territory, that is relevant to the application;

(h) any relevant law of the Commonwealth, or a relevant law of Queensland as in force from time to time, or a relevant plan made under such a law, relating to the management of the environment, or an area in the Marine Park;

(i) any relevant recovery plan, wildlife conservation plan, threat abatement plan or approved conservation advice, under the *Environment Protection and Biodiversity Conservation Act 1999*;

(j) whether the applicant for the permission is a suitable person to hold such a permission, having regard to:

    (i) the applicant's history in relation to environmental matters; and

    (ii) if the applicant is a body corporate — the history of its executive officers in relation to environmental matters; and

    (iii) if the applicant is a company that is a subsidiary of another company (the ***parent body***) — the history of the parent body and its executive officers in relation to environmental matters; and

    (iv) any charge, collected amount or penalty amount that is overdue for payment by the applicant as the holder of a chargeable permission (whether or not the permission is in force); and

    (v) any late payment penalty that is payable by the applicant as the holder of a chargeable permission (whether or not the permission is in force); and

    (vi) any unpaid fines or civil penalties required to be paid by the applicant in relation to a contravention of the Act or of these Regulations;

(k) any other matters relevant to achieving the objects of the Act.

ATTACHMENT 3:

Objects of the *Environment Protection and Biodiversity Conservation Act 1999*

3. Objects of the Act

(a) to provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance

(b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources

(c) to promote the conservation of biodiversity

(d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples

(e) to assist in the co-operative implementation of Australia's international environmental responsibilities

(f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and

(g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.

3A. Principles of Ecologically Sustainable Development

The following principles are principles of ecologically sustainable development:

(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;

(b) if 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;

(c) the principle of inter-generational equity – that the present generation should ensure that the health , diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;

(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making;

(e) improved valuation, pricing and incentive mechanisms should be promoted.

Objects of the *Great Barrier Reef Marine Park Act 1975*

2A Objects of this Act

(1) The main object of this Act is to provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region.

(2) The other objects of this Act are to do the following, so far as is consistent with the main object:

- (a) allow ecologically sustainable use of the Great Barrier Reef Region for purposes including the following:
  - (i) public enjoyment and appreciation;
  - (ii) public education about and understanding of the Region;

(iii) recreational, economic and cultural activities;

(iv) research in relation to the natural, social, economic and cultural systems and value of the Great Barrier Reef Region;

(b) encourage engagement in the protection and management of the Great Barrier Reef Region by interested persons and groups, including Queensland and local governments, communities, Indigenous persons, business and industry;

(c) assist in meeting Australia’s international responsibilities in relation to the environment and protection of world heritage (especially Australia’s responsibilities under the World Heritage Convention).

Port Expansion Project EIS

Appendix B1

Cross Reference Table

AECOM BMT WBM

How the EIS responds to the TOR and EPBC Guidelines

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
	4.2 General advice	The EIS must be a stand-alone document.	All
	4.2 General advice	It must contain sufficient information from any studies or investigations undertaken to avoid the need to refer to previous or supplementary reports.	All
	4.2 General advice	Headers and/or footers should be used on every page to denote which section the page relates to (i.e. based on the table of contents).	All
	4.2 General advice	The EIS must state the criteria adopted in assessing the proposal and its potential impacts, such as: compliance with relevant legislation, policies, standards and best practice; community acceptance; maximisation of environmental benefits (if any); and minimisation of risks and harm.	All
	4.2 General advice	Any and all unknown variables or assumptions made in the assessment must be clearly stated and qualified. The extent to which the limitations, if any, of available information may influence the conclusions of the environmental assessment must be discussed.	All
	4.2 General advice	The proponent must ensure that the personnel providing information to address this EIS have the relevant qualifications and experience in their relevant fields.	Appendix D
	4.2 General advice	The EIS must comprise three elements… …b) The main text of the document, written in a clear and concise manner so as to be readily understood by general readers	Part A, B, C and Appendices
	5.5 Project details	j) Reference must be made to detailed technical information in appendices where relevant;	All
	4.2 General advice	An executive summary must be provided in the EIS and made available as a stand-alone document for public information.	Executive Summary
1 Executive Summary		It should be easy to reproduce and distribute on request to interested parties who may not wish to read or purchase the whole EIS.	Executive Summary
1 Executive		The executive summary should include:	Executive Summary

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
Summary		project title proponent's name and contact details a discussion of previous projects undertaken by the proponent, if applicable, and their commitment to effective environmental management a concise statement of the aims and objectives of the project the legal framework, decision-making authorities and advisory agencies an outline of the background and need for the project, including the consequences of not proceeding with the project an outline of the alternative options considered and reasons for selecting the proposed development option a brief description of the project (pre-construction, construction, operational activities and decommissioning) and the existing environment, using visual aids where appropriate an outline of the principal environmental impacts predicted and the proposed environmental management strategies and commitments to minimise the significance of these impacts a discussion of the cumulative impacts in relation to social, economic and environmental factors of associated infrastructure projects proposed within the region detailed maps of the proposed project location and any other critical figures.	1.1.1 1.1.2 1.1.3 1.2.3, 1.3.1 1.1.4 1.1.4 1.1.2, 1.1.3 1.4 - 1.8 1.6, 1.9 1.1.3
	5.1 Executive summary	An executive summary that outlines the key findings of the EIS must be provided. The executive summary must briefly: a) State the background and the need for the proposal; b) Discuss alternatives and the reasons for selecting the preferred option and rejecting the alternatives; c) Summarise the pre-construction, construction and operational activities associated with putting the proposal into practice; d) State the proposed schedule for each key component of the proposal, the relationships and interdependencies between each stage, the expected duration of each stage and the	Executive Summary 1.1.1-1.1.4 1.1.4 1.1.2, 1.1.3 1.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		proposal as a whole; e) Provide an overview of the existing regional and local environments, summarising the features of the physical, biological, social, cultural and economic environment relating to the proposal and associated activities; f) Summarise stakeholder consultation undertaken in preparing the EIS; g) Describe the expected, likely and potential impacts of the proposal on matters of National Environmental Significance, the physical, biological, social, cultural and economic environment during construction, operational and post-operational phases; h) Summarise the environmental protection measures and safeguards, mitigation measures, offsets and monitoring to be implemented for the proposal; and i) Provide an outline of the environmental record of the proponent.	1.4 – 1.8, 1.2.2 1.6.7 1.9 1.1.2
2. Glossary of terms		Provide a glossary of technical terms, acronyms, abbreviations and references.	Glossary
13. Appendices		Provide a glossary of technical terms	
	4.2 General advice	Technical jargon must be avoided wherever possible and a full glossary included.	
	4.2 General advice	The EIS must be written so that any conclusions reached can be independently assessed. To this end all sources must be appropriately referenced.	All, Appendix B2
	5.20 Appendices and Glossary	A glossary defining technical terms and abbreviations used in the text must be included to assist the general reader.	Glossary
3. Introduction		Clearly explain the function of the EIS, why it has been prepared and what it sets out to achieve. Include an overview of the structure of the document.	A.2.1 – A.2.6
	5.2 Objective	The objectives of the EIS must be clearly stated and include specific reference to EPBC Act and GBRMP Act legislative requirements.	A.2.3
3.1. Project		Describe the proponent's experience, including the nature and extent	A.1.2, A.1.5, A.2.1-A.2.6

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
Proponent		of business activities, experience and qualifications, and environmental record, including the proponent's environmental, health, safety and community policies.	
	5.3 General information	The EIS is to provide the background of the proposed development. This is to include: a) The title of the proposal; b) The full name and postal address of the designated proponent; c) A clear outline of the proposal; d) The location of the proposal; e) The background to the development of the proposal; f) How the proposal relates to any other developments (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region; g) The current status of the proposal; h) Prudent and feasible alternatives to the proposed action, including scale, configuration and staging options; i) The consequences of not proceeding with the proposal or components of the proposal and/or the consequences of other projects (that this action relies upon) not proceeding; j) A brief explanation of the scope, structure and legislative basis of the EIS;	A.1, A.2, A.1.5
	5.5 Project Details	The description of the proposal must cover: a) The environmental principles on which the development will be managed;	A.1.3
3.2 Project Description		Briefly describe the key elements of the project with illustrations or maps.	A.1.3
		Summarise any major associated infrastructure requirements.	A.1.3
3.3. Project rationale		Describe the specific objectives and justification for the project, including its strategic, economic, environmental and social implications, technical feasibility and commercial drivers.	A.1.4, A.2.6
3.3. Project rationale		Discuss the status of the project in a regional, state and national context.	A.1.3, A1.4, A.1.6

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
3.3. Project rationale		Explain the project's compatibility with relevant policy, planning and regulatory frameworks.	A.2.6
3.4. Relationship to other projects		Describe how the project relates to other infrastructure projects (of which the proponent should reasonably be aware) that have been, are being taken or that have been approved in the area affected by the project (including the Townsville Port Marine Precinct project).	A.1.5
		Provide details of how proposed future port activities may impact on the project.	A.1.5,
	5.5 Project details	The description of the proposal must cover : …d) Future development areas that are currently "Greenfield" in the region and the likely nature and timing of development, (including but not limited to strategic port development lands, state development areas);	A1.5, B.1.3.3.3, B.24.1.2
3.4. Relationship to other projects		As a result of this assessment, there may be opportunities to co-locate existing or proposed infrastructure, enabling efficiency gains and mitigating environmental and property impacts. Where co-location may be likely, outline opportunities to coordinate or enhance impact mitigation strategies. Discuss the opportunities in sufficient detail to enable the reader to understand the reasons for preferring certain options or courses of action and rejecting others.	A.1.5, A.1.6
3.5. Project alternatives		Describe feasible alternatives including conceptual, technological and locality alternatives to the proposed project and the consequences of not proceeding with the project.	A1.6
	5.5 Project details	The description of the proposal must cover: …b) all components of the proposal including: ii. describe all feasible, economic alternative site options for the proposal (e.g. through a multi-criteria analysis); iii. development options, including an explanation of prudent and feasible alternatives;	A1.6
3.5. Project alternatives		Detail the criteria used to determine the alternatives including an economic analysis where appropriate and provide sufficient detail to enable the reader to understand why certain options or courses of	A1.6, B.19.4.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		action are preferred and why others are rejected (including the ‘no action’ option).	
3.5. Project alternatives		Discuss the interdependencies of the project components, particularly in regard to how any infrastructure requirements relate to the viability of the project.	A1.6, A.1.6.2
	5.7 Alternatives to the Proposal	This section must describe, to the extent reasonably practicable, any prudent and feasible alternatives to the proposal. For each alternative listed the proponent should provide the project details, impacts (positive and negative), location, scale, configuration and staging options. Sufficient detail must be provided to make clear why any alternative is preferred to another.	A.1.6
		This section must describe, but not be limited to the following: a) The alternative of taking no action or not proceeding with components of the proposal;	A.1.6
		b) Potential alternative locations for different components of the proposal;	A.1.6
		c) Potential alternative configuration or scale options for key components of the proposal;	A1.6
		d) Describe options for integrating operations with existing infrastructure where they exist to mitigate impacts on the general environment, ecosystems and matters of National Environmental Significance;	A.1.6.2
		e) A comparative description of the adverse and beneficial impacts of the development as a whole, each component of the development, and location on the matters protected by the controlling provisions for the proposal;	B.23.0, B.24.0
		f) A description of how each stage would be affected if one or more of the stages does not occur or is significantly modified;	A1.6
		g) The reasons for choosing the preferred location and option for the development as a whole, and each key component of the proposal, must be explained. The explanation must include a comparison of the adverse and beneficial effects used for selecting the preferred	A1.6, A1.4,

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		location and option, and compliance with the objectives of the EPBC Act and GBRMP Act (including the principles of ecologically sustainable development and use);	
		h) The advantages and disadvantages of alternatives when considered against relevant matters protected under the EPBC Act and GBRMP Act, including critical issues identified in the Great Barrier Reef Outlook Report 2009, must be specifically addressed; and	A1.6, Part B, B.24
		i) Short, medium and long-term advantages and disadvantages of the options must be considered.	A1.6, A1.4, Part B
3.6.1. Methodology of the EIS		Provide an outline of the environmental impact assessment process, including the role of the EIS in the Coordinator-General's decision-making process.	A.2.1-A.2.6
		Include information on relevant stages of the EIS development, statutory and public consultation requirements and any interdependencies that exist between approvals sought.	A.2.1-A.2.6
3.6.2. Objectives of the EIS		Provide a statement of the objectives of the environmental impact assessment process. The structure of the EIS can then be outlined and used to explain how the EIS will meet its objectives.	A.2.1-A.2.6
	5.10 Relevant Impacts	This section must include: a) A description of the framework used to assess impacts, including risk assessment processes, based on an approved standard;	A.2.2
		b) A detailed assessment of the nature, extent, likelihood and consequence of the likely short-term and long-term impacts including but not limited to: description of the risks and potential impacts (acute and chronic) from the release of cargo material (such as dust from the handling of mineral ores) from the proposed action to the environment; description of the risks and potential impacts of related activities including blasting and pile driving and the impacts of increased marine underwater noise on marine species including the impacts from noise and varying distances from each project component (considering the environmental variables e.g. depth,	Part B

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		wave height and bottom profile); impacts of the proposal on air quality; specific guidance is provided for dredging and dredged material disposal impacts and impacts from increased shipping;	
		c) A statement whether any relevant impacts are likely to be unknown, unpredictable, irreversible or sub-lethal (reversible over time) and what confidence level is placed on the predictions of relevant impacts;	Part B
		d) Analysis of the significance of the relevant impacts;	Part B
		e) Any technical data, including modelling, and other information used or needed to make a detailed assessment of the relevant impacts;	Part B
		f) A description of the framework used to assess impacts, including risk assessment processes;	A2.4.2, B.4.4.4.1
		g) In discussing potential impacts, consider how the interaction of extreme environmental effects (e.g. cyclones, coral bleaching, flood events) and any related cumulative impacts may impact on the proposal and the environment (both independently and cumulatively);	Part B, B.8.3, B.8.4, B.6.3, B.6.4, B.24
		h) Consideration of potential impacts throughout the life of the proposal – from pre-construction, construction through to operation.	Part B
		i) Downstream impacts of the proposed action on water quality and adjacent reef communities and island communities;	B.2.4, B.3.4, B.4.4, B.5.4, B.6.4, B.24
		j) Impacts to the sea floor through anchoring and/or direct placement of material/infrastructure, sediment disturbance. The GBRMP zone of likely seabed disturbance must be identified.	B.6.4.12, B.5.4 B.18.3.2, B.24, A.3.2.1.5
		k) Impacts of anticipated light illumination on marine fauna particularly seabirds, marine turtles and other migratory species, including impacts on nesting and disorientation;	B.6.4.8, B.7.4.5
		l) Impacts on the existing use of the area and nearby areas that may be affected by the proposed action;	B.1.4
		m) Impacts on amenity (including from the mainland, air, vessels and surrounding islands); and	B.9.4, B.10.4 B.18.4, B.1.4, B.17.4, B.23.0

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		n) A description of anticipated positive and negative social, cultural and/or economic impacts of the proposal on key stakeholder groups and individuals. This should include a consideration of anticipated changes in the social, cultural and heritage values of the Marine Park.	A.2.5.2, B.1.4, B.4.3.2.11, B.4.4, B.4.4.3.2, B.6.4, B.6.4.4.1, B.13.4, B,15.4, B.16.4, B.17.4, B.18.3, B.18.4, B.19.4, B.24.0, B.23.0, Appendix R1
3.6.3. Submissions		Inform the reader how to properly make submissions and what form the submissions should take.	A.2.1.3
		Inform the reader how and when properly made public submissions on the EIS will be addressed and taken into account in the decision-making process.	A.2.1.4
		Also indicate any implications for submissions in the event of any appeal processes.	A.2.1.5
		Outline the methodology that was adopted to: identify the stakeholders and how their involvement was facilitated identify the processes conducted to date and the future consultation strategies and programs including those during the operational phase of the project indicate how consultation involvement and outcomes were integrated into the EIS process and future site activities including opportunities for engagement and provision for feedback and action if necessary.	A.2.5, Appendix E1
		List the stakeholders consulted during the program and provide details of any meetings held, presentations made and any other consultation undertaken for the EIS process. Provide information about the consultation process that has taken place and the results.	A.2.5, Appendix E1
3.8.1. Relevant legislation and approvals		List and describe Commonwealth, state and local legislation and policies relevant to the planning, approval, construction and operation of the project.	A.2.6
	5.3 General Information	The EIS is to provide the background of the proposed development. This is to include: …k) The specific EPBC Act and GBRMP Act matters affected by the proposal; and	A.2.6

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		l) A description of government planning policies, statutory controls and agreements which will influence the proposal. All applicable jurisdictions and areas of responsible authorities within the area (both terrestrial and marine) must be listed and shown on maps at appropriate scales.	
3.8.1. Relevant legislation and approvals		Identify all approvals, permits, licences and authorities that will need to be obtained for the proposed project.	A2.6
	5.5 Project details	The description of the proposal must cover …e) Describe the overall planning context in which proponents‘ decisions for this project have been made (including the overarching plan in which this project sits within);	A.1.3.2, A.2.6
3.8.1. Relevant legislation and approvals		Outline the triggers for the application of each of these and identify relevant approval requirements.	A2.6
		Identify and outline relevant Commonwealth obligations such as: protection of World Heritage values migratory animals (China–Australia Migratory Bird Agreement (CAMBA), Japan–Australia Migratory Bird Agreement (JAMBA), Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) and Bonn Convention) biodiversity climate wetlands of international importance (Ramsar).	A2.6.2, A.2.6.3
		Identify and outline Commonwealth approvals required including, but not limited to: approval, under sections 131(1) and 133 of the EPBC Act, of the proposed action for each of the applicable controlling provisions (SEWPaC) approval to dredge within the boundary of the Great Barrier Reef Marine Park under the GBRMP Act (Great Barrier Reef Marine Park Authority) permit to dispose of dredge material at sea under the EPSD Act	A2.6.3, Table A.2.7

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		(SEWPaC).	
		Also, identify and outline relevant Commonwealth obligations relating to the protection of World Heritage values, National Heritage values, declared Ramsar wetlands, listed threatened species and ecological communities, migratory animals (China–Australia Migratory Bird Agreement (CAMBA), Japan–Australia Migratory Bird Agreement (JAMBA), Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) and Bonn Convention) and biodiversity.	A2.6.2, A.2.6.3
		Key Queensland approvals required, and to be considered in the EIS process include: quarry allocation under the Coastal Act permit for development within a coastal management district, that is: disposal of dredged spoil or other solid waste material in tidal water—Coastal Act development permit for tidal works—Coastal Act reclaiming land under tidal water—Coastal Act development permit for operational work that is the removal, destruction or damage of a marine plant—Fisheries Act 1994 permit for Resource Entitlement under the Land Act 1994 permit to dredge the channel extension area where it falls within the boundary of a State Marine Park (i.e. the Great Barrier Reef Coast Marine Park)—Marine Parks Act 2004 material change of use of a premises for an environmentally relevant activity (ERA)—ERA16: Extractive and screening activities (dredging)—EP Act road impact assessment (including transport impact assessment) and road-use management plan for development on land not contiguous to a state-controlled road—TI Act.	A.2.6.4
		Identify the relevant approval agency for each of the approvals required.	Table A.2.7
		Identify existing approvals that are currently held by the Port that relate to those being sought by this development. In particular, clearly identify existing approvals that are referred to for sections of the	A.2.6

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		development and whether amendments will be sought to these existing approvals.	
3.8.2. Relevant Plans		Outline the project's consistency with the existing national, state, regional and local planning framework that applies to the project location. Refer to all relevant statutory and non-statutory plans, planning policies, guidelines, strategies and agreements.	A.2.6.3, A.2.6.4
	5.14 Other Approvals And Conditions	The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include: a) Details of any local or State Government planning scheme, or plan or policy under any local or State Government planning system that deals with the proposed action, including: i. what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and ii. how the scheme provides for the prevention, minimisation and management of any relevant impacts; b) A description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the EPBC Act), including any conditions that apply to the action; c) A statement identifying any additional approval that is required; and d) A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	A2.6, B.1.2
	a) 5.15 Environmental Record	The EIS must include the environmental record of the proponent. This must include: a) Reference to the GBRMP Regulations 88R(j) which includes the applicant's history in relation to environmental matters (for example compliance with Marine Park permits and environmental management plans) and any outstanding charges; and	A.1.2.2
		b) Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation	A.1.2, A.2.1

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		and sustainable use of natural resources against the person proposing to take the action. If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must be provided.	
		Information relating to the persons' environmental record must also include any accreditations (for example ISO 14001), environmental awards, and other recognition for environmental performance.	A1.2
4.1. Overview of the project		b) Provide an overview of the project to put it into context. Include: - a rationale explaining the selection of the preferred operating scenario, including details such as cost, environmental impacts, and the operational efficiencies of each option - a description of the key components of the project including the use of text and design plans where applicable - a summary of any environmental design features of the project - the expected cost, timing, and overall duration of the project, including details of and justification for, any staging of the development.	A.1.4, A.1.6, A3.1-A3.4
4.2. Location		Describe, using maps at suitable scales, the regional and local context of the project and all associated infrastructure.	A3.1-A3.4, Table A.3.1, Figure A.1.3.2
	5.4 The Proposal Description	This section must describe the proposal in sufficient detail to allow an understanding of all stages (including interdependencies between stages) and components of the proposal, and determine potential environmental impacts associated with the proposal. Those elements with potential implications for matters protected under Part 3 of the EPBC Act must be highlighted.	A.3.0 Part B
		All pre-operational construction, operational and decommissioning components of the action (short and long term) must be described in detail. This includes, but is not limited to, the date or time period over which construction will take place, details of the locations of each component of the proposal (i.e. preferably the precise location	A.3.0

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		(including coordinates) of all works to be undertaken and/or the footprint area(s)), dimensions of structures/vessels to be built and materials, equipment to be used as well as construction access requirements, lay down/set down areas and elements of the action that may have impacts on matters of National Environmental Significance.	
		A discussion of the assumptions underlying the predicted operation of the proposal and associated changes in the activities undertaken in the surrounding environment must be provided.	A.3.6
		Details of proposed monitoring and enforcement programs to help limit the impacts of the ongoing operations, including but not limited to dredging and increased vessel activity in the area, on matters of National Environmental Significance, must also be addressed.	A.2.4.3, Part C, B.18.5, B.9.5.2, (C2.1).4, B.6.5.2, B.7.5.2, B.4.4
	5.5 Project details	The description of the proposal must cover: …b) All the components of the proposal including: i. site selection including the choice of region for the project and site within that region, an analysis of prudent and feasible alternative sites and why this site is likely to have the least impact on matters of National Environmental Significance.	A.1.3, A.1.4, A.1.6 B.24.1
4.2. Location		Provide real property descriptions of the project.	A1.3, B1.2 and B1.3
	5.5 Project details	The description of the proposal must cover: …b) All the components of the proposal including: …iv. associated infrastructure, including transport networks/corridors (both land, estuarine and marine);	A.3.1-A.3.5
4.2. Location		Maps should show the precise location of the project area, in particular the: ▪ location and boundaries of current or proposed land tenures that the project area is or will be subject to, and details of the ownership of that land ▪ location, size and boundaries of the project footprint, including easement widths and access requirements ▪ location and size of any proposed buffers surrounding the	Part A, Chapter B1 & Appendix E2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		working areas (for dredging, construction and operation) ▪ location of infrastructure relevant to the project, including but not limited to, the state-controlled road network, local roads and railways (including the Eastern Access Corridor road and railway alignments), marine infrastructure such as navigation aids and electricity infrastructure ▪ location of features such as waterways (e.g. rivers, streams, creeks, other water bodies and wetlands) and shorelines, significant vegetation and navigation channels ▪ location of any proposed site offices and accommodation sites ▪ extent of strategic port land and future strategic port land ▪ views to and from the site ▪ the relationship to World Heritage Areas and State marine waters.	
	5.5 Project details	The description of the proposal must cover : …g) The precise location of works to be undertaken (including specific footprint area(s)), structures to be built or other elements of the proposal that may have impacts on the environment. Aerial photographs, maps, figures and diagrams must be incorporated where appropriate;	Appendix E2, A3
		h) A general location map that includes the location of other known or potential future developments occurring at the Port of Townsville;	Figure A.1.6
		i) The following maps and figures must be provided in relation to the Great Barrier Reef Marine Park and Great Barrier Reef World Heritage Area: i. a detailed map showing the boundary of the Great Barrier Reef Marine Park, in relation to the proposed development footprint of the project, including the dredge footprint, offshore dredged material disposal ground, breakwaters, reclamation area; berths and other components of the project; ii. a detailed map showing the Great Barrier Reef Zoning adjacent to the project footprint. This map or figure must	Figure A.1.2, Figure B6.6 B.1.2.2.1, Figure B.1.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		include an explanation of the basis for the zoning in this area[1]; iii. a map showing the location of the proposal in relation to the Great Barrier Reef World Heritage Area and National Heritage place; iv. a map showing the boundary of the Bowling Green Bay Ramsar Site; v. a map showing shipping lanes within the Great Barrier Reef Marine Park and Great Barrier Reef World Heritage Area in relation to the project footprint as described in (i); and vi. simulated viewfields of the proposal showing its visual impact from the adjacent coastline, nearby inhabited islands and the Great Barrier Reef World Heritage Area to the east.	B.1.2.2.1, Figure B.1.2, Figure B6.6 B.1.2.2.1, Figure B.1.2, Figure B6.6 B.18.3.3, Figure B6.6 B.17.4.2
4.3 Construction phase		Provide a detailed staging plan and approximate timeframes for the project's construction activities.	A.3.3.
	5.5 Project details	The description of the proposal must cover: …b) All the components of the proposal including: …v. construction, including dredging and dredged material disposal requirements and mooring and anchoring requirements;	A.3.3.2, A.3.6.2
		…k) How the works are to be undertaken and design parameters for all aspects of the structures or elements of the proposal. This must include: i. an explanation of the anticipated timetable for pre-construction, construction and operation; ii. details of construction and operational equipment to be used; and iii. details of the environmental parameters (incorporating predictions of climate change and 'worst case scenarios') the structures are designed to withstand, based on the expected life of asset; and iv. a summary of the design aspects that will be employed to minimise impacts on environmental, social, cultural and heritage values.	A.3.1, A.3.3, Table A.3.2,

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[1] http://www.gbrmpa.gov.au/_data/assets/pdf_file/0016/6172/gbrmpa_report_on_zoning.pdf

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
4.3 Construction phase		Provide an estimate of the number and roles of persons to be employed during the construction phase of the project.	A.3.4.3
		Provide the following information on the pre-construction, construction and commissioning of the project including detailed plans, drawings and maps where appropriate. Reference should be made to building and engineering standards for tidal works.	A.3.2, A.3.3
4.3.1 Pre-construction activities		Describe all pre-construction activities, including nature, scale and timing of : land acquisitions required, be it in full or as easements, leases etc. vegetation clearing site access earthworks interference with watercourses and floodplain areas, including wetlands site establishment requirements for construction facilities, including access restriction measures and expected size, source and control of the construction workforce accommodation, services (water, sewage, communication, power, recreation) and safety requirements temporary works upgrade, relocation, realignment, deviation of or restricted access to roads and other infrastructure (including electricity infrastructure) equipment to be used.	A.3.3, A.3.4
4.3.2 Dredging and reclamation		Describe the location and extent of the proposed reclamation, the source(s) of fill and the likely construction methodologies.	A3.3.2, A.3.3.3
		Address the following requirements for construction and maintenance dredging: - Describe and map the location, area and volume of dredging required, differentiating capital from historical or current dredge areas. Provide maps and map overlays indicating areas that have been disturbed and those areas that have not been disturbed historically.	A.3, Appendix E4, C2.1
		- The boundary of land to be reclaimed by metes and	A.3.2.5, A.3.3.3, Appendix E2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		bounds, tied to real property boundaries, the location of the line of mean high water spring tide, highest astronomical tide and coastal management district (includes all land contained within erosion prone areas) in relation to the reclamation area.	
		- Existing levels of the land and proposed final levels of reclamation in relation to the Australian Height Datum (AHD).	A.3.3.3.2, A.3.2.5
		- Method of protecting seaward boundary of the reclamation from erosion by the sea.	A.3.3.3
		- Details of estimated commencement, completion, rate of progress and estimated cost of the reclamation.	A.3.3.3
		- Provide details of the grading and composition of likely dredged materials, including potential contaminants and/or indurated (hardened or cemented) layers and the methods and sites for disposal via land or sea.	A.3.3.3, A.3.1.2.3
		- Describe proposed disposal methods and locations, including any off-shore options for disposing of maintenance dredge spoil of possibly varying constituencies to be designated dredge spoil disposal/rehandling areas.	A.3.3.2, Appendix E4
		- Quantify the expected amount of maintenance dredging required, the expected frequency of maintenance dredging and the expected composition of dredged material.	A.3.6.8
		- Describe provisions for maintenance dredging in the event of a major cyclone, flood or other extreme conditions.	B.8.4.2
		- Provide details of the dredging methods, including timing of capital dredging and dredge material disposal, which would avoid or minimise impacts on,	B.4.4.4.3, B.6.4, B.7.4, A.3.3.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		birds, marine mammals, turtles and fish, including migrations and marine plant propagation	
		- Provide details of the current approved dredged disposal area e.g. capacity and ability of the site to accommodate dredge material from the proposed development.	A.3.3.2.5, Appendix E4
	5.10.10 Reclamation And Land Based Disposal	a) Describe any prudent and feasible alternatives to the proposed reclamation. For each alternative listed the proponent should detail the impacts (positive and negative), location, scale, and configuration;	A1.6
		b) describe the impact of the proposed reclamation in Cleveland Bay on seagrass, and on hydrodynamics and coastal processes;	B.3.4, B.3.7, B.4.4 , B.6.4.2, B.7.4.2, Appendix H2
		c) A plan of the proposed land to be reclaimed, drawn to an appropriate scale, showing the following information: i. the boundary of the land to be reclaimed, tied to real property boundaries; ii. the location of the line of mean high water spring tide and highest astronomical tide in relation to the area of reclamation; iii. existing levels of the land and proposed final levels of reclamation in relation to the lowest astronomical tide (LAT) or Australian Height Datum (AHD); iv. location of marine plants and species habitat within the land to be reclaimed and existing and proposed bund area; v. typical cross section across the land to be reclaimed showing the proposed finished levels and method of protecting the seaward boundary of the reclamation from erosion; vi. discussion of how the land reclamation may affect the current erosion and deposition patterns in terms of changes to the low water mark of the World Heritage Area boundary; vii. discussion of the impacts to the roosting sites (sand bars) at the mouth of the Ross River due to potential hydrological changes from dredging and land reclamation; and viii. three dimensional modelling of the impacts of the land	A.3, Appendix E2, A.3.3.2.3 B.7.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		reclamation on the current sediment transport and hydrodynamic patterns within Cleveland Bay.	B.3.4, B.5.4
		d) The method, location and issues associated with the disposal of dredged material must be described including: i. for land-based dredge spoil disposal, a detailed description of potential methods, location issues/risks must be presented.	A3.3, C.2.1, Appendix E4
		Consideration must be given to: i. quantities and quality of tail water likely to be generated from dredging activities and the rate of their discharge; ii. the settling rate of fine sediments from all dredge material types; iii. the residence time within settling ponds prior to discharge (related to dredge pumping rate, ratio of solids to water in the dredged material, settling rates, available capacity of the disposal and settling areas, potential bulking factor, intensity and duration of rainfall events with consideration given to the worst case scenario for these factors); iv. source of material for bunds and bund wall stability;	B.4.4.3.4, Appendix H1
4.3.3. Structures		Describe the location and extent of the proposed breakwater and the revetment structures and the likely construction methodologies.	A3.2.3
		Describe all structures, including: - locations and dimensions of buildings and marine infrastructure associated with the port expansion	A.3.5, A.3.2
		- the likely interface of the port expansion infrastructure with the future port road and rail infrastructure	
		- the likely construction methodologies	A.3.3
		- earthworks, including fill and rock that may need to be imported to the project site, and identifying relevant licensed quarries	A.3.4 C2.2
		- pollution control methods that will be used to prevent pollution entering marine areas during the construction	B.8.5

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		- modifications that may be needed to accommodate climate change and sea level rise	
		reference should be made to DERM policies: • Assessment of coastal revetment alignment (2010d) • Building and engineering standards for tidal works (2010e)	Appendix B2
		Information provided should address current legislative policy relating to erosion protection structures.	B3.2.1, B.1.2.2.2, A.3.3
4.3.4. Other construction activities		Describe all the construction elements of the project, providing details of: an indicative construction timetable, including expected commissioning and start-up dates and hours of operation	A3.3
		major work programs for the construction phase, including an outline of construction methodologies	A3.3
		construction inputs, handling and storage including an outline of potential locations for source of construction materials	A.3.3, A.3.4
		major hazardous materials to be transported, stored and/or used on site, including environmental toxicity data and biodegradability	B.22.4.3, B..22.5.1, B.20, B1
		- clean-up and restoration of areas used during construction, including camp site(s) and storage areas, if applicable.	A.3.3.4
4.3.5. Other project-specific infrastructure		Describe: all other infrastructure required to be constructed, upgraded, relocated or decommissioned for the construction and/or operation of the project, such as resource extraction areas, access roads and haulage routes, power supply, connection to sewerage or water supply	A.3.5
		the design and construction standards to be met (e.g. waterway crossings should be designed to meet the requirements of the *Fisheries Act 1994* (Qld) and in consultation with DEEDI staff)	A3, A.2.6
		alternative approaches or the opportunity to obtain materials from alternative sources.	A1.6

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
4.3.6. Commissioning		Describe the commissioning process including the associated environmental impacts.	A3.4
	5.5 Project Details	The description of the proposal must cover: …b) All the components of the proposal including: …vi. commissioning;	A3.4
4.4 Operation phase		Describe the location and nature of the processes to be used and provide supporting maps, diagrams and artist's impressions as required. Provide full details of the operation for all elements of the project, including: a description of the nature and description of all key operational activities (including expected plant and equipment) the capacity of the project equipment and operations maintenance dredging requirements a description of arrangements for long-term maintenance of the marine facilities, including details of the responsible parties details of the predicted usage of the marine facilities, including opportunities for recreational and public usage detailed requirements of vessel operations, including tugs, pilotage, channel closures, quarantine and security arrangements etc. estimated numbers and roles of persons to be employed during the operational phase of the project opportunities for future expansion.	A.3
	5.5 Project Details	The description of the proposal must cover: …b) All the components of the proposal including: …vii. operation, including details of the expected vessel numbers for each stage of the proposed development; and viii. related maintenance activities, both long and short term including but not limited to dredging and dredged material disposal requirements.	A.3
4.5 Associated infrastructure		Detail, with the aid of concept and layout plans, requirements for new infrastructure or upgrading/relocating existing infrastructure to service the project. Consider infrastructure such as transportation (road/rail/air/ship), water supply, energy supply, telecommunications,	A.1.3.3, Table A3.1, A.3.5

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		stormwater, waste disposal and sewerage.	
4.6 Decommissioning and rehabilitation		This section should present general strategies and methods for decommissioning and rehabilitation of the project should it ever be required.	A3.6.9
5. Environmental values and management impacts		Detail the environmental protection and mitigation measures incorporated in the planning, construction, rehabilitation, commissioning, operations and decommissioning of all facets of the project. Measures should prevent, or where prevention is not possible, minimise environmental harm and maximise environmental benefits of the project.	All
		Identify and describe preferred measures in more detail than other alternatives.	All
		The protection and enhancement of human health during construction and operation of the project must be described.	B20.0
5. Environmental values and management impacts		Where negative impacts of the project cannot be avoided or adequately minimised or mitigated, present proposals to offset impacts in accordance with the Queensland Government Environmental Offsets Policy (Environmental Protection Agency 2008b).	B.23.2
	5.12 Offsets	This section of the EIS must outline plans to offset the remaining residual impacts of the proposal.	B.23.2
5.1 Climate, natural hazards and climate change		Describe the climatic conditions that may affect management of the project. This includes a description of the vulnerability of the project area to seasonal conditions, extremes of climate (e.g. cyclones) and natural or induced hazards (including bushfires) and climate change.	B.8.2, B.8.3
		Reference should also be made to the State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (Department of Local Government and Planning & Department of Emergency Services 2003).	B.8.2
		Provide a risk assessment (as part of the requirements of 8.1 “Hazard and risk assessment”) and management plan detailing these	B.8.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		potential climatic threats to the construction, and operation of the project. Include the following: a risk assessment of changing climate patterns that may affect the viability and environmental management of the project the preferred and alternative adaptation strategies to be implemented commitments to working cooperatively, where practicable, with government, other industry and other sectors to address adaptation to climate change.	
5.1.1 Flood plain management		Due to the location of the site, a comprehensive flood study should be included in the EIS that: quantifies flood impacts on properties surrounding and external to the project site from redirection or concentration of flows identifies potential variation of increased flood levels, increased flow velocities or increased time of flood inundation as a result of the development.	Appendix G, B.2
		The flood study should address any requirements of local or regional planning schemes for flood affected areas. The study report should include details of all calculations along with descriptions of base data, any potential for loss of flood plain storage, and triangulated surface meshes produced in terrain modelling software. Reference must be made to any studies undertaken by the local council in relation to flooding.	Appendix G
		Reference should be made to Temporary State Planning Policy 2/11: Planning for stronger, more resilient floodplains (Queensland Reconstruction Authority 2011).	B.1.2.2.2
	5.9 The Existing Environment	A description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that his include the following information: …f) Identify factors that influence matters of National Environmental Significance including human-induced and natural factors e.g. climate change and flooding;	All, B.24
5.2 Land		Detail the existing land environment values for all areas associated with the project.	B.1.0 - B.1.3

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		Describe the potential for the construction and operation of the project to change existing and potential land uses of the project sites and adjacent areas (on and off Port land).	B1.0 – B.1.3
5.2.1 Scenic amenity and lighting		**Description of environmental values** Describe, in general terms, the existing character of the landscape and the general impression that would be obtained while travelling through and around it.	B.17.3
		Outline existing landscape features, panoramas and views that have, or could be expected to have, value to the community. Include information such as maps and photographs, particularly where addressing the following issues: major views, view sheds, outlooks, and features contributing to the amenity of the area, including assessment from private residences focal points, landmarks, waterways and other features contributing to the visual quality of the area and the project site(s) character of the local and surrounding areas including vegetation and land use.	B.17.2, B.17.3, B.17.4
		Reference should be made to the *Queensland Coastal Plan: State Planning Policy for Coastal Protection Guideline* (Department of Environment and Resource Management 2011e) (Annex 3—Determining scenic preference in the coastal zone).	B.17.2.1.2
		Include any relevant World Heritage and National Heritage values of the area.	B.17.2.1.1, B.24.2
		Potential impacts and mitigation measures Describe the potential beneficial and adverse impacts of the project on landscape character and visual qualities of the site and the surrounding area. Address the local and broader visual impacts of the project buildings, other structures, and breakwater. This should include views from: places of residence, work, and recreation road, cycle and walkways	B.17.4,

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		the air other known vantage points day and night (e.g. Castle Hill) during all stages of the project as it relates to the surrounding landscape. Use sketches, diagrams, computer imaging/simulation and photos where possible to portray the near and far views of the completed structures and their surroundings from visually sensitive locations.	
		Detail the measures to be undertaken to mitigate or avoid identified adverse impacts.	B.17.5
		Lighting Provide an assessment of all potential impacts of the project's lighting, during all stages, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid, such as: the visual impact at night night operations/maintenance and effects of lighting on marine and terrestrial fauna and residents the potential impact of increased vehicular traffic changed habitat conditions for nocturnal fauna and associated impacts.	B.17.3.3, Appendix S2 B.17.4.2 B.7.4.5, B.6.4.8 B.17.4.2.5 B.17.4.5
5.2.2 Topography, geology and soils		**Description of environmental values** Provide maps locating the project in state, regional and local contexts.	B.1.1
		The topography should be detailed with contours at suitable increments, shown with respect to AHD. Include significant features of the landscape and topography, and accompanying comments on the maps.	B.17.0 (Figure B.17.4)
		Provide a description, map and a series of cross-sections of the geology of the project area relevant to the project components. Describe the geological properties that may influence ground stability, occupational health and safety, or the quality of stormwater leaving any area disturbed by the project. In locations where the age and type of geology is such that significant fossil specimens may be	B.1.3

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		uncovered during construction/operations, address the potential for significant finds.	
		A soil survey of the sites affected by the project must be conducted at a suitable scale, with particular reference to the physical and chemical properties of the materials that will influence erosion potential, stormwater run-off quality, rehabilitation and agricultural productivity of the land. Provide information on soil stability and suitability for construction of project facilities.	B1.3.1.3, B.5.0, A.3.1.2
		Assess the potential for acid sulfate soils in accordance with: Queensland Acid Sulfate Soil Technical Manual (refer to: **www.derm.qld.gov.au/land/ass/products.html**) State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (Department of Natural Resources and Mines & Department of Local Government and Planning 2002a) State *Planning Policy 2/02 Guideline: Acid Sulfate Soils* (Department of Natural Resources and Mines & Department of Local Government and Planning 2002b).	B1.2.1, B.1.3.1.3, B.1.4.1, A.3.1.2.3
		Soils should be described and mapped at a suitable scale and described according to the *Guidelines for Surveying Soil and Land Resources* (McKenzie et al. 2008) and *Australian soil classification* (Isbell & CSIRO 2002). Undertake an appraisal of the depth and quality of useable soil. Provide a map and description of: the location of key tidal planes such as: - the Highest Astronomical Tide - Mean High Water Spring Tide - Mean High Water Neap Tide - Mean Sea Level - Mean Low Water Neap Tide - Mean Low Water Spring Tide - Lowest Astronomical Tide. - the bathymetry of the project area and surrounds - relevant coastal geomorphology.	B1.3.1.3, A.3.1.2 A.3

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		Potential impacts and mitigation measures Provide details of any potential impacts to the topography or geomorphology associated with the project and proposed mitigation measures, including: - a discussion of the project in the context of major topographic features and any measures taken to avoid or minimise impact to such, if required - the objectives to be used for the project in any re-contouring or consolidation, rehabilitation, landscaping, and fencing.	B.1.4
		Identify the possible soil erosion rate for all permanent and temporary landforms and describe the techniques used to manage the impact. Include an assessment of likely erosion effects, especially those resulting from removing vegetation, and constructing retaining walls both on-site and off-site for all disturbed areas.	B.2.4.1.1, B.2.5.1.1
		Identify all soil types and outline the erosion potential (both wind and water) and erosion management techniques to be used. Provide details of an erosion-monitoring program (including rehabilitation measures for erosion problems identified during construction), and detail acceptable mitigation strategies.	B.1.3.1.3, B.2.4.1.1, B.2.5.1.1
		Summarise methods proposed to prevent or control erosion with regard to: - the *Soil Erosion and Sediment Control—Engineering Guidelines for Queensland Construction Sites* (Institution of Engineers Australia 1996) - the *Urban Stormwater Quality Planning Guidelines 2010* (Department of Environment and Resource Management 2010h) - preventing soil loss in order to maintain land capability/suitability - preventing degradation of local waterways.	(C2.5)5.2, C.1.8.3, B.2.5
		Discuss the potential for acid generation through disturbance of acid sulfate soils during earthworks and construction, and propose	B1.4.1, B.1.5.1

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		measures to manage soils and mitigate impacts for all site earthworks and construction activities	
		Should action criteria be triggered by acid generating potential as a result of testing, outline management measures in an acid sulfate soils management plan prepared in accordance with: Queensland Acid Sulfate Soil Technical Manual (refer to: **www.derm.qld.gov.au/land/ass/products.html#guidelines**) the requirements of State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (Department of Natural Resources and Mines & Department of Local Government and Planning 2002a) *State Planning Policy 2/02 Guideline: Acid Sulfate Soils* (Department of Natural Resources and Mines and Department of Local Government and Planning 2002b).	Appendix F2
5.2.3 Land contamination:		**Description of environmental values** Include: mapping of any areas listed on the Environmental Management Register or Contaminated Land Register under the EP Act identification of any potentially contaminated sites not on the registers whether or not remediation is required a description of the nature and extent of contamination at each site.	B.1.3.2.1
		Potential impacts and mitigation measures Discuss the management of any contaminated land and potential for contamination from construction, commissioning and operation, in accordance with the Department of Environment and Resource Management's *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland* (Department of Environment 1998) and the National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cwlth).	B1.4.2, C2.1, C2.2, C2.5
		Describe strategies and methods to be used to prevent and manage any land contamination resulting from the project, including the management of any acid generation or management of chemicals and fuels to prevent spills or leaks.	B1.5.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		State any intentions concerning the classification of land contamination after project completion.	A.3.6.10, B1.5.1
5.2.4 Land use and tenure		Description of environmental situation Identify with the aid of maps: - land tenure, including reserves, tenure of special interest such as protected areas and forest reserves, existing and proposed gas infrastructure, water pipelines, power infrastructure (above and underground) and transport corridors, including local roads, state-controlled roads and rail corridors - Existing land uses and facilities surrounding the project - Distance of the project from residential and recreational areas - Location of the project in relation to environmentally sensitive areas	B1.0 B.1.3.3.2 B.1.3.3.3 B.1.3.3.4
		Potential impacts and mitigation measures Detail the potential for the construction and operation of the project to change existing and potential land uses of the project site and adjacent area. Describe the following: - Impacts on surrounding land uses and human activities and strategies for minimisation, such as: – key resource areas (refer to State Planning Policy 2/07: Protection of Extractive Resources (Department of Mines and Energy 2007a) and *State Planning Policy 2/07 Guideline: Protection of Extractive Resources* (Department of Mines and Energy 2007b)) – Residential and industrial uses - Possible effect on town planning objectives and control, including local government zoning and	B1.0 B.1.4.3 B.1.2.2.2, B.1.4.3.2 B.1.5.3 B.1.4.4 B.1.4.5

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		strategic plans - Constraints to potential developments and possibilities of rezoning adjacent to the development area - Management of the immediate environs of the project including construction buffer zones - The potential native title rights and interests likely to be impacted upon by the project and the potential for managing those impacts by an indigenous land use agreement or other native title compliance outcomes - Proposed land use changes in any areas of high conservation value and information on how easement widths and vegetation clearance in sensitive environmental areas will be minimised - Potential issues involved in proximity and/or co-location of other current or proposed infrastructure services (e.g. rail corridor) - Any land units requiring specific management measures	B.1.4.6 B.1.4.7 B.1.4.8 B.1.4.9 B.1.4.10
5.3.1 Existing infrastructure		Describe the extent, condition and capacity of the existing transport infrastructure on which the project will depend. Particular mention must be made of the interaction with the Townsville Port Access Transport Corridor. This will include identification and analysis of construction measures for the interface between the port and the access corridor (road and rail). This should also demonstrate how the integrity of the road/rail corridor will be maintained.	B14.3
		Describe the project's impact on local and state-controlled road networks. Include an overview map(s) that shows the project's relationship with current and future local and state-controlled road networks. Include in the map(s) the location of construction activities	B14.3.2.2, B.14.3.2.3

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		and access locations (existing and proposed).	
		Also describe the existing rail network and interaction of the project with the rail corridor and infrastructure with maps at an appropriate scale.	B14.3.4
5.3.2 Transport tasks and routes		Describe: - expected volumes of project inputs and outputs of transported raw materials, wastes, hazardous goods, finished products for all phases of the project	B.14.1, B.14.3, B.12.4
		- how identified project inputs and outputs will be moved through the transport network (volume, composition, trip timing and routes)	B14.3.2.4
		- traffic generated by workforce personnel including visitors (volume, composition, timing and routes)	c) B14.3.2.4
		- likely heavy and oversize/indivisible loads (volume, composition, timing and routes), highlighting any vulnerable bridges and structures along proposed routes.	B.14.4
5.3.3 Potential impacts and mitigation measures		Impact assessment reports should include details of the adopted assessment methodology (for impacts on roads: the road impact assessment report in general accordance with the *Guidelines for Assessment of Road Impacts of Development* (Department of Main Roads 2006).	B.14.3.2.1
		Assess project impacts on: - local and state road networks - capacity, safety (including level crossing safety in consultation with Queensland Rail), local amenity, efficiency and condition of transport operations, services and assets (from either transport or project operations) - walking and cycling paths - possible interruptions to transport operations - the natural environment within the jurisdiction of an	B.14.4, B.14.5, B.20.4.10, C2.2, C2.5, B.1.4.9, B.1.2, B.13.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		affected transport authority (e.g. road and rail corridors) - the nature and likelihood of product-spill during transport, if relevant - driver fatigue for workers travelling to and from regional centres and key destinations - any existing or proposed strategies for public passenger transport and active transport and address, where relevant, requirements of Part 2A of the *Transport Planning and Coordination Act 1994* (Qld) - access to transport for people with a disability	
5.3.4 Infrastructure alterations		Detail: - any proposed alterations or new transport-related infrastructure and services required by the project (as distinct from impact mitigation works)	A.3.5
		- construction of any project-related plant and utilities, within or impacting on the jurisdiction of any transport authority.	A.3.5, A.2.6
5.3.5 Transport management strategies		Discuss and recommend how identified impacts will be mitigated so as to maintain safety, efficiency and condition of each mode. These mitigation strategies are to be prepared in close consultation with relevant transport authorities and consider those authorities' works programs and forward planning.	B14.5
		Road/rail management planning Outline: consideration of any mitigation works for road/rail corridors, including consultation with relevant road/rail managers and strategies for any associated works strategies to minimise the effects of project transport on existing and future public road or rail corridors and rail level crossing safety steps to be taken to prevent access from public roads/rail corridors to the project sites	B.14.5, B.14.7

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		strategies to maintain safe access to public road/rail reserves to allow road/rail/pipeline maintenance activities process for decommissioning any temporary access to road/rail reserves, e.g. stockpile sites	
		Shipping management planning Develop management plans in accordance with the Maritime Safety Queensland Guidelines for Major Development Proposals (Department of Transport and Main Roads 2010).	B.18.2.4, C2.3, C2.4
		The Regional Harbour Master (RHM) should be consulted on maritime issues relating to the movement and loading of tankers and any barge operations. The EIS should discuss the results of the consultation.	B.18.5 C2.4(5.2)
		Describe current vessels utilising the port and in the Commonwealth Marine Area, their size, shipping movements, anchorages, access to/from the port and navigational arrangements.	B.18.3
		In regard to increased shipping volumes, the following should be specifically addressed: potential for introduction of exotic organisms/marine pests from increased shipping and relevant investigation screening methodology ballast water management arrangements—including Australian Quarantine and Inspection Service mandatory arrangements and the port's contingency planning management of ship waste, in particular quarantine waste, domestic garbage, oil and sewage risk of spills and their management potential foreshore damage caused by tanker and tug activities potential for increased vessel strike to marine species potential impacts on existing shipping activity and navigable channels potential use of the Great Barrier Reef World Heritage Area routes of ships in transit through port waters and the aligned infrastructure such as navigational aids in consultation with Maritime Safety Queensland, the RHM and other	B.18.5, C2.4, C2.3

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		relevant agencies as required prepare: an aids to navigational management plan a vessel traffic management plan a ship-sourced pollution management plan and a cyclone contingency plan. Consider also the potential of the proposal to impact on recreational craft.	
	5.10.11 Increased Shipping	a) In relation to the projected increase in shipping, at a minimum, details of the following must be discussed: i. describe current vessel numbers and type utilising the port, their speed, their size, shipping movements, anchorages, access to/from the port and navigational arrangements; ii. describe projected total vessel movements at each stage of the project, including at the completion of the project. Include a comparison with total shipping movements through the Great Barrier Reef World Heritage Area and National Heritage place, Great Barrier Reef Marine Park; and iii. shipping routes to be used by vessels beyond the port in Commonwealth marine waters. These should be indicated on a map in relationship to the Great Barrier Reef World Heritage area and National Heritage place, Great Barrier Reef Marine Park and to the main shipping channels and any other navigational arrangements.	B.18.3
		b) In regard to increased shipping volumes, the following should be specifically addressed: i. potential for introduction of marine invasive species from increased shipping rates; ii. potential increase in ship groundings and related impacts; iii. potential increased risk of vessel collisions and related impacts; iv. potential for increased vessel strike to marine species; v. ballast water management arrangements - including Australian Quarantine and Inspection Service (AQIS) mandatory arrangements	B.18.4, B.18.5, C2.3, C2.4, A.3.6.2.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		and agency contingency planning; vi. management of ship waste, in particular quarantine waste, domestic garbage, oil and sewage; vii. potential risk of spills and their management, including stochastic modelling of potential worst case potential spill scenarios; viii. potential impacts on existing shipping activity. ix. the potential use of the Great Barrier Reef World Heritage Area and Great Barrier Reef Marine Park for the offshore anchorage of ships and the associated impacts of anchorages, including impacts on other users of large areas of the Great Barrier Reef Marine Park potentially being set aside (almost exclusively) as designated anchorage areas; and x. additional marine transport issues that should be considered include the potential of the proposal to impact on domestic commercial and recreational vessels.	B.12.4.1.3, B.4.4.4, B6.4.10, B6.4.14.3, B6.4.9, B6.4.12, Appendix X1
5.4 Coastal Environment		Describe the existing coastal environment that may be affected by the project in the context of coastal values identified in the Queensland State of the Environment reports and environmental values as defined by the EP Act and environmental protection policies.	B.1.3, B.3.3, B.4.3 B6.3
		Identify actions associated with the project that are assessable development within the coastal zone and will require assessment under the provisions of the *Coastal Protection and Management Act 1995* (Coastal Act).	A.2.6.4, B.3.2.1
		Assess the project's consistency with the relevant policies of the *Queensland Coastal Plan*, including the State Planning Policy 3/11: Coastal Protection (Department of Environment and Resource Management 2011e) and the State Policy for Coastal Management (Department of Environment and Resource Management 2012b).	B.3.2.1, A.2.6.4
	5.9 The Existing Environment	This section must provide a description of the project area including baseline condition and trends of Cleveland Bay's coastal and marine environments, including hydrology, sediment flows, geography, flora and fauna, cultural and heritage values, and all relevant socio-	B.3.3, B.6.3, B.7.3, B.15.3, B.16.3, B.13.3, B.19.3.7

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		economic considerations.	
		This section must link to the proposal description, potential impacts, and proposed avoidance, mitigation, adaptive management measures and/or offset measures throughout the life of the project including pre-construction, construction and operation.	
		This section is to also identify and reference any relevant (published and unpublished) studies undertaken in the area which will assist in describing patterns and trends in the environment.	All
5.4.1 Hydrodynamics and sedimentation		**Description of environmental values** Assess the physical and chemical characteristics of sediments within the littoral and marine zone of Cleveland Bay adjacent to the project area.	B.5.3, Appendix J1, J2
		Describe the physical processes of coastal environment related to the project including: ▪ Waves ▪ Currents ▪ Tides ▪ storm surges ▪ freshwater flows ▪ the key influencing factors of cyclones and other severe weather events and their interaction in relation to the assimilation and transport of pollutants entering marine waters from, or adjacent to, the project area.	B3.3.2, B.3.3.4, B3.3.5, B.4.3.2, B.4.4.4.1
		Describe the environmental values of the coastal resources of the affected area in terms of the physical integrity and morphology of landforms created or modified by coastal processes.	B3.3.3
		Describe the tidal hydrodynamics of the project area and the adjoining tidal waterways in terms of water levels and current velocities and directions at different tidal states. Undertake two- and/or three-dimensional modelling. Provide details of water levels and flows associated with historical and predicted storm surges.	B3.3.4, Appendix H1, B.2.1.1
		Describe the wave climate in the vicinity of the project area and the	B.3.3.4.3

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		adjacent beaches including inter-annual variability and details of historical and predicted extreme wave conditions generated by tropical cyclones or other severe storm events.	
		Describe the hydrology of the area and the adjacent catchments of the rivers and the associated freshwater flows within the study area and the adjoining tidal waterways in terms of water levels and discharges. Detail the interaction of freshwater flows with different tidal states, including storm tides. Describe inter-annual variability and details of historical and predicted floods including extent, levels and frequency. Flood studies should include a range of annual exceedence probabilities for affected waterways, where data permits.	B.2.3, B.4.3
		Describe the amount of beach sand movement and or loss, adjacent to the project area that may be affected by the project.	B.3.3.6.1 – B.3.3.6.3
		Potential impacts and mitigation measures Describe the potential changes to the hydrodynamic processes and local sedimentation within Cleveland Bay and adjoining waterways resulting from the construction and operation of the project. This should include: impacts on tidal flows and water levels changes to sediment transport patterns, including the potential of the proposal to impact on bank erosion and/or bed degradation within adjacent waterways Any additional effects of climate change and sea level rise This assessment should also discuss the potential impacts associated with extreme events such as storm tide flooding which may result from changes to bathymetry and coastline as a result of the project. This must include an assessment of the vulnerability of the project to storm tide flooding and the potential of the project to affect vulnerability to storm tide flooding on adjacent properties.	B.3.4, B.3.5 B.8.4.2 B.3.3.4, B.3.4
		Describe the impact and relevant strategies of long swell wave energy reflection on dredging and breakwater protection.	B3.4, B3.5
		Predict the likely changes to hydrodynamics (including water levels, currents, wave conditions and freshwater flows) and sedimentation in	B.3.4.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		the project area (including Cleveland Bay and the banks of the Ross River) due to climate change.	
		When assessing the hydrodynamics of the area and movement of sediment along the coast, consider coastal processes such as erosion and accretion at adjacent locations including The Strand, Rowes Bay and Pallarenda. Determine the potential sand loss and the amount to renourish beaches adjacent to the project area quantified in terms of tonnes per annum.	B.3.4.3, B.3.4.4, B.3.4.5
		Discuss any impacts on upstream flood risk in the Ross River and any mitigation measures that may be required.	B.3.4.5.1, B.2.4.2
5.4.2 Water quality		**Description of environmental values** Provide baseline information on water quality of coastal waters. This information should include (but is not necessarily be limited to) general physical chemical water quality parameters such as dissolved oxygen, pH, heavy metals, nutrients, temperature, salinity, oil in water and turbidity. For coastal areas potentially affected by sediment run-off or dredging, suspended solids concentration and turbidity should also be included. Discuss the interaction of freshwater flows from the Ross River and Ross Creek with coastal waters and the significance of this in relation to marine flora and fauna adjacent to the project area. Baseline water quality values should be collected at site-specific locations with the precinct. The description of baseline water quality should include a discussion on blue green algae (*Trichdesmium sp.*) blooms, their frequency within the bay as well as causal factors.	B.4.3, B.4.3.2 B.4.3.2, B6.3, B.2.3, B2.4
		Describe the environmental values of coastal waters in the affected area in terms of: - variability associated with the local wind climate, seasonal factors, freshwater flows and extreme events - values identified in the EPP (Water) 2009 - reference should be made to the draft water quality objectives, as identified in the *Black Ross (Townsville)*	B.4.3.2, B.2.3, B.2.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		Water Quality Improvement Plan (Townsville City Council 2010).	
		Potential impacts and mitigation measures Define and describe the water quality objectives and practical measures for protecting, mitigating or enhancing coastal environmental values. This includes how nominated quantitative standards and indicators may be achieved, and how the achievement of the water quality objectives will be monitored, audited and managed. The potential environmental harm caused by the project on coastal resources and processes shall be described in the context of controlling such effects. Specific issues to be addressed include: - the water quality objectives used (including how they were developed), and how predicted activities will meet these objectives (refer to the *Queensland Water Quality Guidelines 2009* (Department of Environment and Resource Management 2009) and *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000) - potential threats to the water quality and sediment quality of the coastal environment within the project footprint, specifically associated with constructing and operating the facilities - reference should be made to the draft water quality objectives, as identified in the *Black Ross (Townsville) Water Quality Improvement Plan* (Townsville City Council 2010). This assessment shall consider, at minimum: - dredging and dredge material disposal, including disturbance of fine-grained sediments and contaminated material	B4.2, B4.3, B4.4 B5.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		- impacts of construction of the breakwater and revetment structures - potential accidental discharges of contaminants during construction and operation of the marine precinct - release of contaminants from marine structures and vessels, including potential for introducing marine pests - stormwater run-off from the marine precinct facilities and associated - flooding of Ross River and Ross Creek - other extreme events.	B2.4, Appendix G1
		Describe strategies for protecting Ramsar wetlands; and discuss any obligations imposed by state or Commonwealth legislation or policy, or international treaty obligations (i.e. JAMBA, CAMBA and ROKAMBA).	B6.4.13, B.7.3
	5.9 Existing Environment	A description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: …i) Identification of the World Heritage and National Heritage values expressed in the vicinity of the proposed development, including an evaluation of the contribution that the values expressed at this location make to the overall values for the Great Barrier Reef World Heritage Area and National Heritage place;	B24.1
		j) A description of the ecological character of the Bowling Green Bay Ramsar site.	B.6.3.2.1, B.7.3.1, Appendix K2
		k) A description of the Commonwealth marine environment and identification of those aspects of the Commonwealth marine area potentially affected by the proposal, including but not limited to baseline data on listed threatened species, migratory and marine species and any other species of conservation significance, including cetaceans.	B6.3.2.1, B.6.4.13.7
		l) Provide a description of biota/biotic habitats, including a map of	B6.3

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		marine/intertidal habitats (including information on seasonal fluctuations e.g. seagrass prevalence), likely to be affected by the proposed development;	
		m) Identify, describe and map environments important to the health of the Great Barrier Reef Marine Park, including terrestrial and intertidal habitats, that are likely to be affected by the proposed development;	B.6.3, B.7.3
		n) Identify, describe and map reef communities[2] and those species supported by coral reefs in areas likely to be affected by the proposed development, including information on species diversity and abundance;	B.6.3, B.6.3.5
		o) Identify, describe and map seagrass communities in areas likely to be affected by the proposed development, including information on species diversity, seasonality and abundance;	B.6.3.4
		p) Identify, describe and map soft sediment fauna communities (e.g. infauna, benthic invertebrates) in areas likely to be affected by the proposed development, including information on species diversity, seasonality and abundance;	B.6.3.6
		q) Describe oceanographic conditions in the region, especially those which may have a bearing on the proposal. Include information on seasonal variation, waves, tides, currents, water salinity, clarity, temperature and depths. Discuss the frequency and severity of weather conditions such as storms and cyclones, for two, ten and 100 year conditions;	B3.3
		r) Identify and describe the existing uses of the area and nearby areas that may be affected by the proposed action (for example; tourism, commercial and recreational fishing, research and traditional use activities); and	B.6.3.9, B.13.3, B.15.3.1, B.19.3
		All habitat maps must be produced at a sufficiently fine scale and as accurately as possible, considering their primary purpose and end	B.6.0, B.7.0

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[2] A reference to reef communities includes all Great Barrier Reef ecosystem components including corals, algae, mangroves, soft sediment habitats etc. (as per the Great Barrier Reef Outlook Report, 2009).

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		use. (for example; to evaluate habitat loss and inform locations of monitoring and reference sites).	
5.4.3 Sediment quality and dredging		Provide baseline information on marine sediments and sediment quality in the area likely to be disturbed by dredging or vessel movements, including contaminants (such as heavy metals, nutrients and pesticides), the presence of fines and/or indurated layers and acid sulfate potential. Present this information as a map of sediment types based on their physical and chemical properties and include depth profiles.	B.5.2.2, B.5.3
		Assessment of marine sediments should be undertaken in accordance with the *National Assessment Guidelines for Dredging* (Commonwealth of Australia 2009).	B.1.2.1, B.1.4, B.1.5, B.5.2.1, B.5.5,
		Detail specific measures to maintain sediment quality to nominated quantitative standards within the project and surrounding areas, particularly where future maintenance dredging may be required.	B.5.4, B.5.5
		Comment on the choice of the disposal site in relation to coastal management outcomes, having regard to the nature of the spoil, cost of alternatives and potential impacts on coastal resources and their values. Describe provisions for dredge material disposal and associated impacts on sediment quality. Discuss disposal options for contaminated material, if required. This must include a description of the arrangements to be put in place for long-term (20 years) dredge material disposal including details of proposed material placement areas.	B.5.4, B.5.5, B.4.4.3.3, Appendix E4
	5.10.9 Dredging And Spoil Disposal Related Impacts	The EIS must provide an assessment of the dredging and dredged material disposal related elements of the project and its impacts, including but not limited to the following: a) Review of the historical use of the dredge disposal ground/s used by the Proponent, including but not limited to; i. location, volume, timing, nature of material and equipment used; ii. identification of direct and indirect impacts of dredge material	A.3.3, A.3.3.2.5, Appendix E4, B.3.4, B.4.4, B.5.4, B.6.4,

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		disposal over time; and iii. an assessment of alternatives to the current dredge disposal ground.	
		b) Detailed evaluation of all potential disposal options in accordance with the National Assessment Guidelines for Dredging 2009 (NAGD 2009) and Annex 2 of the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972 (as amended in 2006) (London Protocol), identification of the preferred disposal option(s) and explanation of how the preferred option was selected;	Appendix E4
		c) The amount to be dredged and a map of the dredge footprint and locations for proposed disposal. The map should also indicate the proposed staging of dredging activities;	A.3.3, A.3.3.2.5, Appendix E4
		d) The type and method of dredging proposed with the expected length and timing of the dredging activities;	A3.3
		e) Discussion of proposed dredging equipment and methodology;	A3.3
		f) Other uses of the dredged material including any re-use, recycling or possible future use;	A.3.3.2.2, Appendix E4
		g) Assessment of sediment according to the NAGD 2009 this must include an assessment of the suitability of this material for land deposition and reclamation and offshore disposal at any proposed dredged material disposal ground;	B.5.3, B.5.4, B5.5.1, B.5.5.2
		h) Assessment of the risk and potential impacts of acid sulfate soils (ASS) and potential acid sulfate soils (PASS);	B.5.3, B.1.3, B4.4.3.4
		i) Consideration of potential impacts of mobilised sediments (e.g. metal or contaminant release);	B.4.4, B.5.4
		j) Details of future maintenance dredging requirements over the life of the project;	A.3.6.8, B.4.4.4.3
		k) Details of any previous sea dumping permits applied for including dates and volumes and whether the permit was for capital dredging or maintenance dredging;	B18.0, Appendix E4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		l) Detailed descriptions of potential impacts on the marine habitats and species within the proposed dredge footprint and disposal areas, including but not limited to assessment of seagrass and species that depend on it, including any marine flora and fauna protection measures proposed;	B.6.3, B.6.4
		m) The characteristics of the dredged material disposal area(s) proposed including the history of the site and the predicted fate of the material after disposal and over time and the potential zone of impact;	Appendix E4, A.3.3, A.3.3.2.5, B.5.4, B.3.4.3.4, B4.4
		n) Detailed descriptions of both the direct and indirect impacts along with an assessment of the reversibility of those impacts are to be included in predications of impacts associated with the activity of dredging and disposal on marine habitats and species[3];	B.6.3, B.6.4, B.7.3, B.7.4
		o) Predictive three dimensional modelling of indirect impacts of dredge generated sediments must include: i. hydrodynamic modelling; ii. sediment transport modelling where the rang of particle fractions (sand, silt and clay) area all modelled; iii. modelling must include all types of resuspension possibilities including currents and wave-induced bottom shear stresses as well as wave induce mud fluidisation. If not modelled a justification as to why this phenomena was not relevant for that site. iv. ecological impact predictions. Lethal and sub lethal thresholds used for the ecological impact predictions must be clearly indicated and substantiated with relevant scientific peer reviewed articles; v. testing the sensitivity of ecological impact predictions to different pressure thresholds and considering seasonal effects must also be undertaken to understand the likely rang of prediction outcomes;	Appendix H1, B3, B4, B5

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[3] The Environmental Assessment Guideline for Marine Dredging Proposals, September 2011, prepared by the EPA, Western Australia, is an example of a document that presents guidance on predicted impacts of dredging activities on benthic communities and habitats.

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		vi. proponent to provide results of modelling in electronic format (i.e. shapefiles); and vii. the modelling must represent the conditions at the time of year in which the dredging will actually occur. If this is not known then modelling should be undertaken for all seasons (i.e. summer conditions, winter conditions, transitional conditions) depending on prevalent oceanographic conditions.	
		p) Modelling must include likely dispersion and resuspension from both dredging operations and dredge material disposal during a range of probable hydrodynamic conditions, weather events and expected dredge equipment scenarios;	Appendix H1, B3.0
		q) Site selection of dredge disposal site (even if a historic site) must be justified and compared to other possible sites with a prediction for resuspension and possible direction and distance of the migration of the dredge spoil under different current conditions;	Appendix E4
		r) Model outputs must use a spatially based scheme that provides for a clear and consistent way of describing and presenting the extent, severity and duration of predicted impacts of dredging and material disposal and must include likely "best case" and likely "worst case" scenarios;	B3.0, B4.4 (supported by Appendix H1)
		s) Modelling should be independently peer reviewed. Information relating to the peer review, including the Terms of Reference and the peer reviewer's report must be included as part of the EIS documentation;	Appendix H2
		t) Impacts to benthic habitat, in particular benthic primary producer habitat (BPPH), must be described. The benthic habitat must be mapped and the potential impacts must be described, taking into consideration the sediment plume monitoring. Cumulative impacts of the entire dredge operation and likely maintenance dredging requirements must be described; and	B6.4
		u) Identify the potential vectors and risks of introducing marine invasive species though vessels involved in dredging operations; and	B.6.4.10, B.6.7, B.6.3.8, B4.4.4, Part C

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		how these risks will be appropriately managed. Must include but not be limited to ballast water, entrainment of mud and sediment and biofouling in dredge equipment and ancillary fitting, niche areas, internal seawater systems, vessel history, previous work locations and maintenance history.	
5.5 Nature conservation		Detail the existing nature conservation values that may be affected by the proposal. Describe the environmental values in terms of: - integrity of ecological processes, including habitats of rare and threatened species - conservation of resources - biological diversity, including habitats of rare and threatened species - integrity of landscapes and places including wilderness and similar natural places - aquatic and terrestrial ecosystems.	B.6.3. B.7.3
		Survey effort should be sufficient to identify, or adequately extrapolate, the floral and faunal values over the range of seasons, particularly during and following a wet season. The survey should account for the ephemeral nature of watercourses traversing the proposal area, and seasonal variation in fauna populations.	B.6.2.2, B.7.3
		Wherever possible, seek the involvement of the local Indigenous community in conducting field observations and survey activities to identify the traditional and contemporary Indigenous uses of species.	B.13.3.3.3
5.5 Nature conservation		Also outline the proposed strategies to avoid, or minimise and mitigate, impacts on the identified values within the project's footprint.	B.6.4, B.6.5 B.7.4, B.7.5
		Identify key flora and fauna indicators for ongoing monitoring.	B6.0, B7.0, C2.1, C2.2, C2.5
5.5.1 Sensitive environmental areas		**Description of environmental values** Identify areas that are environmentally sensitive in proximity to the project on a map of suitable scale. This should include areas classified as having national, state, regional or local biodiversity significance, or flagged as important for their integrated biodiversity values. Refer to both Queensland and Commonwealth legislation and	B.7.3.1, B.6.3

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		policies on threatened species and ecological communities.	
		Areas regarded as sensitive with respect to flora and fauna have one or more of the following features and should be identified and mapped: ▪ important habitats of species listed under the *Nature Conservation Act 1992* (Qld) (NC Act) and/or EPBC Act as presumed extinct, endangered, vulnerable or rare ▪ regional ecosystems listed as 'endangered' or 'of concern' under state legislation, and/or ecosystems listed as presumed extinct, endangered or vulnerable under the EPBC Act ▪ good representative examples of remnant regional ecosystems or regional ecosystems that are described as having 'medium' or 'low' representation in the protected area estate as defined in the Regional Ecosystem Description Database (REDD), available at www.derm.qld.gov.au ▪ sites listed under international treaties such as Ramsar wetlands and World Heritage areas ▪ sites containing near-threatened or bio-regionally significant species or essential, viable habitat for near-threatened or bio-regionally significant species\ ▪ sites in, or adjacent to, areas containing important resting, feeding or breeding sites for migratory species of conservation concern listed under the Convention of Migratory Species of Wild Animals, and/or bilateral agreements between Australia and other countries ▪ sites adjacent to nesting beaches, feeding, resting or calving areas of species of special interest (e.g. marine turtles, dugongs and cetaceans) ▪ sites containing common species that represent a distributional limit and are of scientific value or that contain feeding, breeding,	B.7.3, B7.4, B.6.3, B.6.3.2.1, B.6.4, B1.3, B1.4

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		resting areas for populations of echidna, koala, platypus and other species of special cultural significance ▪ sites of high biodiversity that are of a suitable size or with connectivity to corridors/protected areas to ensure survival in the longer term; such land may contain: - natural vegetation in good condition or other habitat in good condition (e.g. wetlands) - degraded vegetation or other habitats that still support high levels of biodiversity or act as an important corridor for maintaining high levels of biodiversity in the area ▪ a site containing other special ecological values (e.g. high habitat diversity and areas of high endemism) including seagrass beds ▪ ecosystems that provide important ecological functions such as: - wetlands of national, state and regional significance - coral reefs - riparian vegetation - important buffer to a protected area or important habitat corridor between areas ▪ declared fish habitat areas and sites containing protected marine plants under the *Fisheries Act 1994* (Qld) ▪ sites of palaeontologic significance such as fossil sites ▪ sites of geomorphological significance, such as lava tubes or karst ▪ protected areas that have been proclaimed under the NC Act and *Marine Parks Act 2004* (Qld) or are under consideration for	

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		proclamation - areas of major interest, or critical habitat declared under the NC Act - remnant vegetation listed under the *Vegetation Management Act 1999* (Qld) (VM Act) as containing endangered and of concern regional ecosystems where clearing is likely to result in land degradation and a loss of ecosystem function and biodiversity. Areas of special sensitivity include the marine environment and wetlands, wildlife breeding or roosting areas, any significant habitat or relevant bird flight paths for migratory species, bat roosting and breeding caves including existing structures such as adits and shafts, and habitat of threatened plants, animals and communities.	
	5.6 Matters of National Environmental Significance	In relation to matters of National Environmental Significance listed as controlling provisions for the proposal an inventory of surveys, whether office-based or field-based, must be provided. These may be provided as appendices, but must at least be fully referenced and must be made publicly available unless DSEWPAC is furnished with compelling reasons not to do so.	B6.0, Appendix K2, B.7.0, Appendix L
		Any anticipated future surveys to be conducted in relation to matters of National Environmental Significance, whether office-based or field-based, must also be discussed.	B.23.2, B.6.5, B.7.5
		Output from the protected matters search tool (accessible from DSEWPAC's website) must be also included as an appendix	B.6.3.7.1, B.7.2.1,Appendix K2, Appendix L1
		The results, indicating the presence of matters of National Environmental Significance, must also be provided. Any species or values considered likely or known to occur in areas impacted by the controlled action must be addressed. The description of matters of National Environmental Significance should focus on, but not be limited to the following controlling provisions:	B.6.3, B.6.4, B.7.3, B.7.4 Appendix K2, Appendix L, B.6.4.14

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		a) World Heritage properties (sections 12 & 15A); b) National Heritage places (sections 15B & 15C); c) Wetlands of international importance (sections 16 & 17B); d) Listed threatened species and ecological communities (sections 18 & 18A); e) Listed migratory species (sections 20 & 20A); f) Commonwealth marine areas (sections 23 & 24A); and g) Great Barrier Reef Marine Park (sections 24B & 24C)	
	5.9 The Existing Environment	A description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: …d) Identify the desired conservation outcomes that the project has for matters of National Environmental Significance;	B.6.3, B.7.3
		e) Describe the biophysical/regional conditions that are required for matters of National Environmental Significance to be maintained and that are required to reach articulated conservation objectives for matters of National Environmental Significance;	B.6.3, B.7.3
		…g) Describe and quantify natural variability of matters of National Environmental Significance where adequate data is available or can be sourced;	B.6.3, B.7.3
		h) Describe the extent to which the general environment, ecosystems and matters of National Environmental Significance are already stressed by natural and anthropogenic effects;	B.6.3, B.6.4.14, B.7.3, B.7.4
5.5.1 Sensitive environmental areas		**Potential impacts and mitigation measures** Discuss the impact of the project on species, communities and habitats of local, regional or national significance in sensitive environmental areas as identified above. Include human impacts and the control of any domestic animals introduced to the area.	B.6.4, B.7.3.5, B.7.4
5.5.1 Sensitive environmental areas		Demonstrate how the project would comply with the following hierarchy: ▪ avoiding impact on areas of remnant vegetation and other areas of conservation value including listed species and their habitat	B6.4, B6.5, B6.7, B.7.4, B.7.5,

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		▪ mitigating impacts through rehabilitation and restoration including, where relevant, a discussion of any relevant previous experience or trials of the proposed rehabilitation ▪ measures to be taken to replace or offset the loss of conservation values where avoiding and mitigating impacts cannot be achieved. Explain why the measures above would not apply in areas where loss would occur.	
5.5.1 Sensitive environmental areas		Discuss the boundaries of the areas impacted by the project within or adjacent to an endangered ecological community, including details of footprint width. If the project area will impact upon a threatened community, include reasons for the preferred alignment and the viability of alternatives.	B6.3, B.7.3
5.5.1 Sensitive environmental areas		Address any actions of the project or likely impacts that require an authority under the NC Act, and/or would be assessable development for the purposes of the VM Act. Outline how these measures will be implemented in the overall EMP for the project. Provide details about the approvals that will be required under the NC Act and the VM Act for development made assessable under SPA. The overall EMP for the project should address the performance requirements of the relevant policies and regional vegetation management codes published by DERM.	B6.4, B.6.5, B.7.4, B.7.2.2, B.7.5, C.2.2
5.5.1 Sensitive environmental areas		Where relevant, this section should discuss environmental offset requirements in accordance with the Queensland Government Environmental Offsets Policy (Environmental Protection Agency 2008b) and take into account the applicable specific-issue offset policies, as follows: - Policy for Vegetation Management Offsets (Department of Environment and Resource Management 2011b)	B6.4.2.7, B23.2

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		- Queensland Biodiversity Offset Policy (Department of Environment and Resource Management 2011c) - *Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss* (Fish Habitat Management Operational Policy FHMOP 005) (Dixon & Beumer 2002).	
5.5.1 Sensitive environmental areas		Describe any departure from no net loss of ecological values.	B6.4.2.7, B.7.4, B7.7
5.5.2 Terrestrial flora		**Description of environmental values** Provide vegetation mapping for all relevant project sites. Adjacent areas should also be mapped to illustrate interconnectivity. Mapping should also illustrate any larger scale interconnections between areas of remnant or regrowth vegetation where the project site includes a corridor connecting those other areas.	B.7.3.4
		Discuss any variances between site mapping and mapping produced by the Queensland Herbarium.	B.7.2
		Describe the terrestrial vegetation communities within the affected areas at an appropriate scale (maximum 1:10 000), with mapping produced from aerial photographs and ground-truthing, showing the following: - location and extent of vegetation types using the regional ecosystem type descriptions in accordance with the REDD - location of vegetation types of conservation significance based on regional ecosystem types and occurrence of species listed as protected plants under the Nature Conservation (Wildlife) Regulation 1994 (Qld) and subsequent amendments, as well as areas subject to the VM Act - the current extent (bioregional and catchment) of protected vegetation types of conservation significance within the protected area estate (national	B.7.3

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		parks, conservation parks, resource reserves, nature refuges and conservation reserves under the *Land Act 1994* (Qld)) - any plant communities of cultural, commercial or recreational significance - the location of any horticultural crops in the vicinity of the project area - location and abundance of any exotic or weed species.	
		Highlight sensitive or important vegetation types, including any marine littoral and subtidal zone and riparian vegetation, and their value as habitat for fauna and conservation of specific rare floral and faunal assemblages or community types. The description should contain a review of published information regarding the assessment of the significance of the vegetation to conservation, recreation, scientific, educational and historical interests. For each significant natural vegetation community likely to be impacted by the project, vegetation surveys should be undertaken at an appropriate number of sites, allowing for seasonal factors, and satisfying the following: - the relevant regional vegetation management codes - site data should be recorded in a form compatible with the Queensland Herbarium CORVEG database - the minimum site size should be 10 × 50 metres - a complete list of species present at each site should be recorded - the surveys to include species structure, assemblage, diversity and abundance - the relative abundance of plant species present to be recorded - any plant species of conservation, cultural, commercial or recreational significance to be identified - any plant species of conservation, cultural,	B.7.2, B.7.3, B.7.4, B.6.3, B.6.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		commercial or recreational significance to be identified - specimens of species listed as protected plants under the Nature Conservation (Wildlife) Regulation, other than common species, are to be submitted to the Queensland Herbarium for identification. Existing information on plant species may be used instead of new survey work, provided that the data is derived from previous surveys at the site consistent with the above methodology. The methodology used for flora surveys should be specified in the appendices to the report.	
		Potential impacts and mitigation measures Describe the potential environmental harm to the ecological values of the area arising from the construction, operation and decommissioning of the project including clearing, salvaging or removing vegetation. Discuss the indirect effects on remaining vegetation. Consider short- and long-term effects and comment on whether the impacts are reversible or irreversible. With regard to all components of the project, include: - a description of the potential impacts that clearing vegetation will have on listed species and communities in the extent of the proposed vegetation clearing - any management actions to minimise vegetation disturbance and clearance - a discussion of the ability of identified vegetation to withstand any increased pressure resulting from the project and any measures proposed to mitigate potential impacts - a description of the methods to ensure rapid rehabilitation of disturbed areas following construction, including the species chosen for revegetation, which should be consistent with the surrounding associations	B.7.4, B.7.5, B.7.6, C2.2, C2.5

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		- details of any post construction monitoring programs - a discussion of the potential environmental harm on flora due to any alterations to the local surface and groundwater environment with specific reference to impacts on riparian vegetation or other sensitive vegetation communities - a description of any foreseen impacts which increase the susceptibility of ecological communities and species to the impacts of climate change.	
		Outline how these measures will be implemented in the overall EMP for the project. Weed management strategies are required for containing existing weed species (e.g. parthenium and other declared plants) and ensuring no new declared plants are introduced to the area. Refer to the local government authority's pest management plan and any strategies and plans recommended for the project area by Biosecurity Queensland. Discuss the strategies in accordance with provisions of the *Land Protection (Pest and Stock Route Management) Act 2002* (Qld) in the main body of the EIS and in the pest management plan within the EMP for the project.	B.7.4, C2.2, C2.5
5.5.3 Terrestrial fauna		**Description of environmental values** Describe the terrestrial and riparian fauna occurring in the areas affected by the proposal, noting the broad distribution patterns in relation to vegetation, topography and substrate. The description of the fauna present or likely to be present in the area should include: - species diversity (i.e. a species list) and abundance of animals of recognised significance - any species that are poorly known but suspected of being rare or threatened - habitat requirements and sensitivity to changes, including movement corridors and barriers to movement - the existence of feral or introduced animals including those of economic or conservation significance - existence (actual or likely) of any species/communities	B.7.3

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		of conservation significance in the study area, including discussion of range, habitat, breeding, recruitment feeding and movement requirements, and current level of protection (e.g. any requirements of protected area management plans or threatened species recovery plans) - habitat requirements and sensitivity to changes, including movement corridors and barriers to movement - an estimate of commonness or rarity for the listed or otherwise significant species - use of the area by coastal/marine birds, migratory birds, nomadic birds and terrestrial fauna.	
		Identify any species listed by the EPBC Act and the NC Act occurring in the project area. Identify any species listed by the DERM 'Back on Track' species prioritisation methodology (refer to www.derm.qld.gov.au/wildlife-ecosystems/wildlife/ back_on_track_species_prioritisation_framework/index.html).	B7.3.4, B.7.4.6.4
		Indicate how well any affected communities are represented and protected elsewhere in the bio-region where the project occurs. Specify the methodology used for fauna surveys. Provide relevant site data to DERM in a format compatible with the Wildlife Online database for listed threatened species (refer to www.derm.qld.gov.au/wildlife-ecosystems/wildlife/wildlife_online/index.html).	B7.4.6.4
		Potential impacts and mitigation measures The assessment of potential impact should consider impacts the project may have on terrestrial fauna, relevant wildlife habitat and other fauna conservation values, including: - impacts due to loss of range/habitat, food supply, nest sites, breeding/recruiting potential or movement corridors or as a result of hydrological change - impacts on native species, particularly species of	B.7.4.1, B.7.6

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		conservation significance - cumulative effects of direct and indirect impacts - threatening processes leading to progressive loss - a description of any foreseen impacts which increase the susceptibility of ecological communities and species to the impacts of climate change.	
		Describe strategies for protecting rare or threatened species, and discuss any obligations imposed by state or Commonwealth endangered species legislation or policy or international obligations (i.e. JAMBA, CAMBA and ROKAMBA).	B.7.4.6.4, B.7.2
		Address any actions of the project or likely impacts that require an authority under the NC Act. Provide the following information on mitigation strategies: - measures to avoid and mitigate the identified impacts. Any provision for buffer zones and movement corridors, nature reserves or special provisions for migratory animals should be discussed and coordinated with the outputs of the flora assessment - details of the methodologies that would be used to avoid injuries to livestock and native fauna as a result of the project's construction and operational works, and if accidental injuries should occur, the methodologies to assess and handle injuries - strategies for complying with the objectives and management practices of relevant recovery plans. d) Outline how these measures will be implemented in the overall EMP for the project. Rehabilitation of disturbed areas should incorporate, where appropriate, provision of nest hollows and ground litter.	B.7.5
		Address feral animal (including pest) management strategies and practices. The study should develop strategies to ensure that the project does not contribute to increased encroachment of a feral animal species. Refer to the local government authority's pest	B.7.3.5, B.7.4.3, B.7.5.5

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		management plan and any strategies and plans recommended for the project area by Biosecurity Queensland. Discuss the strategies in accordance with the provisions of the Land Protection (Pest and Stock Route Management) Act in the main body of the EIS and in the pest management plan within the EMP for the project.	
5.5.4 Aquatic ecology		**Description of environmental values** *General* Describe the aquatic flora and fauna present, or likely to be present, in the areas affected by the proposal, noting the patterns and distribution in the waterways and any associated wetlands. Include: - fish species, mammals, reptiles, amphibians, crustaceans and aquatic invertebrates occurring in the waterways within the affected area (as defined under section 5 of the Fisheries Act 1994) - any rare or threatened marine species - a description of the habitat requirements and the sensitivity of aquatic species to changes in flow regime, water levels and water quality in the project areas - aquatic plants including native and exotic/weed species - aquatic and benthic substrate - habitat downstream of the project or potentially impacted due to currents in associated lacustrine and marine environments - aquatic substrate and stream type, including extent of tidal influence and common levels such as highest astronomical tide and mean high water springs.	B6.3, Appendix K2
	5.9 The Existing Environment	A description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: a) Listed migratory species and listed threatened species and ecological communities that are likely to be present in the vicinity of the site, including but not limited to marine turtles, inshore dolphins,	B6.3, B.7.3, Appendix K2, Appendix L)

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		cetaceans, dugong and migratory birds including shorebirds;	
		b) At a minimum the following details must be included: i. details of the scope, timing (survey season/s) and methodology for studies or surveys used to provide information on the listed species/community/habitat at the site (and in areas that may be impacted by the project).	B6.3, Appendix K2, Appendix L, B.7.2, B.7.3
		ii. include a summary of the location, size and breeding status of threatened and migratory species listed under the EPBC Act which are likely to occur in the area affected by the proposal.	B.6.3, B.7.3, Appendix K2, Appendix L
		c) Information on listed threatened and migratory species, including foraging, roosting, resting and nesting habitats, must include but not be limited to: i. describe and map critical habitat for threatened species, ecological communities and migratory species; ii. the importance of habitat in a local, regional, national and international context; iii. the status of the population (e.g. abundance) in the area likely to be affected by the proposed development relative to other areas outside the area likely to be affected; iv. genetic diversity; v. the viability of the local, regional and overall populations; vi. local and regional representation; vii. conservation and biodiversity values; viii. economic, social and cultural values of species; ix. the extent (in hectares) of any areas of important or unique habitat; and x. seasonality influences.	B6.3, B.7.3, B.15.3, B.24.2.6,
5.5.4 Aquatic ecology		Describe any wetlands listed by DERM as areas of national, state or regional significance and detail their values and importance for aquatic flora and fauna species.	B6.3, Appendix K2
		Flora Define the nature and extent of existing marine features such as littoral and sub-littoral lands, waterways, affected tidal and subtidal	B6.3, Appendix K2

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		lands and marine plants vegetation (e.g. aquatic plants, salt couch, seagrass and mangroves) within the proposed area of development and in the areas adjacent to the project.	
		Conduct field assessments for plant species, preferably in both pre- and post-wet season conditions, as follows: - record site data in a form compatible with the Queensland Herbarium CORVEG database - record a complete list of species present at each site, including those species defined and protected under the Fisheries Act - record the relative abundance of plant species present - identify any plant species of conservation, cultural, commercial or recreational significance - submit specimens of species listed as protected plants under the Nature Conservation (Wildlife) Regulation (other than common species) to the Queensland Herbarium for identification and entry into the HERBRECS database.	B6.3, Appendix K2
		Fauna—megafauna Describe the aquatic fauna, such as dugongs, dolphins, whales, sea snakes and rays that may be impacted by the proposed development.	B6.3.7, Appendix K2
		Fauna—turtles Describe the turtle species that may be using beaches in proximity to the proposed development area. The proponent should monitor turtle nesting along beaches near the proposed project area for the duration of the turtle nesting seasons, for turtle species occurring in the area. Undertake a desktop review of information on the turtle communities of the study area, particularly the green, hawksbill, loggerhead, olive ridley and flatback turtles, paying specific attention to any anecdotal or recorded information on turtle populations frequenting the port	B6.3.7, Appendix K2

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		area and any known nesting sites. Refer to studies of the turtle populations and consult DERM on historical data for the area, particularly in relation to previously conducted nesting surveys. Particular reference should be given to the protection of turtles from boat strike, given the potential increase in boat traffic closer to feeding grounds than the existing port channel.	
		Benthic macro invertebrates Benthic macro invertebrate communities likely to be directly or indirectly impacted by the project should be characterised for the assessment of the potential impacts of proposed capital works. Consider the effect of ongoing maintenance activities, including dredging, on benthic fauna.	B6.3.6, Appendix K2
		Reef communities Describe the reef communities that may be impacted by the proposed development.	B6.3.5, Appendix K2
		Potential impacts and mitigation measures Discuss the potential impacts of the project on the aquatic ecosystems, including: - loss of tidal flats on juvenile and adult aquatic species leading to loss of productivity in fish, crustaceans etc - loss of seagrasses in relation to the extent and regional significance of seagrass communities and associated impact on fisheries, dugongs, turtles etc - potential impacts associated with dredging and dredge material disposal (e.g. impacts of seagrass, mangroves, corals and benthic fauna) - potential impact of marine structures (whether temporary during construction or permanent) that may impair the movement of fish. Where waterway barrier works are proposed, these are to be described and mapped and will require approval under the Fisheries Act	B6.4, B6.5

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		- benefits and/or disadvantages to recreational and commercial fishers resulting from provision of infrastructure or other aspects of the proposal - the impact of creating the reclaimed area and the likely colonisation of the marina and marine structures, including the breakwaters that may partially offset the adverse impacts of the development on marine biodiversity. Discuss the design of the reclamation area and breakwater in relation to Fisheries Guidelines for Fish-Friendly Structures—Fish Habitat Guideline 006 (Derbyshire 2006) and, where appropriate, demonstrate fish-friendly design features of the proposed infrastructure - potential impacts from climate change and the project's potential to increase the susceptibility of aquatic ecological communities and species, e.g. coral bleaching.	
	5.10.1 Impacts to listed migratory species, threatened species and ecological communities	The EIS must provide an assessment of all potential and likely impacts to listed migratory species, threatened species and ecological communities from the construction and on-going operation of the development.	B6.4, B.7.4
	5.10.2 Impacts to listed values of the great barrier reef world heritage property	Provide an assessment of all potential and likely impacts to the World Heritage values of the Great Barrier Reef World Heritage property that have been identified as being expressed in the vicinity of the proposal during construction, operation and (if applicable) decommissioning of the proposal. This assessment must include an analysis of the impact of the proposal on the expression of the values at this location and how this in turn impacts on the overall values of the Great Barrier Reef World Heritage property.	Part B, B.6.4.14.2, B.7.4.6.2, B.23, B.24.2
		Provide an analysis of direct, indirect and relevant impacts of the proposal on the integrity and Outstanding Universal Value of the Great Barrier Reef World Heritage Area.	B.6.4.14.2, B.24.2, A.2.6.2.1,
	5.10.3 Impacts to listed	Provide an assessment of all potential and likely impacts to the	Part B, B.6.4.14.4, B.24.2.2

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	values of the Great Barrier Reef National Heritage Place	National Heritage values of the Great Barrier Reef National Heritage place that have been identifies as being expressed in the vicinity of the proposal during construction, operation and (if applicable) decommissioning of the proposal. This assessment must include an analysis of the impact on the overall values of the Great Barrier Reef National Heritage Place.	
	5.10.4 Impacts to the Bowling Green Bay Ramsar Site	Provide an assessment of all potential and likely impacts to the ecological character of the Bowling Green Bay Ramsar site during construction, operation and (if applicable) decommissioning of the proposal.	B6.4.14.5, B.6.4.13.5, B.24.3.2, B.7.4.6.3
	5.10.5 Impacts to the Commonwealth Marine Environment	Provide an assessment and discussion of the potential direct, indirect and consequential impacts of the proposed development on the Commonwealth marine environment.	B6.4.14.7, B.24.3.1, B.6.4.13.7, B.18.3.3
	5.10.6 Impacts to the Great Barrier Reef Marine Park	Provide an assessment and discussion of the potential direct, indirect and consequential impacts of the proposed development on the environment and values of the Great Barrier Reef Marine Park.	Part B, B6.4.14.8, B.24.3
5.5.4 Aquatic ecology		Describe proposed mitigation actions, including: - proposed location, type and design of waterway barrier works (both temporary and permanent) that would impact on aquatic resources, particularly fish movement; and provide an appropriately scaled map - potential mechanism to ensure adequate fish passage is provided at proposed waterway barriers - strategies for protecting any rare or threatened species - measures to reduce the impacts on the Australian snubfin dolphin, Indo-Pacific humpback dolphin, turtles and dugongs related to increased commercial use (i.e. boat strike, degraded water quality) - measures to avoid fish spawning periods, such as seasonal construction of waterway crossings and measures to facilitate fish movements through water crossings	B6.5

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		- offsets proposed for unavoidable, permanent loss of fisheries habitat in accordance with Mitigation and Compensation for Works or Activities Causing Marine Fish Habitat Loss (Fish Habitat Management Operational Policy 005) (Dixon & Beumer 2002). - methods to minimise the potential for introducing or spreading weed species or plant disease - monitoring aquatic biology health, productivity and biodiversity in areas subject to direct discharge - measures to prevent direct impacts on marine fauna and flora by any dredging works.	
		Address any actions of the project or likely impacts that require an authority under the relevant legislation including the NC Act and/or the Fisheries Act. Outline how these measures will be implemented in the overall EMP for the project.	B6.5
5.6 Water resources 5.6.1 Description of environmental values		Describe the existing water resources that may be affected by the project in the context of environmental values, as defined in such documents as: - the EP Act - Environmental Protection (Water) Policy 2009 (EPP (Water)) - *Australia and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000) - *Queensland Water Quality Guidelines 2009* (Department of Environment and Resource Management 2009).	B.2.3, B.2.2, B.4.2, B.4.3
		Provide an indication of the quality and quantity of water resources in the vicinity of the project area, describing: - existing surface and groundwater in terms of physical, chemical and biological characteristics	B.2.3

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		- existing surface drainage patterns, flows, history of flooding including extent, levels and frequency and present water uses.	
		Describe the environmental values of the surface waterways (including Ross River and Ross Creek) and groundwater of the affected area in terms of: - values identified in the EPP (Water) - physical integrity, fluvial processes and morphology, including riparian zone vegetation and form, if relevant - any impoundments (e.g. dams, levees, weirs etc.) - hydrology of waterways and groundwater - sustainability, including both quality and quantity - dependent ecosystems - existing and other potential surface and groundwater users - water resource plans relevant to the affected catchments.	B.2.3.1, B.2.4
		If the project is likely to use or affect local sources of groundwater, describe groundwater resources in the area in terms of: - geology/stratigraphy - aquifer type—such as confined, unconfined - depth to and thickness of the aquifers - depth to water level and seasonal changes in levels - groundwater flow directions (defined from water level contours) - interaction with surface water - possible sources of recharge - potential exposure to pollution - current access to groundwater resources in the form of bores, springs and ponds (including quantitative yield of water and locations of access). The groundwater assessment should also be consistent with relevant guidelines for the assessment of acid sulfate soils including spatial and temporal monitoring to accurately characterise baseline	B.2.3.2, B.2.4

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		groundwater characteristics.	
5.6.2 Potential impacts and mitigation measures		Assess the potential impacts of the project on water resource environmental values identified in the previous section. Also, define and describe the objectives and practical measures for protecting or enhancing water resource environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of objectives will be monitored, audited and managed. Include the following:	B2.0 B.2.4, B.2.5
		- potential impacts on the flow and the quality of surface and groundwater from all phases of the project, with reference to their suitability for the current and potential downstream uses and discharge licences	B4.4.3.1
		- an assessment of all likely impacts on groundwater depletion or recharge regimes	
		- potential impacts of surface water flow on existing infrastructure, with reference to the EPP (Water) and the Water Act 2000	C2.4, C2.4
		- chemical and physical properties of any wastewater (including stormwater at the point of discharge into natural surface waters), and the toxicity of effluent to flora and fauna	B.2.5
		- potential impacts on other downstream receiving environments, if it is proposed to discharge water to a riverine system	B.4.4.4.1 Part C, A.2.4.3
		- the results of a risk assessment for uncontrolled releases to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and list strategies to prevent, minimise and contain impacts	
		- an assessment of the potential to contaminate surface and groundwater resources and measures to prevent, mitigate and remediate such contamination. Strategies should be adequately detailed to demonstrate best	

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		practice management and that environmental values of receiving waters will be maintained to nominated water quality objectives. Describe the monitoring programs that will assess the effectiveness of management strategies for protecting water resources during the construction, operation and decommissioning of the project. Outline how these strategies are incorporated into appropriate sections of the EMP.	
5.7.1 Description of environmental values		Describe the existing air quality that may be affected by the project in the context of environmental values as defined by the EP Act and Environmental Protection (Air) Policy 2008 (EPP (Air)) and State Planning Policy 5/10: Air, Noise and Hazardous materials (Department of Environment and Resource Management 2010g).	B.9.2, B.9.3
		Discuss the existing air shed environment, both local and regional, including: - background levels and sources of particulates, gaseous and odorous compounds and any major constituent - pollutants, including greenhouse gases, that may be generated by the project - baseline monitoring results, sensitive receptors - data on local meteorology and ambient levels of pollutants should be gathered to provide a baseline for later studies or for the modelling of air quality environmental harms. Parameters should include air temperature, wind speed and direction, atmospheric stability, mixing depth and other parameters necessary for input to the models.	B.9.3
5.7.2 Potential impacts and mitigation measures		Consider the following air quality issues and their mitigation: - an inventory of air emissions from the project expected during construction and operational activities - 'worst case' emissions that may occur during operation. If these emissions are significantly higher	B.9.3, B.9.4, B.8.4

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		than those for normal operations, it will be necessary to separately evaluate the worst-case impact to determine whether the planned buffer distance between the facility and neighbouring sensitive receptors will be adequate - ground level predictions should be made at any site that includes the environmental values identified by the EPP (Air), including any sites that could be sensitive to the effects of predicted emissions - dust generation from construction activities, especially in areas where construction activities are adjacent to existing road networks or are in close proximity to sensitive receivers - climatic patterns that could affect dust generation and movement - vehicle emissions and dust generation along major haulage routes both internal and external to the project site - human health risk associated with emissions from the facility of all hazardous or toxic pollutants - impacts on terrestrial flora and fauna.	
		Detail the mitigation measures together with proactive and predictive operational and maintenance strategies that could be used to prevent and mitigate impacts.	B.9.5
		Discuss potential air quality impacts from emissions, with reference to the National Environmental Protection (Ambient Air Quality) Measure 2003 (Cwlth) and the EPP (Air). If an emission is not addressed in these legislative instruments, the emission should be discussed with reference to its risk to human health, including appropriate health-based guidelines/standards.	B.9.2, B.9.4
5.8.1 Description of environmental situation		Provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in ‘CO_2 equivalent’ terms for the following categories:	B.11

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		- Scope 1 emissions—means direct emissions of greenhouse gases from sources within the boundary of the facility and as a result of the facility's activities - Scope 2 emissions—means emissions of greenhouse gases from the production of electricity, heat or steam that the facility will consume, but that are physically produced by another facility Briefly describe method(s) by which estimates were made. Use the *National Greenhouse Accounts (NGA) Factors* (Commonwealth of Australia 2010) as a reference source for emission estimates, supplemented by other sources where practicable and appropriate. As a requirement of the NGA factors, estimates should include the loss of carbon sink capacity of vegetation due to clearing and impoundment.	
5.8.2 Potential impacts and mitigation		Discuss the potential for greenhouse gas abatement measures, including: the proposed measures (alternatives and preferred) to avoid and/or minimise direct greenhouse gas emissions how the preferred measures minimise emissions and achieve energy efficiency any opportunities to further offset greenhouse gas emissions through indirect means including sequestration and carbon trading.	B.11.5
5.9.1 Description of environmental values		Describe the existing noise and vibration environment that may be affected by the project in the context of the environmental values defined by the Environmental Protection (Noise) Policy 2008. The *Noise Measurement Manual* (Environmental Protection Agency 2000) should be considered and references should be made to the *EPA Guideline: Noise and vibration from blasting* (Environmental Protection Agency 2006) and *Guideline: Planning for noise control* (Environmental Protection Agency 2004).	B.10.2 B.10.3
		Identify sensitive noise receptors adjacent to all project components and estimate typical background noise and vibration levels based on	B.10.3

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		surveys at representative sites. Discuss the potential sensitivity of such receptors and nominate performance indicators and standards.	
5.9.2 Potential impacts and mitigation measures		Describe the impacts of noise and vibration generated during the construction and operational phases of the project. Noise and vibration impact analysis should include: - the levels of noise and vibration generated, including noise contours, assessed against current typical background levels, using modelling (such as Environmental Noise Model or SoundPLAN) where appropriate - impact of noise, including low frequency noise (noise with components below 200 Hz) and vibration at all potentially sensitive receivers (e.g. residences, social and public infrastructure, such as health, recreational and educational facilities, roads, etc) compared with the performance indicators and standards nominated above - impact on terrestrial and aquatic fauna - proposals to minimise or eliminate these effects, including details of any screening, lining, enclosing or bunding of facilities, or timing schedules for construction and operations that would minimise environmental harm and environmental nuisance from noise and vibration - options for sensitive receivers that are otherwise unable to achieve a satisfactory internal noise level for the preservation of health and wellbeing as identified within the EPP (Noise).	B.10.4, B.10.5 B.7.4.4, B.7.5.3, B.6.4.7
		Night-time works Provide details of any night-time work that may be undertaken. Specifically include: - the reasons why night-time work may be undertaken (e.g. to avoid peak traffic periods, or to undertake work in a rail corridor)	B.10.4.3.2, B10.6, C2.2(1.8.7)

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		- the likely duration of work (if known) - the proposed hours of the work - the nature of the work to be undertaken - the likely impact on residents and the associated mitigation measures to be undertaken by the proponent - the methods that will be used to communicate with affected residents.	
5.10.1 Waste generation		Identify and describe all sources, likely volumes and quality (where applicable) of waste associated with construction, operation and decommissioning of all aspects of the project. Reference is to be made to the *Waste Reduction and Recycling Act 2011* (Qld). Describe: - waste generated by delivery of material to site(s) - all chemical and mechanical processes conducted on the construction sites that produce waste - the amount and characteristics of solid and liquid waste produced on site by the project - hazardous materials to be stored and/or used on site, including environmental toxicity data and biodegradability.	e) B.12.4
5.10.2 Waste management		Assess the potential impact of all wastes generated during construction and operation, with regard for best practice waste management strategies in accordance with the Waste Reduction and Recycling Act. Provide details of each waste in terms of: - the options available for avoidance/minimisation - operational handling and fate of all wastes including storage - on-site treatment methods proposed for any wastes - methods of disposal (including the need to transport wastes off site for disposal) proposed to be used for any trade wastes, liquid wastes and solid wastes - the potential level of impact on environmental values - measures to ensure stability of the waste storage	B.12.4.2, B.12.5, B.12.3.2

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		areas and impoundments - methods to prevent seepage and contamination of groundwater from stockpiles and/or storage areas and impoundments - measures to minimise attraction of vermin, insects and pests - options available for using recycled materials - market demand for recyclable waste (where appropriate) - decommissioning of the construction site.	
5.11 Indigenous cultural heritage		Identify areas covered by applications for native title claims or native title determinations, providing boundary descriptions of native title representative body(ies), and whether it is necessary to notify the representative body(ies) or if there is evidence that native title does not exist.	B1.3.3.1, B15.3.1
5.11.1 Description of existing indigenous cultural heritage values		Describe the existing Indigenous cultural heritage values that may be affected by the project and the environmental values of the cultural landscapes of the affected area in terms of the physical and cultural integrity of the landforms.	B15.3
		Also describe how, in conjunction with the appropriate Indigenous people, the cultural heritage values were ascertained. This could include: - the results of any Aboriginal cultural heritage survey undertaken - the DERM Aboriginal Cultural Heritage Register and Database - any existing literature relating to Indigenous cultural heritage in the project area.	B.15.2.2
5.11.2 Potential impacts and mitigation measures		Define and describe the objectives and practical measures for protecting or enhancing Indigenous cultural heritage environmental values. Describe how nominated quantitative standards and indicators may be achieved for cultural heritage management, and describe how the achievement of the objectives will be monitored,	B.15.4, 15.5

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		assessed and managed. The EIS should provide an assessment of likely effects on sites of Indigenous cultural heritage value, including but not limited to the following: - description of the significance of artefacts, items or places of conservation or cultural heritage values likely to be affected by the project and their values at a local, regional and national level - recommended means of mitigating any negative impact on cultural heritage values and enhancing any positive impacts. As a minimum, impact assessment, management and protection strategies should satisfy statutory responsibilities and duties of care.	
		If an NT agreement is not finalised or a CHMP has not been approved when the EIS is submitted to the Coordinator-General, the following must be provided: - an outline of the draft CHMP or draft plan within the NT agreement that addresses management and protection strategies for cultural heritage, subject to any confidentiality provisions, outlining the position of the relevant parties - details of the proposed steps and timeframes for finalising the CHMP or NT agreement.	B.15.5
5.11.3 Native title		Identify areas covered by applications for native title claims or native title determinations, providing boundary descriptions of native title representative body(ies), and whether it is necessary to notify the representative body(ies) or if there is evidence that native title does not exist.	B1.3.3.1, B15.3.1
		Identify the potential for native title rights and interests likely to be impacted upon by the project and the potential for managing those impacts by an Indigenous land use agreement or other native title	B1.3.3.1, B15.3.1

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		compliance outcomes.	
5.12.1 Description of existing non-indigenous cultural heritage values		Include a cultural heritage study that describes non-Indigenous cultural heritage sites and places, and their values. Any such study should be conducted by an appropriately qualified cultural heritage practitioner and should include the following: - review of: • the Australian Heritage Places Inventory • the Queensland Heritage Register and other information regarding places of potential non-Indigenous cultural heritage significance • any local government heritage register • any existing literature relating to the heritage of the affected areas - liaison with relevant community groups/organisations (e.g. local historical societies) concerning places of non-Indigenous cultural heritage significance located or identified - locations of culturally and historically significant sites, shown on maps, that are likely to be impacted by the project - a constraints analysis of the proposed development area to identify and record non-Indigenous cultural heritage places.	B.16.0 B.16.2, B.16.3
5.12.2 Potential impacts and mitigation measures		Provide an assessment of any likely effects on sites of non-Indigenous cultural heritage values, including but not limited to the following: - description of the significance of artefacts, items or places of conservation or non-Indigenous cultural heritage value likely to be affected by the project and their values at a local, regional, state and national level - recommended means of mitigating any negative impacts on non-Indigenous cultural heritage values and enhancing any positive impacts - strategies to manage places of historic heritage	B.16.4

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		significance, taking account also of community interests and concerns.	
6.1 Description of existing social values		Conduct a social impact assessment and consider: - the social and cultural area, which should include the suburbs intersected by and adjacent to the project - community engagement - a social baseline study - a workforce profile - potential impacts and mitigation measures - management strategies.	B13.0 B.13.3.1 13.3.2, A.2.5 B.13.3.3 B.13.3.2, B.19.3.5 B.13.4, B.13.5
6.1.1 Social and cultural area		Define the project's social and cultural area of influence, including the local, district, regional and state level as relevant, taking into account the: - potential for social and cultural impacts to occur - location of other relevant proposals or projects - location and types of physical and social infrastructure, settlement and land use patterns - social values that might be affected by the project (e.g. integrity of social conditions, visual amenity and liveability, social harmony and wellbeing, and sense of community) - Indigenous social and cultural characteristics, such as native title rights and interests, and cultural heritage - use of the harbour/port area for commercial and recreational boating and fishing.	B13.0, B.13.3.1 B.13.4 B.13.3.3.11 B.13.3.3.7 - B.13.3.3.10 B.13.3.4, B.13.4.3 B.13.3.3.3, B.13.4.12, B.13.3.3.9 B.13.3.1.4, B.13.4.4.3
	5.10.12 Other Uses Of The Area And Nearby Areas	The EIS must identify the potential impacts of the proposed action on other uses of the area identified in section 5.9, including but not limited to the following: a) Social, cultural and heritage values for each stage of the proposal; b) Current and projected commercial, recreational and scientific use, including any changes in visitation patterns; c) Heritage and social values, including sites of historic or archaeological significance;	A.2.5, B.1.4, B.4.3.2.11, B.4.4, B.4.4.3.2, B.6.4, B.6.4.4.1, B.13.4, B,15.4, B.16.4, B.17.4, B.18.3, B.18.4, B.19.4, B.24.0, B.23.0, Appendix R1

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		d) Commercial and recreational fishing; and e) Traditional use activities.	
6.1.2 Community engagement		Describe the community engagement processes used to conduct open and transparent dialogue with stakeholders. Such processes should include, but not limited to, the use of community reference group forums. Include the project's planning and design stages and future operations including affected local and state authorities. Engagement processes will involve consideration of social and cultural factors, customs and values, and relevant consideration of linkages between environmental, economic, and social impact issues. Discuss engagement strategies and processes, including how complaint resolution will be addressed, for all stages of the project.	A.2.5, B.13.3.2
	5.8 Consultation	The proponent is required to consult with all stakeholders, with a particular focus on individuals/sectors that may be affected by the proposal (affected parties), as part of the EIS process.	A.2.5, B.13.3.2
		Details of any consultation about the action must be provided. This is to include: a) Any consultation that has already taken place including details on the frequency, forum and timetables provided for consultation; b) Proposed consultation about relevant impacts of the action; c) If there has been consultation about the proposed action, details of the issues discussed, including the views of the affected and any documented response to, or result of, the consultation; d) Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views; e) Details on how affected parties comments received during consultations have been addressed in the EIS; and f) Any further proposed consultation about potential impacts of the proposal.	A.2.5, Appendix E1, B.13.3.2, B.13.4.5
6.1.3 Social baseline study		Include a targeted baseline study of the people residing in the project's social and cultural area is required to identify the project's critical social issues, potential adverse and positive social impacts,	B.13.3.3, A.2.5

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		and strategies and measures developed to address the impacts. The social baseline study should be based on qualitative, quantitative, and participatory methods. It should be **supplemented by community engagement processes, and reference relevant data c**ontained in Local and State Government publications, reports, plans, guidelines and documentation, including regional plans and, where available, community plans. Describe: the current social infrastructure including community and civic facilities (e.g. Townsville Yacht Club), services and networks—for definition see South East Queensland Regional Plan 2005–2026: Implementation Guideline No.5: Social infrastructure planning (Department of Infrastructure 2007) settlement patterns including the names, locations, size, history and cultural aspects of settlement in the social and cultural area the identity, values, lifestyles, vitality, characteristics and aspirations of communities in the social and cultural area, including Indigenous communities land use and land ownership patterns including: the number of properties directly affected by the project the number of families directly and indirectly affected by the project including Indigenous traditional owners and their families, property owners, and families of workers either living on the property or workers where the property is their primary employment. use of the social and cultural area for fishing, recreation, business and industry, tourism, aquaculture, and Indigenous cultural use of flora and fauna.	B.13.3.3.7 B.13.3.3.8 B.13.3.4 B.13.3.3.9 B.13.3.3.10
6.1.4 Workforce profile		Include a profile of the workforce that describes the: number of personnel to be employed, the skills base of the required workforce and the likely sources (i.e. local, regional or overseas) for the workforce during the construction and operational phases for each component of the project estimated number of people to be employed during construction and	B.13.4.1, B.19.3.5

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		operation, and arrangements for their transport to and from the project areas, including proposed use of regional or charter air services. Estimates should be provided according to occupational groupings and variations in the workforce numbers for the duration of the project and show anticipated peaks in worker numbers during the construction and operation phase of the project.	
		Provide an outline of recruitment schedules and policies for recruiting workers, addressing recruitment of local and non-local workers including Indigenous workers, people from culturally and linguistically diverse backgrounds and people with a disability.	B.13.3.3.3, B13.4.1.2, A.3.4.3. A.3.6.9
		Provide information on the location of other major projects or proposals under study within the social and cultural area, together with workforce numbers.	B.13.3.3.11
6.2 Potential impacts		Assess and describe the type, level and significance of the project's social impacts (both beneficial and adverse) on the local and cultural area, based on outcomes of community engagement processes and the social baseline study. Furthermore: describe and summarise outcomes of community engagement processes including the likely response of the affected communities, including Indigenous people and other interest groups such as port and marina users including the Townsville Yacht Club include sufficient data to enable affected local and state authorities to make informed decisions about the project's effect on their business and plan for the provision of social infrastructure in the project's social and cultural area address direct, indirect and secondary impacts from any existing projects and the proposed project including an assessment of the size, significance, and likelihood of these impacts at the local and regional level. Consider the following: key population/demographic shifts; disruptions to existing lifestyles, the health and social wellbeing of families and communities; social dysfunction including alcohol and drugs,	B13.0 B.13.3.2, A.2.5 B.13.3, B.13.4 B.13.3, B.13.4

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		crime, violence, and social or cultural disruption due to population influx the needs of vulnerable groups including women, children and young people, the aged and people with a disability Indigenous peoples including cultural property issues local, regional and state labour markets, with regard to the source of the workforce. Present this information according to occupational groupings of the workforce. Detail whether the proponent, and/or contractors, is likely to employ locally or through other means and whether there are initiatives for local employment business opportunities proposed new skills and training related to the project including the occupational skill groups required and potential skill shortages anticipated how much service revenue and work from the project would be likely to flow to the project's social and cultural area impact of additional marine transport on recreational boating and fishing impacts of construction and operational workforces, their families, and associated contractors on housing and accommodation availability and affordability, land use and land availability. Discuss the capability of the existing housing and rental accommodation, to meet any additional demands created by the project, including direct impacts on Indigenous people.	
		Evaluate and discuss the potential cumulative social impacts resulting from the project including an estimation of the overall size, significance and likelihood of those impacts. In this context, 'cumulative impacts' is defined as the additional impacts on population, workforce, accommodation, housing, and use of community infrastructure and services, from the project, and other proposals for development projects in the area, which are publicly known or communicated by DEEDI, if they overlap the proposed project in the same timeframe as its construction period.	B.13.4, B.13.4.7

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		Discuss the concept of longitudinal cumulative impacts, or 'project fatigue', where the community in the study area has been subjected to a number of large-scale construction projects in recent years.	B.13.4.7
6.2.1 Mitigation measures and management strategies		For identified social impacts, social impact mitigation strategies and measures should be presented to address the: recruitment and training of the construction and operational workforces and the social and cultural implications this may have for the host community, including if any part of the workforce is sourced from outside the social and cultural area	B.13.5, B.13.4.1.1
		housing and accommodation issues, in consultation with relevant local authorities and State Government agencies, with proposals for accommodating the project workforce and their families that avoid, mitigate or offset any short- and medium-term adverse effects on housing affordability and availability, including the rental market, in the social and cultural area	B.13.5, B.13.4.2
		demographic changes in the profile of the region and the associated sufficiency of current social infrastructure, particularly health and welfare, education, policing and emergency services	B.13.5, B.13.3.3.6, B.13.3.3.7
		adequate provision of education, training and employment for women, people with a disability, and Indigenous peoples via an Indigenous Participation Plan.	B.13.5
		Describe any consultation about acceptance of proposed mitigation strategies and how practical management and monitoring regimes are proposed to be implemented.	B.13.5
7.1.1 Description of affected local and regional economies		Describe the existing economy in which the project is located and the economies materially impacted by the project. Include: a map illustrating the local and regional economies (local government areas) that could be potentially affected by the project gross regional product or other appropriate measure of annual economic production population labour force statistics economic indicators	B.19.3

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		the regional economy's key industries and their contribution to regional economic income sufficient baseline economic data to underpin a comprehensive assessment of the direct, indirect, cumulative, costs and impacts of the project the key regional markets relevant to the project: labour market housing and land markets construction services and building inputs market regional competitive advantage and expected future growth.	
	5.5 Project details	c) Describe the local and regional economic, social and built context, including historical and future trends (e.g. Australian Bureau of Statistics and *Great Barrier Reef Outlook Report 2009)* in which this project is proposed;	B.1.2.2.1, B.1.3, B.13.3, B.19.3
	5.5 Project details	f) A detailed description of social and economic impacts and drivers for the proposal	B.13.3, B.13.4, B.19.3, B.19.4, A.1.4
7.1.1 Description of affected local and regional economies		With regard to the region's key industries and factor prices, provide information on: current input costs (wage rates, building costs, housing rent etc.) land values in the region by type of use.	B.19.3
7.1.2 Potential impacts and mitigation measures		An assessment should use a Regional General Equilibrium Model analysis tool or similar model to measure impacts. The analysis should describe both the potential and direct economic impacts including estimated costs, if material, on industry and the community, assessing the following: property values industry output (e.g. large construction projects) employment commercial fishing the indirect impacts likely to flow to other industries and economies from the development of the project. This should also consider the implications of the project for future development the distributional effects of the proposal including proposals to	B.19.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		mitigate any negative impact on disadvantaged groups.	
		Strategies for local participation The assessment of economic impacts should outline strategies for local participation, including: strategies for assessing the cost effectiveness of sourcing local inputs from the regional economy during the construction, operation and rehabilitation phases of the project employment strategies for local residents including members of Indigenous communities and people with a disability, including a skills assessment and recruitment and training programs to be offered strategies responding to relevant government policy, relating to: the level of training provided for construction contracts on Queensland Government building and construction contracts, with regard to the Queensland Government Building and Construction Contracts Structured Training Policy (the 10 per cent policy) (see http://training.qld.gov.au/industry/10percent-policy.html) Indigenous employment opportunities, with regard to the Indigenous Employment Policy for Queensland Government Building and Civil Construction Projects—the 20 per cent policy (Department of Employment, Economic Development and Innovation 2008a) development of a Local Industry Participation Plan and other reports in accordance with the Local Industry Policy (Department of Employment, Economic Development and Innovation 2010) in conjunction with the DEEDI Office of Advanced Manufacturing to embrace the use of locally sourced goods and services.	B.19.4.6.3
	5.16 Additional Social and Economic Matters	Accordingly, information must be provided in the EIS on the broad social and economic impacts (positive or negative) of the proposal for the purposes of the Part 9 decision on approval *[EPBC Act].*	B.13.4, B.19.4
		A table cross-referencing information relevant to 5.22 should be	Appendix B1

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		provided identifying relevant text in the body of the EIS.	
7.2 Sustainable development		Provide a comparative analysis of how the project conforms to the objectives for 'sustainable development'—see the *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee 1992). Consider the cumulative impacts (both beneficial and adverse) of the project from a life-of-project perspective, taking into consideration the scale, intensity, duration and frequency of the impacts to demonstrate a balance between environmental integrity, social development and economic development.	B.23.2, B.1.2.2
8.1 Hazard and risk assessment		Describe the potential hazards and risks to people and property that may be associated with the project, which may include but are not restricted to: - identifying potential hazards, accidents, spillages and abnormal events that may occur during all stages of the project, including possible frequency of occurrence - identifying all hazardous substances to be used, stored, processed or produced and the rate of usage - potential wildlife hazards, natural events (reference should also be made to the SPP 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (Department of Local Government and Planning & Department of Emergency Services 2003)) and implications related to climate change - terrorist attack (refer sections 8.4.1 and 8.5).	B.20.3, B.20.4, B.21.3, B.21.4, B.22.3, B.22.4 B.8.2, B.8.4
		Undertake a preliminary risk assessment for all components of the project, as part of the EIS process in accordance with *Australia/New Zealand AS/NZS ISO 31000:2009 Risk management—Principles and guidelines* (Standards Australia & Standards New Zealand 2009). With respect to risk assessment, the EIS should: - deal comprehensively with external and on-site risks including transport risks	B.20.4, B.21.4, B.22.4

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		- assess risks during the construction, operational and decommissioning phases of the project - include an analysis of the consequences of each hazard on safety in the project area, examining the likelihood of both individual and collective consequences, involving injuries and fatalities to workers and to the public - present quantitative levels of risks from the above analysis.	
		Provide details on the safeguards that would reduce the likelihood and severity of hazards, consequences and risks to persons, within and adjacent to the project area(s).	B.20.5, B.21.5, B.22.5
		Present a comparison of assessed and mitigated risks with acceptable risk criteria for land uses in and adjacent to the project area(s).	B.1
		Provide a risk management plan. Cross-reference to sections 8.4.1 and 8.5 below.	B20.0, B21.0, B22.0, B23.0
8.2 Cumulative risk		The risk analysis is to address the potential impacts that may occur on the normal on-site day-to-day activities during the construction and/or operation of the facilities. Furthermore, determine the level of change that may affect the risk contours of other relevant existing or proposed industrial facilities in the area, as a result of the proposed project (where details of such proposed facilities are provided by DEEDI or otherwise published). Individual risk criteria should be used to limit risks to individual workers and members of the public. Societal risk criteria should be used to limit risk to the affected population as a whole.	B.20.4.10, B.20.5 Appendix U, B.21.4, B.21.5, B.22.4, B.22.5 B.20.2, B.21.2, B.22.2
		Identify and adopt, where appropriate, any changes to operating or storage procedures that would reduce the possibility of these events occurring, or reduce the severity of the events should they occur	B.20.4.10, B.20.5, B.21.4, B.21.5, B.22.4, B.22.5
	5.10.7 Cumulative Impacts Of The Proposed Development	The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities. The EIS should also address the potential cumulative	All B24.0

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment should also be considered in the assessment of ecosystem resilience. Where relevant to the potential impact a risk assessment should be conducted and documented.	
		The risk assessment must include known potential future expansions or developments by the proponent and other proponents and known impacts on ecosystem resilience and matters of National Environmental Significance.	All B24.0
		Information on cumulative impacts may include as appropriate, but not be limited to: a) Description of existing, planned or potential developments (including construction status) of a similar type and scale to the proposed development, that have been approved within the last five years or are still under assessment with emphasis on those in the region that have, will have or are likely to have impacts on the same matters of National Environmental Significance;	A.1.5, B.24.1.2
		b) Description of existing, planned or potential developments (including construction status) of a similar type and scale to the proposed development, that have been approved within the last five years that have, will have or are likely to have impacts on the same matters of National Environmental Significance;	A.1.5, B.24.1.2
		c) Description of any current or likely development precincts or zones in the region, their relationship to the proposed development and the likely cumulative impacts on the general environment, ecosystems and matters of National Environmental Significance as all projects are developed to capacity;	B.1.2, B.1.3, B.1.4, B.1.6, B24.0
		d) Discussion of the impacts of other tourism, residential, industrial and infrastructure projects both directly and indirectly related to the proposal in a regional context;	B.1.4, B.6.4, B13.4, B19.4, B24.0
		e) Discussion of the range of developments which will be facilitated or impacted (either positively or negatively) by the proposal and if the project will result in an intensification of development in the region;	A.3.5, A.1.5, B.1.4, B13.4, B19.4, B24.0

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		f) Discussion and analysis of the cumulative impacts of this proposal on the integrity and Outstanding Universal Value of the Great Barrier Reef World Heritage Area;	B6.4.14.2, B.24.0
		g) Discussion of known impacts on ecosystem resilience, including reference to issues identified in the Great Barrier Reef Outlook Report 2009;	B6.3, B6.4, B.7.4, B24.0
		h) Discussion of any potential future changes to the development which are likely to change the nature or scale of environmental impacts;	A.3.6, B.18.4
		i) Outline if existing impacts on the environment in general and matters of National Environmental Significance will be amplified by the action in combination with impacts of other projects;	B.24.0
		j) Discussion of the developments and activities which are likely to be facilitated by the proposal;	A.3
		k) Identify if the resulting impacts on the general environment, ecosystems and matters of National Environmental Significance could be unacceptable;	Part B, B.23.0, B.24.0
		l) Identify if these impacts on the general environment, ecosystems and matters of National Environmental Significance could be permanent. If the impacts on matters of National Environmental Significance are not permanent, describe how long it will take before recovery from the effect;	Part B, B.23.0, B.24.0
		m) Describe how the proposed project will impact on the reproductive capacity and/or survival of listed threatened and migratory species;	B6.4, B.7.3, B.7.14, B.24.4,
		n) Explain how much recovery of a matters of National Environmental Significance population, habitat, ecosystems and the environment in general could occur, with and without mitigation (e.g. complete, partial, none);	B6.4, B6.5, B.7.5, B.23.0, B.24.0
		o) Describe how soon restoration of habitat could be achieved to reinstate ecosystem function for matters of National Environmental Significance;	B6.4.14, B.7.5, B.23.0, B.24.0

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		p) Where possible, identify how much likely change to matters of National Environmental Significance exceeds natural variability in the region;	B6.4.14, B6.6, B.24
		q) Describe how this project will contribute to the desired conservation objectives for matters of National Environmental Significance; and	B6.4.14, B.7.4, B.24.0
		r) In conducting the risk assessment, key information sources and indicators for assessing change and impact must be described.	All
8.3.1 Description of public health and safety community values		Describe the existing health and safety values of the community, workforce, suppliers and other stakeholders in terms of the environmental factors that can affect human health, public safety and quality of life, such as air pollutants, odour, lighting and amenity, dust, noise and water.	B.20.3, B.20.4.10,
8.3.2 Potential impact and mitigation measures		Define and describe the objectives and practical measures for protecting or enhancing health and safety community values. Describe how nominated quantitative standards and indicators may be achieved for social impacts management, and how the achievement of the objectives will be monitored, audited and managed.	B.20.4, B.20.5, B.21.4, B.21.5, B.22.4, B.22.5 Part C
		Assess the cumulative effects on public health values and occupational health and safety impacts on the community and workforce from project operations and emissions. Recommend any practical monitoring regimes in this section. Include relevant consultation with the appropriate regional health service providers.	Part C
8.4 Emergency management plan		Present preliminary information on the design and operation of proposed safety/contingency systems to address significant emergency issues delineated in the risk assessment, together with at least the following areas of emergency: terrorist attack marine collision minimisation fire prevention/protection leak detection/minimisation	B20.0, B21.0, B22.0 Part C

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		release of contaminants emergency shutdown systems and procedures.	
		In addition, undertake an assessment of businesses that may be affected in the event of an emergency, including strategies to mitigate the impact on these businesses.	B.22.5
		In regard to fires, outline strategies to manage the provision of: - fire management systems to ensure the retention on site of fire water or other fire suppressants used to combat emergency incidents - building fire safety measures for any construction or permanent accommodation - details of any emergency response plans and bushfire mitigation plans under the State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (Department of Local Government and Planning & Department of Emergency Services 2003)\ - on-site firefighting equipment provided and the level of training of staff who will be tasked with emergency management activities - Detailed maps showing the plant outline, potential hazardous material stores, incident control points, firefighting equipment, etc - an outline of any dangerous goods stores associated with the plant operations, including fuel storage and emergency response plans.	B22.3, B.22.4, B.22.5
		Present outlines of emergency planning and response strategies to deal with relevant incidents above, which have been determined in consultation with state and regional emergency service providers, and which show integration of emergency services into the plans.	B22.0
		Present plans for emergency medical response and transport and first aid matters with involvement of the relevant state agencies (such as the Queensland Ambulance Service, Queensland Fire and Rescue Service and Emergency Management Queensland).	B22.0

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
8.4.1 Maritime security plan		The emergency management plan is to include a maritime security plan which meets the security requirements included in the: *Maritime Transport and Offshore Facilities Security Act 2003* and *Maritime Transport and Offshore Facilities Security Regulation 2003* (Cwlth) *Transport Security (Counter Terrorism) Act 2008* and Regulations (Qld) International Ship and Port Facility Security Code (International Maritime Organization 2003). A maritime security plan should be submitted as a separate confidential document to the Coordinator-General at the time of submission of the EIS.	B21.0, C2.4
8.5 Counter-terrorism and critical infrastructure protection		Provide information on the design and operation of proposed safety and contingency systems to address the National and Queensland counter-terrorism and critical infrastructure protection legislation, policies and arrangements including: - *National Counter-Terrorism Plan* (National Counter-Terrorism Committee 2005) - *Critical Infrastructure Protection National Strategy* (Trusted Information Security Network 2004) - *Critical Infrastructure Emergency Risk Management and Assurance: Handbook* (Emergency Management Australia 2004) - *Queensland Counter-Terrorism Strategy 2008–2010* (Department of the Premier and Cabinet 2007) - *Queensland Infrastructure Protection and Resilience Framework* (Department of the Premier and Cabinet 2005) - *Queensland Government Information Security Classification Framework* (Department of Public Works 2010) - *Transport Security (Counter Terrorism) Act 2008* and	B.21.2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		Regulations - *Australia/New Zealand AS/NZS ISO 31000:2009 Risk management—Principles and guidelines* (Standards Australia & Standards New Zealand 2009) - *Handbook: Security Risk Management* (HB 167:2006) (Standards Australia & Standards New Zealand 2006) - *Business Continuity Management* (HB 221:2004) (Standards Australia & Standards New Zealand 2004) - *A Practitioners Guide to Business Continuity Management* (HB 292-2006) (Standards Australia 2006a) - Executive Guide to Business Continuity Management (HB 293-2006) (Standards Australia 2006b).	
		Provide information on the design and operation of the port's operational security plan. Such information should be provided as a separate confidential document to the Coordinator-General at the time of submission of the EIS.	B.21.2.11, B.21.5
	5.10.8 Consequential Impacts	Provide a detailed assessment of any likely impacts that this development may facilitate on the following (at the local, regional, state, national and international scale)5: a) The World Heritage values of the Great Barrier Reef World Heritage Area; b) The National Heritage values of the Great Barrier Reef National Heritage place; c) Wetlands of international importance; d) The environment of the Great Barrier Reef Marine Park; e) Listed threatened species and ecological communities; f) Listed migratory species; and g) The Commonwealth marine environment.	Part B A.2.5.2, B.1.4, B.4.4, B.6.4.14, B.13.4, B,15.4, B.16.4, B.17.4, B.18.3, B.18.4, B.19.4, B.24.0, B.23.0, (C2.4)3.0
9. Cumulative impacts		Summarise the project's cumulative impacts and describe these impacts in combination with those of existing or proposed project(s) publicly known or advised by DEEDI to be in the region (including the	B.24

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		Townsville Port Marine Precinct project), to the greatest extent practicable. Assess cumulative impacts with respect to both geographic location and environmental values. Explain the methodology used to determine the cumulative impacts of the project, detailing the range of variables considered (including relevant baseline or other criteria upon which the cumulative aspects of the project have been assessed, where applicable).	
	5.10.7 Cumulative Impacts Of The Proposed Development	The EIS must also address the potential cumulative impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment must also be considered in the assessment of ecosystem resilience.	B.24
	5.11 Proposed Safeguards, Management And Mitigation Measures	Specific and detailed descriptions of proposed measures must be provided and substantiated, based on best available practices and must include the following elements: a) Identify the level of risk associated with potential impacts identified in section 5.10 and those that require mitigation, monitoring or management to avoid or reduce impacts to an acceptable level;	All
		b) A consolidated list of measures proposed to be undertaken to avoid, prevent, minimise or manage the impacts of the action, including: i. a description of proposed avoidance measures, safeguards and mitigation measures to deal with impacts of the action, including measures proposed to be taken by State governments, local governments or the Proponent; ii. assessment of the expected or predicted effectiveness of the measures; iii. any statutory or policy basis for the mitigation measures; and iv. the cost of the associated with the implementation of the mitigation measures; and v. the resulting risk level for that impact post-avoidance, mitigation and /or management.	C1.0, Part C
		c) Particular focus must be given to: i. determining factors in the planning of the proposal so as to avoid	Part B, Part C

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		damage to the environment; ii. measures to avoid or minimise damage to the Great Barrier Reef World Heritage Area and estuary environment; iii. measures to avoid or minimise damage to the National Heritage Values of the Great Barrier Reef; iv. measures to avoid or minimise damage to the environment of the Great Barrier Reef Marine Park; v. articulating conservation objectives for individual matters of National Environmental Significance with a focus on receptors; vi. describing how this project is likely to contribute to protection of matters of National Environmental Significance; vii. outline how any avoidance, safeguards, management and mitigation measures will increase resilience of the environment, ecosystems and matters of National Environmental Significance within the region; viii. demonstrate how impact management and mitigation measures would ensure that matters of National Environmental Significance in the affected region are maintained or improved; ix. characterise, quantify and address uncertainties that may affect the effectiveness of management measures and therefore on the confidence that biodiversity values would be maintained (or improved) during and after the project; x. measures to avoid or minimise disturbance to fauna and flora found around and within the proposal area (particularly listed threatened species and communities and listed migratory species); xi. management of the dredged material during the loading of the dredged material; xii. management of the dredged material disposal area(s) during disposal operations; xiii. management strategies for dredging, loading and dredged material disposal, including trigger levels for management actions linked to quantitative measurements of water quality and Benthic Primary Producer Habitat (BPPH) based on baseline data; xiv. proposed monitoring before, during and after dumping including	

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		turbidity, water quality parameters that are likely to be affected and BPPH monitoring. Water quality parameters being monitored should include but may not be restricted to dissolved oxygen, nutrients, pH, turbidity, light attenuation, metals and metalloids and toxicants. Baseline water quality data that includes values for these parameters needs to be included in the EIS. This section should also include the likely impacts on turbidity and water quality from dredging and dredge spoil disposal and establish the triggers for management actions and specify proposed management actions; xv. for reclamation based dredge dredged material disposal proposed management must be presented. This must include how water quality will be monitored and managed to ensure that water quality objectives for this area are achieved and the environmental values of the connected surface water and groundwater are maintained. Reference should be given to the National Water Quality Management Strategy including the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), Queensland Water Quality Guidelines 2009, Water Quality Guidelines for the Great Barrier Reef 2010 and) the Australian Monitoring and Reporting Guidelines (2000). Any toxicants that may occur in the sediments must be identified and must be managed appropriately; xvi. measures to limit channelling and sediment re-suspension in settling ponds; xvii. measures to limit erosion and sediment re-suspension in discharge channels; xviii. monitoring of water quality and operational performance monitoring; xix. disposal of tail waters or overflow due to climatic conditions (such as rain or flooding) to the receiving environment; xx. contingency measures in the event that discharge limits are exceeded; and xxi. staff training, including training in relation to environmental issues.	
		d) An outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring	C2.5

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		programs for the relevant impacts of the action, including any provisions for independent environmental auditing; and	
		e) The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Part C
	5.13 Monitoring and Reporting	Appropriate baseline data requirements are to be provided as part of the EIS to form the basis for baseline measurement and ongoing monitoring of environmental parameters. It must be demonstrated that the proposed methods for baseline measurements and subsequent monitoring are based on current best practice, scientifically robust and statistically sound to enable diligent and systematic data collection that will deliver unbiased and sound responses to EIS Guideline requirements. This section must identify parameters to be monitored, the performance indicators to be used to evaluate accuracy of predicted impacts and effectiveness of mitigation measures and offsets, and management response trigger values and response activities.	Part A, Part B, Part C B.23, C1
		This section is to also identify and describe monitoring programs, procedural and compliance audit programs and reporting requirements and arrangements which will demonstrate the effectiveness of proposed management measures and monitoring.	B.23, Part C, A.2.6.4.6
		The proponent must, in addition to outlining proposed programs, clearly identify what is to be monitored and why. Monitoring programs must be designed to provide objective evidence regarding activities associated with the proposal and if these activities are adversely impacting on the environment in the short, medium and long term. Monitoring programs must demonstrate an understanding and consideration of: a) Ecosystems and habitats, climatic or seasonal variations, flora and fauna (particularly listed threatened species/ecological communities and listed migratory species), and water quality issues affected by the proposed development; b) Measuring the effectiveness of mitigation and/or environmental offset measures;	All, B.4.5.2, B.6.5.2, B.7.5.2, B.9.5.2, B.23, Part C, (C2.1).4,

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		c) Documenting the difference between predicted and actual impacts; d) Methods for identification of non-predicted impacts and appropriate reporting and remedial measures; e) Application and effectiveness of emergency and contingency plans; and f) Review of consultation and management arrangements with regulatory authorities and the community.	
		A diagram showing monitoring and reporting arrangements must be included in the EIS.	Part C
10. Environmental management plan		Detail the EMPs for both the construction and operation phases of the project. The EMP should be developed from, and be consistent with, the information in the EIS. The EMP must address discrete project elements and provide life-of-proposal control strategies. It must be capable of being read as a stand-alone document without reference to other parts of the EIS. The EMP must comprise the following components for performance criteria and implementation strategies: ▪ the proponent's commitments to acceptable levels of environmental performance, including environmental objectives, performance standards and associated measurable indicators, performance monitoring and reporting ▪ impact prevention or mitigation actions to implement the commitments ▪ corrective actions to rectify any deviation from performance standards ▪ an action program to ensure the environmental protection commitments are achieved and implemented. This will include strategies in relation to: - continuous improvement - environmental auditing - monitoring - reporting - staff training	Part C

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		- a rehabilitation program for land proposed to be disturbed under each relevant aspect of the proposal The proponent's commitments to environmental performance, as described in the EMP, may be included as Coordinator-General's conditions to ensure the commitments are met. Therefore, the EMP is a relevant document for project approvals, environmental authorities and permits, and may be referenced by them.	
11. Conclusions and recommendations		Make conclusions and recommendations with respect to the project, based on the studies presented, the EMP and conformity of the project with legislative and policy requirements.	B.25.0
	5.17 Conclusion	An overall conclusion as to the environmental acceptability of the proposal must be provided, including discussion on compliance with the objectives and requirements of the EPBC Act and the GBRMP Act including the principles of ESD (see Attachment 3). Reasons justifying undertaking the proposal in the manner proposed must also be outlined. The conclusion must highlight measures proposed or required to avoid, mitigate or offset any unavoidable impacts on the environment.	B.25.0
12. References		All references consulted should be presented in the EIS in a recognised format	Appendix B2
	5.19 Reference List and Bibliography	The reference list and bibliography provided in the EIS is to be accurate and concise and include the address of any internet pages used as data sources.	Appendix B2
	5.18 Information Sources	Information sources used in the formulation of the EIS are to be provided. This section will describe consultations and studies undertaken in the course of proposal formulation and preparation of the draft EIS, and sources of information and technical data. The following details must be provided for information used in developing the EIS: a) The source of the information; b) How recent the information is; c) How the reliability of the information was tested; and d) What uncertainties and/or gaps (if any) are in the information.	All, Appendix B2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
		A copy of all data and the sampling methodologies must be made available to the DSEWPAC and GBRMPA for the purpose of peer review on receipt of a written request from the DSEWPAC or GBRMPA. In making this statement, the sampling methodology (including time samples were collected, replication, size of samples etc) should be specified in the relevant sections where data has been collected.	
		Any further or ongoing consultations or studies must be outlined here.	C1.0(3.1), C2.2(1.10)
13. Appendices		**Final TOR for this EIS** Include a copy of the final TOR in the EIS.	Appendix A1
	4.2 General advice	The EIS must comprise... c) Appendices containing...ii. a copy of these Guidelines	Appendix A2
13. Appendices		**TOR cross-reference table** Provide a cross-reference table that links the requirements of each section/subsection of the TOR with the corresponding section/subsection of the EIS, where those requirements have been addressed.	Appendix B1
	4.2 General Advice	The EIS is to address both the Australian Government Guidelines and the Queensland Government Terms of Reference. A cross referencing table should be provided in an Appendix to enable cross referencing of information provided in the EIS with Australian and State Government requirements.	
13. Appendices		**Project approvals** Provide a list of the project approvals required by the project	A2.6
	5.20 Appendices And Glossary	Detailed technical information studies or investigations necessary to support the main text of the EIS, but not suitable for inclusion in the main text must be included as appendices; for example, detailed technical or statistical information, maps, risk assessment, baseline data, supplementary reports etc.	Part D
		A copy of the Guidelines must also be included.	Appendix A2

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
	5.6 Matters of National Environmental Significance	Output from the protected matters search tool (accessible from DSEWPAC's website) must be also included as an appendix.	Appendix L1, Appendix K2
13. Appendices		**Consultation report** The report should include the methodology used in the public consultation plan including: criteria for identifying stakeholders and the communication methods used (the consultation plan) a list of stakeholders identified, including the Commonwealth, Queensland and local government agencies, and/or the affected parties (as defined by the EP Act) a summary of the issues raised by stakeholders and the means by which the issues have been addressed plans for ongoing consultation to be outlined and included in the EMP.	Appendix E1
13. Appendices		**Study team** List the relevant qualifications and experience of the key study team members and specialist sub-consultants.	Appendix D1
13. Appendices		**Specialist studies** All reports generated on specialist studies undertaken as part of the EIS are to be included as appendices. These may include, but are not limited to: - air pollution, noise and vibration - groundwater and surface water hydrology - geology and geomorphology - economic studies and/or cost-benefit analyses - transport studies - cultural heritage - hazard and risk studies - land use and land capability studies.	Part D
	4.2 General advice	Detailed technical information, studies or investigations necessary to support the main text must be included as appendices issued with the EIS.	

Terms of Reference (TOR)	Final EPBC EIS Guidelines	Statement from TOR or EIS Guidelines	Chapter and Section In EIS
13. Appendices		**Corporate environmental policy** Attach a copy of the proponent's corporate environmental policy and planning framework document	Appendix C
13. Appendices		**List of proponent commitments** Provide a list of all commitments made by the proponent in the EIS, together with a reference to the relevant section in the report.	Part C

Port Expansion Project EIS

Appendix B2
Reference List

AECOM BMT WBM

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Appendix C1

Port of Townsville Limited Environmental Policy

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ENVIRONMENTAL POLICY

Port of Townsville Limited (the Corporation) and its senior management are committed to the protection of the environment and considers it as critical corporate value in the delivery and maintenance of port infrastructure and services and in planning for the future development of the Port of Townsville and Port of Lucinda.

The Corporation is committed to sustainable development and operation through responsible environmental management and continual improvement of environmental performance and the effectiveness of its Environmental Management System.

To achieve corporate performance consistent with this policy, the Corporation will employ the following principles: -

- Integrate environmental considerations into decision making and work practices related to the Corporation’s core functions.
- Maintain a high level of environmental awareness throughout the Corporation and the wider port community.
- Implement systems which act to minimise the risk of environmental harm through the identification, reporting, assessment, monitoring and control of environmental risks.
- Establish a framework for setting and reviewing environmental objectives and targets and measuring the Corporation’s performance.
- Establish and maintain systems for assessing the environmental impacts associated with the Corporation’s activities, identifying and acting on opportunities for improvement.
- Compliance with all relevant legislation, codes of practice and standards.
- Core functions to be conducted in a manner that will minimise waste, prevent pollution, promote efficient use of resources, reduce environmental impacts, and continually improve environmental and management system performance.
- Providing adequate resources including finances, to facilitate the fulfilment of the Corporation’s environmental responsibilities.

Senior Management is responsible for providing the leadership to support the development and implementation of this Policy and for ensuring it is effectively applied.

This policy will be regularly reviewed following legislative or organisational changes, or as a minimum, every three years.

Barry Holden
Chief Executive Officer

March 2011

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Appendix D1

EIS Study Team and Organisational Chart

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Study Team

Team Member	Location	Study Role	Relevant Experience
Chris Paterson *Regional Manager – North Queensland*	Townsville	Project Director	Chris has almost 25 years experience as a professional engineer and project manager in both the public and private sector, in heavy industry and small business, and as a consultant. Chris is currently Group Leader of the Water and Infrastructure Services Group in Queensland with overall responsibility for the financial performance of the Group. He is also contributing to a number of projects in the capacity of Project Director. Prior to this, Chris occupied the role of Operations with the Port of Townsville where he contributed to the planning of the port, and the development of port infrastructure, particularly in the Eastern Port Development.
Glenn Stephens *Associate Director*	Townsville	Project Manager	Glenn has 16 years experience in the Civil Construction Industry. He has undertaken various roles including Quality Engineer, Project Engineer, Project Manager, Design Manager and Superintendent's Representative as both Contractor (for 6 years) and Consultant (10 years). Glenn has been involved in a number of projects at Port of Townsville as Project Manager including Inner Harbour Expansion (Berth 10A and Berth 8) ECI Stage, Berth 10 Expansion and Berth 4 Upgrade.
Greg Fisk *National Practice Leader (Environment) Associate*	BMT WBM	EIS Manager	Greg has over 15 years of experience in preparing, assessing and managing multi-disciplinary environmental plans and impact assessments. Recently, Greg has been involved in several large-scale infrastructure feasibility/EIS projects in the transport and energy sectors as well as a range of high profile natural resource assessments in the fields of wetland ecology, waterway management and climate change.
Noel Ducray *Associate Director - Ports & Marine*	Brisbane	Engineering Manager	Noel has worked as a port planner and port engineer for most of his career, initially with the Port of Durban where he fulfilled a number of roles including the position of Manager Planning and Development. Noel was the Resident Engineer for the construction of the new Port of Coega, South Africa. Noel has significant experience with Port of Townsville projects including PEES, the Port Master-plan, and Berth 10X.
Kelly Timmerman *Associate Director - Communication & Community*	Townsville	Stakeholder Communications	Kelly has over 15 years experience in communication, consultation and stakeholder management roles across a broad range of sectors. Kelly is accomplished in planning, developing and implementing a suite of communications and community engagement programs that are specific to client needs and inform and involve stakeholders and community members at all levels. Kelly has provided strategic leadership and project delivery for a range of clients including Transport and Main Roads, Queensland Rail, Port of Townsville. Townsville City Council, Xstrata and the Department of Premier and Cabinet.
Troy Collie *Technical Director – Environment*	Newcastle	Environmental Studies Lead/ EIS Lead Author	Troy has over twenty years experience in project execution and delivery through his technical contribution to and overseeing environmental planning investigations, environmental management plans and compliance assessments. He has skills in environmental assessment, aquatic monitoring and experimental design, survey techniques and matching environmental studies and advice to regulatory compliance and decision making frameworks.
Brad Grant *Senior*	BMT WBM	Marine Studies Lead	Brad has over 9 years experience working for local government and private organisations in South East Queensland and overseas. He has a broad range of expertise including water quality, total water

Team Member	Location	Study Role	Relevant Experience
Environmental Scientist			cycle management, environmental auditing and monitoring, catchment modelling and stormwater management. He also has a broad knowledge of environmental legislation as it relates to infrastructure projects and pollution control.
Frans Hoogerwerf *Master Marine r-Consultant*	Hoogerwerf Maritime Pty Ltd	Dredging and Reclamation	Frans has been a Master Mariner in Australia since 1970 and has extensive knowledge of dredging and reclamation through his previous experience in the dredging industry in Australia. Frans has worked in executive and management positions for Westham Dredging until 2002 at which time he commenced a consulting practice based upon practical, hands-on dredging and reclamation advice.
Albert Kwong *Principal Engineer – Strategic Planning and Advisory*	Brisbane	Transport and Infrastructure	Albert has over 21 years of experience as a transport planner/traffic engineer. He has skills in design, planning and project management, and has worked with the private and public sectors in Australia, the United Kingdom and Hong Kong. His work has included transport planning and feasibility studies, development impact assessment, highway improvement and district planning studies
Thomas Mitchell *Principal Consultant*	Newcastle	Public Hazard, Safety and Risk	Thomas has 30 years experience occupying various executive and senior management roles in multinational organisations delivering innovative Work Health and Safety (WHS) and Environmental management services. He has held a position of Lecturer and Senior Research Officer with University of Ballarat (Victorian Institute of Occupational Safety and Health) generalising in Safety Engineering, Safety in Design, Industrial Hygiene and Ergonomics and specialising in Risk Management, Compliance Auditing and Management Systems, Training and Education.
Anthony Charlesworth *Senior Engineer*	BMT WBM	Water Quality	Anthony has 17 years of experience specialising in integrated surface and subsurface water management. Anthony has a Bachelor of Engineering in Civil Engineering and a Master of Engineering Science (Env.) and has specialised in waterway, catchment management, flooding and groundwater within the community, local government and overseas.
Will Van Vaerenbergh *Environment Practice Leader – Queensland*	Brisbane	Land and Groundwater	Willy is a Principal Hydrogeologist with 23 years international and local experience across a number of environmental and engineering sectors. His breadth of experience covers development and management roles across groundwater resources investigations, water resources management, environmental hydrogeology, groundwater modelling, and contaminated land assessment and remediation.
Henry Parsons *Senior Scientist*	Golder Geotechnical	Soils, Marine Sediments and Groundwater	Henry is a senior scientist with 10 years experience in Acid Sulfate Soil (ASS) assessments, and over 20 years experience with geotechnical testing and investigations. Henry has managed a variety of large-scale ASS projects including the New Parallel Runway at the Brisbane Airport, the Trade Coast Commercial Development at the former Brisbane Airport, ASS issues for the North South Bipass Tunnel (NSBT) and preliminary and detailed investigations throughout Queensland. Henry is also experienced in erosion and sediment control assessment/management measures; Soil chemistry issues, ie, dry land salinity and top soil suitability studies; Contaminated Land/Environmental Site Assessments and Remediation and Management Plans and related geotechnical issues.

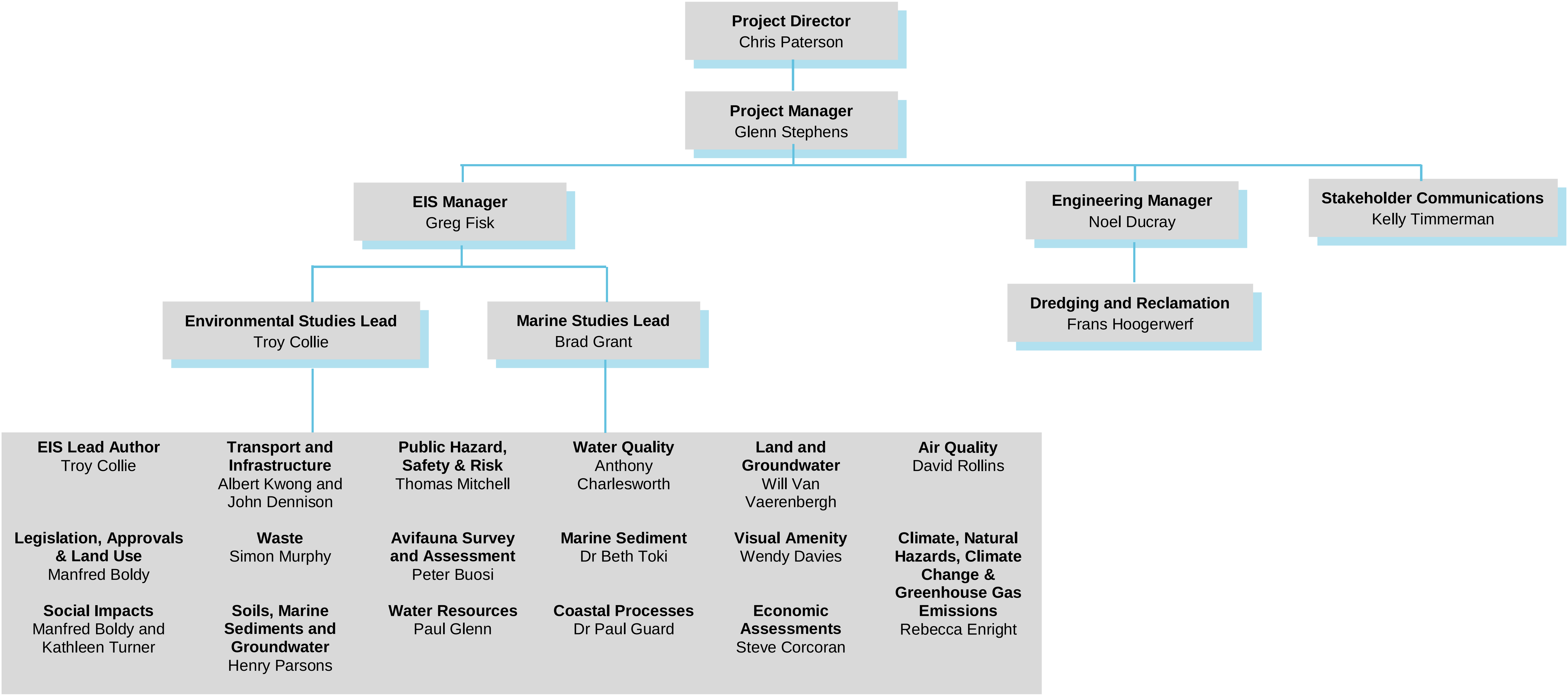
Team Member	Location	Study Role	Relevant Experience
Manfred Boldy *Principal Environmental Planner*	Townsville	Legislation, Approvals and Land Use/Social Impacts	Manfred Boldy is a land use planner with over 30 years senior experience in the compilation and management of strategic land use studies and environmental assessments for a range of development and environmental management activities. This has included a wide range of development assessments, local and regional planning studies, master planning, housing analyses and strategic environmental assessments. The work undertaken has included planning for major urban growth corridors in Sydney, Perth, Sunshine Coast, Cairns and Townsville as well as regional centres along the North Coast of NSW and in Margaret River WA.
Simon Murphy *Professional Environmental Planner*	Newcastle	Waste	Simon Murphy is an Environmental Planner with seven years' experience in environmental impact assessment and town planning. In addition to preparing Environmental Impact Assessments Simon has also prepared feasibility assessments for a variety of developments, Bushfire Threat Assessments, Traffic Impact Assessments and Social Impact Assessments. Simon's experience has allowed him to develop a range of skills required to be effective in the Environmental Planning role.
Peter Buosi *Principal Ecologist*	NRA Environmental Consultants	Avifauna Survey and Assessment	Peter has over 15 years' experience in research and applied science. Since joining NRA in 1998, Peter has provided his services to a variety of government departments and non-government organisations, including resource and civil development clients. While Peter has experience in a range of science disciplines, his specific area of expertise is in the design, management and conduct of ecological studies, and he has extensive experience in both terrestrial and inter-tidal ecosystems of northern Australia.
Beth Toki *Senior Marine Ecologist*	BMT WBM	Marine Sediment	Beth has nine years post-graduate experience in ecological research and environmental consulting. Beth has a thorough understanding of the ecology and management of coastal environments, as well as the complex interactions between terrestrial, estuarine and marine systems. She has hands-on experience conducting a variety of ecological research and monitoring projects in marine, estuarine, freshwater and beach environments.
Wendy Davies *Associate Director - Landscape Planner*	Brisbane	Visual Amenity	Wendy Davies leads Queensland's Environmental and Ecological Planning (EEP) team and brings over 14 years experience in the field of landscape planning and design. She has extensive experience in landscape design and character assessment, environmental impact assessment, landscape and visual appraisals, planning applications and public inquiry and community consultation. Wendy has particular skills in strategic land use and development planning, landscape and visual impact assessment and in the development of landscape strategy plans. She has worked widely on major infrastructure projects including energy, minerals and transportation infrastructure.
David Rollings *Principal Engineer*	Newcastle	Air Quality	David Rollings is a Chemical Engineer with over 12 years experience in a wide range of environmental consulting fields including air quality, contaminated site assessment and environmental sampling encompassing air, water, soil and noise. David has worked with a wide variety of clients from industry sectors ranging from government to energy, mining, manufacturing, minerals processing, aviation and building construction. David has been responsible for the preparation of numerous air quality impact assessments for clients across Australia including some of the largest power generators and mines in Australia.

Team Member	Location	Study Role	Relevant Experience
Kathleen Turner *Social Planner (Associate Director)*	Brisbane	Social impacts	Kathleen has extensive experience in compiling both concept and planning phase social impact assessments, social impact management plans, human rights impact assessments, and land acquisition and resettlement action plans for mining, onshore and offshore oil & gas, and infrastructure projects in Australia and internationally including Indonesia, Malaysia, Philippines, PNG, Turkey, Azerbaijan, and Qatar.
Paul Glenn *Senior Engineer*	Townsville	Water Resources	Paul has more than 12 years experience in urban land development, civil infrastructure and hydrogeology projects. Paul's skills are specialized in the design of stormwater conveyance and flood control infrastructure, design of sanitary sewer infrastructure, water balance studies, flood studies, flood mitigation plans and flood risk assessments and has significant experience in hydrologic, hydraulic and water quality modelling, as well as hydrogeologic characterization and groundwater modelling.
Paul Guard *Senior Coastal Engineer*	BMT WBM	Coastal Processes	Paul is an engineer with the Coastal Engineering Group within BMT WBM. Paul's main area of expertise is in the modelling of coastal processes, in particular ocean waves, coastal sediment transport and beach morphology. Paul also has experience in urban water supply and stormwater drainage systems, riverine and estuarine hydraulic modelling and water quality assessments.
Steve Corcoran *Director*	Deloitte Access Economics	Economic Assessment	Steve is a senior economist and has participated in a large number of economic impact assessments for different clients which have varied in scale and scope. Steve has a wide knowledge in economic impact assessments including: cost benefit analysis; construction of financial models; survey design and development; reviews of productivity and growth and market analysis.
Rebecca Enright *Senior Consultant – Sustainability & Climate Change*	Brisbane	Climate, Natural Hazards, Climate Change and Greenhouse Gas Emissions	Rebecca has almost 10 years experience in policy development and advice across a wide range of climate change, environmental and natural resource management issues in the Queensland Government. Rebecca also has strong capabilities in the areas of planning, legislation development and stakeholder engagement. Rebecca has broad knowledge and understanding of contemporary climate change issues, including the most recent climate change science, emissions abatement opportunities and approaches to climate change risk assessment.
John Stephens *Associate Director - Economics*	Sydney	Economic Impact	John Stephens combines strong technical skills in economics with the ability to think strategically. He has 30 years consulting experience, and has also been an academic, most recently as visiting lecturer in the School of Planning at Dundee University, and a member of UK Government Economic Service where he worked on the appraisal of overseas aid proposals. In consultancy he has accumulated substantial experience across a wide range of studies, working with a broad spectrum of clients that have included technical experts, non-experts, politicians, stakeholder organisations and members of the public. John has proven experience of working on complex, multi-disciplinary studies and in new policy and economic environments.
Rachael Foster *Principal Engineer – Acoustics*	Townsville	Noise Vibration	Rachel has more than fifteen years' experience in varying engineering work environments. Her background includes mechanical services equipment design, development and implementation of management systems, acoustic monitoring, assessment and project management.

Team Member	Location	Study Role	Relevant Experience
Dee Goring *Senior Cultural Heritage Consultant*	Brisbane	Cultural Heritage	Dee has over nine years experience working as an archaeologist and cultural heritage consultant. During that time Dee worked on many varied cultural heritage projects gaining a comprehensive understanding of the legislative requirements under which to apply her anthropological, archaeological and historical knowledge and expertise in Queensland, South Australia, the Northern Territory and New South Wales. Her cultural heritage works included initial contact and client liaison, development and implementation of site specific cultural heritage surveys, development and execution of site specific archaeological excavations, site recording, artefact analysis, report writing and risk analysis which include recommendations and management strategies in relation to Duty of Care compliance.
Darren Richardson *Associate & Ecology Manager*	BMT WBM	Marine Ecology	Darren has over 19 years industry experience focussed on marine ecology. Darren's consultancy work has a primary focus on sediment contamination assessment and management, and the effects of dredging and dredged material disposal on marine communities and ecosystems. Darren has undertaken numerous sediment contamination studies, most of which considered the suitability of dredged sediments for ocean disposal. Darren has project managed and/or prepared Long Term Dredge Disposal Management Strategies (LTDDMS) and Sampling and Analysis Plans (SAP) in accordance with National Assessment Guidelines for Dredging.
Rochelle Lawson *Senior Environmental Scientist*	Newcastle	Terrestrial Ecology	Rochelle Lawson has fifteen years' experience managing natural resource management projects, including ecosystem condition assessment and monitoring, impact assessment, biodiversity assessment and rangeland monitoring. She has ecological research experience, particularly on biodiversity issues from both Canada and Australia. Her recent experience is with ecological survey and monitoring, land management planning, aviation hazard management, Biobanking, sustainability reporting, constraints analyses, assessments of significance for development impacts, and large scale environmental reviews and impact studies.

Townsville Port Expansion EIS

Organisational Chart – Study Team



Project Director
Chris Paterson

Project Manager
Glenn Stephens

EIS Manager
Greg Fisk

Engineering Manager
Noel Ducray

Stakeholder Communications
Kelly Timmerman

Environmental Studies Lead
Troy Collie

Marine Studies Lead
Brad Grant

Dredging and Reclamation
Frans Hoogerwerf

EIS Lead Author Troy Collie	**Transport and Infrastructure** Albert Kwong and John Dennison	**Public Hazard, Safety & Risk** Thomas Mitchell	**Water Quality** Anthony Charlesworth	**Land and Groundwater** Will Van Vaerenbergh	**Air Quality** David Rollins
Legislation, Approvals & Land Use Manfred Boldy	**Waste** Simon Murphy	**Avifauna Survey and Assessment** Peter Buosi	**Marine Sediment** Dr Beth Toki	**Visual Amenity** Wendy Davies	**Climate, Natural Hazards, Climate Change & Greenhouse Gas Emissions** Rebecca Enright
Social Impacts Manfred Boldy and Kathleen Turner	**Soils, Marine Sediments and Groundwater** Henry Parsons	**Water Resources** Paul Glenn	**Coastal Processes** Dr Paul Guard	**Economic Assessments** Steve Corcoran	

Port Expansion Project EIS

Appendix E1

Community and Stakeholder Engagement Plan

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Port of Townsville Limited
31 May 2012
Document No. 60161996

Port Expansion Project

Community & Stakeholder Engagement Plan

Port Expansion Project

Community & Stakeholder Engagement Plan

Prepared for

Port of Townsville Limited

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AECOM in Australia and New Zealand is certified to the latest version of ISO9001 and ISO14001.

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Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	22-Oct-2010	Draft for Review	Peter Burton Project Manager	Original previously signed
B	11-Jun-2011	Final for Issue	Peter Burton Project Manager	Original previously signed
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Executive Summary

This Community and Stakeholder Engagement Plan defines the community engagement program for the Port of Townsville's Port Expansion Project (PEP).

The PEP is a forward-looking project following on from the Master Planning exercise which in 2007 demonstrated the need to accommodate forecasts of trebling of trade over Port of Townsville wharves by 2030.

Working on a 25 year development horizon, the project flags improved flexibility of inner harbour berths as a priority, however, also recognises new berths in the outer harbour will be required. Overall, it will create up to seven new berths in the outer harbour, as well as see the reclamation of about 100 hectares of land, and will ensure the infrastructure is positioned well ahead of demand.

The first stage of the PEP will be to undertake environmental studies to feed into the required Environmental Impact Statement (EIS).

The plan outlines the project's history along with a situation analysis of the current environment and previous engagement, noting existing sensitivities of the community towards port activities, along with the region's reliance on the income generated from the activities of the port.

Along with the objectives of information sharing, community inclusion and reputation management the community and stakeholder engagement activities will seek to facilitate community understanding and acceptance of the PEP.

The plan defines the project's stakeholders ranging from the broader community, traditional owners, port users, surrounding residents, community (including environmental) groups, local businesses through to regulatory agencies and government stakeholders.

All communication activities and mechanisms will follow Port of Townsville Limited (POTL) policies, protocols and guidelines and approval processes.

All data resulting from the engagement activities will be captured on a web based database and will manage confidentiality while facilitating reporting and analysis on themes, issues and community and stakeholder perceptions.

At the completion of the PEP, evaluation of the plan, activities and mechanisms will be undertaken to secure evidence of the effectiveness of the program. This will ensure future engagement activities are continuously improved and that project learnings can be clearly communicated.

1.0 Introduction

This Community and Stakeholder Engagement Plan for the Port Expansion Project (PEP) outlines the framework for engagement to support the project. This plan:

- recognises project history and its important contextual basis
- provides clear communication and engagement goals and objectives
- identifies existing and potential issues
- lists and classifies key stakeholders
- provides key project messages
- outlines a draft action plan that will safeguard and build upon Port of Townsville Limited (POTL)'s existing relationships, trust and reputation
- clarifies communication protocols for the project team
- defines reporting mechanisms
- sets evaluation targets for the engagement program.

It is intended to be a living document and will need to be closely aligned to broader positioning and strategic communications associated with POTL, as well as adapt to meet the changing needs of the project.

2.0 Project history

Since its official 1865 proclamation as a port in the principal town of North Queensland, the Port of Townsville has become a local landmark for the Townsville community. Years of development have created a port that visually represents the growth and development of the community. Its relationship with the place and its people has been at the heart of that development.

As a result of this continuing and forecast growth, the need to expand the port has become a critical component of the port's future. The Environmental Impact Statement (EIS) is a significant step in defining the way in which the PEP will proceed.

The project is proposed to accommodate forecast growth in trade at the port over a planning horizon to 2030, and to address current capacity constraints by expanding the existing port infrastructure seaward of the existing eastern breakwater. It includes the development of up to six additional vessel berths (Berth 14 through Berth 19), provided through a program of staged construction that will support maritime and land-based port operations.

New berths in the Townsville Port Expansion will be developed in a staged manner and in response to demand from increases in existing trade throughput or the advent of new trades. The expansion may be developed on a sequential berth-by-berth basis or in stages that include development of multiple berths.

Expansion will accommodate ships up to Panamax size (maximum beam 32.3 metres); however the layout of channels and basin areas will give consideration to the possibility that there may be a future requirement for Post-Panamax shipping to call Townsville.

The PEP involves the development of additional core port infrastructure only in the proposed outer harbour and reclamation area. The particular trades to be handled through the port expansion are not precisely defined and will be determined by growth of existing trades and by the advent of new trades over the planning horizon. However, it is anticipated that dry bulk and bulk liquid trades will be prevalent, based on the trade forecast.

The main port infrastructure components are:

- Harbour dredging and channel deepening
- Land reclamation, predominantly through the placement of dredging material
- Installation of new breakwater and revetment structures
- Development of new internal bunds to facilitate effective land reclamation
- Installation of new wharf structures
- Installation of new navigational aids
- Upgrades to road and rail infrastructure as well as construction of new road and rail infrastructure
- Installation of new services infrastructure.

The PEP represents the largest infrastructure development to be undertaken at the Port of Townsville and will stand as one of the largest infrastructure projects to be undertaken in North Queensland. The scale and complexity of the project will require careful resolution of complex and interrelated engineering and environmental issues.

During the approvals phase it will be imperative that the implications, in terms of the project's capital cost and the port's operation, of impact assessments and impact mitigation measures are understood and managed.

The engagement of shareholding ministers, POTL, government authorities and agencies, key stakeholders and the community in the EIS process and the project through delivering successful outcomes through open and value adding engagement will be achieved through the implementation of the shared goals of this Community and Stakeholder Engagement Plan.

3.0 Situation analysis

3.1 Current environment – the Townsville community

The local Townsville community recognises that Port of Townsville has been the significant entity responsible for the development of Townsville as Queensland's northern port city. Through existing relationships and a commitment to engagement, the Port of Townsville is continuing to influence the values of the community through its interaction with the natural, social and economic environments of the region.

It is widely known that the community values the natural environment surrounding the port and all it offers in terms of the adjacent location of valuable waterside residential properties, significant aquatic leisure opportunities, recreation activities on The Strand and the tourism and cultural heritage values of Magnetic Island. This access and the enjoyment of these activities are central to the core interests of the Townsville community and associated leisure tourism industries and it is understood that concern relating to any potential impact on these amenities will attract attention from these groups, as key stakeholders of the project.

The port exists in an environment of competing interests due to the diversity of the region's economy. In addition to the abovementioned tourism industry, the interests of the likes of defence, education, agriculture, export, manufacturing and the public service sectors are well represented. It is the intention of the project team to effectively engage with all key stakeholders to ensure that the interests of the port are not incorrectly reported as being contrary to the interests of the broader community.

This Community and Stakeholder Engagement Plan defines a proactive tailored approach to the management of stakeholders to accurately highlight the port's day-to-day commitment to stakeholder engagement and recognise the importance of the function of engagement as part of any expansion planning, design and delivery.

While opinions on the port may be varied within the community, the port's contribution to the economic future of the region is one without opposition. This is an important reputational asset for moving forward to expand the facilities at the port to cope with the future needs of its users and will be reflected in the key communication and engagement messages.

3.2 Previous engagement

POTL has employed numerous general engagement mechanisms for stakeholders and the community over time, including:

- POTL website
- Port Community Partnerships Forum (recommencing in 2011)
- On line POTL complaint lodgement form
- Online website feedback form
- In Depth and RapPort newsletters
- Sponsorship of local charities, local business activities, regional development bureaux, cultural and trade events, tourism, and mining activities
- Annual customer surveys
- Annual resident surveys
- Port tours for local industry, charitable organisations, schools and universities, businesses and government officials
- Port Advisory Body (PAB).

These initiatives demonstrate POTL is committed to engagement with stakeholders and the community on relevant issues and has undertaken, and continues to provide, proactive engagement opportunities for stakeholders and the community.

POTL has also developed strong networks amongst stakeholders and community members through their commitment to implementing community consultation plans for all major port developments and projects. The most recent community engagement program undertaken was for the preparation of the Environmental Impact Statement for the Townsville Marine Precinct Project (TMPP).

It is important for the project to build and strengthen these existing relationships through ensuring appropriate, informed participation in relevant engagement activities.

The engagement activities will also seek to identify proactive media opportunities for referral and consideration by POTL Marketing and Customer Relations Officer to maximise opportunities for positive reputation management.

3.3 Communication environment

The PEP team recognises that we live and operate in a communication environment where the playing field for the community is constantly changing. In 2010, the community frequently has access to information almost instantaneously (media, internet, social media etc.). Engagement in this environment must be an ongoing, proactive and interactive process, in which stakeholders and the community are engaged as active partners and not treated as passive recipients of information.

3.3.1 Existing community sensitivities

The operations of the port have historically been perceived by the community as the cause of environmental nuisance due to noise, dust and light emissions. More recently, the local media has included the port as a key target in local debate over the Townsville Ocean Terminal project, boat ramp facilities and dust.

The continuous attention directed toward the port has raised a heightened community awareness of the potential impacts of the port's operations.

Whether real or perceived, these issues are to be identified and carefully managed throughout and beyond the PEP – the port's proximity to the city establishes a large number of observers, including local media. The port's approach to existing and future issues of importance to the community will influence the overall perception of the project and of the port. Further issues management information is outlined in section 5.0.

3.3.2 Commitment to effective engagement

The PEP team understands that the community sensitivities listed in section 3.3.1 (and those yet to be identified) are likely to generate significant community interest. In response, the engagement program will employ an active and transparent program of community consultation that seeks to complement POTL's existing communication mechanisms and collateral to create efficiencies where relevant.

Information is to be provided in a timely manner and feedback measured and recorded to provide meaningful insight into assessments of potential impacts of the project on the community and stakeholders as well as local social values.

It is recognised that POTL is committed beyond its legislative requirements to engage with the community and stakeholders for the PEP EIS. Past, existing and future engagement activities (including the implementation of POTL Community Engagement Policy in 2010/2011) coalesce to build the context and communication and consultation environment in which this project will effectively engage and communicate both internally and externally.

3.3.3 Non-negotiables and Negotiables (to be confirmed)

Different elements of the community and stakeholder engagement program have different degrees of flexibility to respond to changes in the program. Table 1 below established a starting position of the negotiable and non-negotiable project aspects for the engagement program.

Table 1 Non-negotiables and Negotiables

Non-negotiables	Negotiables
The community and stakeholder engagement program and related communication activities are to adhere to POTL corporate protocols, policies and guidelines	Alterations to the planned community and stakeholder engagement program to respond to changes in the communication environment can be undertaken at the request of the project team or as directed by POTL
All communication activities and communication collateral to be approved by POTL, and where required, shareholding ministers and POTL Board of Directors	
No employee or contractor is permitted to speak to the media regarding any of the activities of POTL or the Port of Townsville Expansion project	
Legislative requirements of the EIS process are to be fulfilled by the community and stakeholder engagement program	

4.0 Community and stakeholder engagement

4.1 Objectives

The objectives of the community and stakeholder engagement program are to:

- provide a framework for engagement of and communication with the local community to mitigate risks that local community opposition could present to the PEP
- deliver an appropriate community consultation process in accordance with the requirements of the EIS process
- ensure activities facilitate the building of relationships with members of the community and stakeholders through trust, transparency and mutual respect
- through the delivery of engagement using a range of mechanisms, provide ongoing opportunities for community and stakeholder participation at appropriate intervals within the EIS process
- openly engage to identify broad issues of concern to the local community, stakeholders and interest groups
- provide mitigation strategies for identified issues to prevent escalation
- facilitate the project team's understanding of community and stakeholder issues and how these relate to the preparation of the EIS
- ensure the engagement mechanisms consider matters including accessibility, relevance, varying levels of understanding, participation etc.
- build community and stakeholder acceptance for the PEP
- manage community and stakeholder expectations about their level of influence over project outcomes
- protect POTL's reputation with the community and key stakeholders
- at the project level, support POTL's goal to obtain authorisation of the EIS from the Coordinator General's office
- facilitate the delivery of the project within the required timeframe
- undertake engagement from project planning through to project completion
- close the communication loop by providing appropriate and timely feedback to participants and the broader community on both the outcomes of the engagement process and how input has been integrated into the project and issues addressed.

4.2 Preferred outcomes

The PEP team are committed to delivering a Community and Stakeholder Engagement Plan that will facilitate:

- a community that is well informed and aware of the outcome of the EIS process for the PEP
- a community that accepts and supports the need for the PEP
- under the direction of POTL Marketing and Customer Relations Officer, the community engagement and communication activities optimise positive media opportunities and negate negative and unbalanced media reporting
- the establishment of an agreed, consistent and co-ordinated public position with project team members and partners
- that POTL is viewed by the community and stakeholders as:
- rigorous in its risk assessment
- responsive to the community
- the creation of an understanding in the community of the positive opportunities that will follow the PEP

- the delivery of a well informed EIS that clearly integrates outcomes from the community and stakeholder engagement activities.

4.3 Consultation stages

The PEP will commence with the EIS program. The engagement and public comment elements of the EIS process occur as illustrated in Figure 1 below. The community and stakeholder engagement program will fulfill the legislative requirements for the provision of adequate opportunities of engagement and public comment. The first stage shown below is reserved for internal project establishment and alignment.

Figure 1 **Engagement and public comment in the EIS process**

Throughout the ensuing stages of the PEP, the communication and engagement mechanisms, activities and objectives established for the EIS process will be maintained. Continuity of contact points, messages and engagement will support continued project understanding within the community and maintain and further develop key relationships with stakeholders and the community.

5.0 Issues management

5.1 Engagement issues identification

There are a number of community issues that have been identified through previous community engagement activities and day to day operations of the port that are likely to be raised by the community in relation to the PEP.

Current issues that are known to POTL and are likely to remain active include:

Table 2 Known project issues

Issue	Action
Noise of port operations (including expansion) Dust from port operations (including expansion) Impact on visual amenity (including expansion) Environment impact of operations (including expansion) Impact on tourism Impact on property values	- Develop and disseminate clear, consistent key messages about the reality of the impact using a range of mediums targeting specific stakeholders and the community - Have prepared, approved responses to Frequently Asked Questions (FAQs) - Deliver key messages in context with the key project benefits - Promote any relevant mitigation strategies
Lack of understanding of the need for the project	- Develop and disseminate clear, consistent key messages about the need and benefits of the project using a range of mediums targeting specific stakeholders and the community - Have prepared, approved responses to FAQs - Seize any proactive, positive media opportunities that may arise
Community and stakeholders' level of influence on the decision-making process	- Early expectation management with targeted key stakeholders and the community to outline their level of involvement and influence - In key messages (FAQs) clearly communicate negotiables and non-negotiables with supporting rationale to clarify the level of involvement. Need to ensure the release of this information is appropriate in the context of project timings
Confusion with other related or previous projects	- Develop and disseminate clear, consistent key messages about the project using a range of mediums targeting specific stakeholders and the community - Have prepared, approved responses to FAQs - Liaise with relevant organisations to coordinate and synchronise responses to public enquiries to ensure key messages are accurately communicated and ensure enquiries are directed to the project team for a response - Undertake briefings with engagement staff on any related or similar projects to ensure appropriate communication channels are created and supported. Also support with agreed key messages for project interaction
Management of project impact on Great Barrier Reef Marine Park Authority (GBRMPA)	- Engage at regular intervals with GBRMPA representatives and seek assistance to ensure project has minimal impact on the park and seek information on the required processes for permits etc
Impact of increase in bulk trade	- Develop and disseminate clear, consistent key messages about the reality that increased trade traffic will be predominantly rail based

Issue	Action
	- Have prepared, approved responses to FAQs - Deliver key messages in context with the key project benefits - Promote any relevant mitigation strategies
Impact (real and perceived) on the Strand	- Develop and disseminate clear, consistent key messages about the reality that increased trade traffic will be predominantly rail based - Have prepared, approved responses to FAQs - Deliver key messages in context with the key project benefits - Promote any relevant mitigation strategies
Impact (real and perceived) on Cleveland Bay	- Develop and disseminate clear, consistent key messages about the reality that increased trade traffic will be predominantly rail based - Have prepared, approved responses to FAQs - Deliver key messages in context with the key project benefits - Promote any relevant mitigation strategies
Impact (real and perceived) passing from the Strand/Ross Creek to Ross River	- Develop and disseminate clear, consistent key messages about the reality that increased trade traffic will be predominantly rail based - Have prepared, approved responses to FAQs - Deliver key messages in context with the key project benefits - Promote any relevant mitigation strategies
Construction activity/traffic management	- Refresh and disseminate clear, consistent key messages about the reality that increased trade traffic will be predominantly rail based - Update approved responses to FAQs - Deliver updated key messages in context with the key project benefits - Communicate impacts and mitigation strategies to the community and port users

6.0 Methodology

The project team has an appreciation that the port's location and significance within the economic fabric of Townsville and North Queensland is likely to attract a high level of interest from stakeholders, in particular relating to its future activities (in particular after public notification of the PEP). In response, the methodology for the engagement program will deliver a transparent, measured, timely and consistent program that facilitates effective community engagement activities to support the success of the EIS process.

Targeted engagement with stakeholders will furnish the opportunity for the project team to understand stakeholder perceptions, the level of project acceptance and surface existing issues. The consultation process will enable management and mitigation of risks to corporate reputation through misinformation and disengagement of community and stakeholders.

6.1 Engagement methods and mechanisms

The community and stakeholder engagement program to support the EIS process will include (but not be limited to) the following communication mechanisms and materials:

- Key messages and themes for communication with the community and stakeholders (in consultation with POTL)
- Written content for POTL website at project commencement and updated at key milestones
- FAQs
- Written content for public display advertisements in the Townsville Bulletin and community newspapers
- Coordination and delivery of key stakeholder briefings and note taking
- Support for delivery of Whole of Government briefings and note taking
- Delivery of community information sessions in workshop format (including on Magnetic Island)
- Preparation of community information bulletins
- Production of static displays (posters, maps, information sheets, submission forms)
- Development of project fact sheets
- Establishment and maintenance of submission and enquiry response mechanisms (project email address [pep@aecom.com], prepaid postal address [Reply Paid Port Expansion Project, PO Box 5423 Townsville QLD 4810] and 1800 enquires phone number [1800012 284])
- Development of project contact cards
- Establishment and maintenance of Consultation Manager database (record keeping).

It is acknowledged that some of this communication material may also need shareholding ministers and POTL Board of Director approval before public release.

6.1.1 Recommendations

As relevant during the project, the following engagement mechanisms will be sought (facilitated in consultation with the project team and POTL's Marketing and Customer Relations Officer):

- The integration of a community outreach/education campaign using the collateral and mechanisms outlined above to deliver key project information and to uncover the silent and/or supportive community members is recommended. This campaign would utilise public displays and information stalls at local gathering points frequented by the targeted audiences such as the local libraries, or at existing events, such as market days and fairs.
- Undertake public speaking opportunities to local community groups and schools, with technical advisors available to answer any technical questions about the project to ensure locals have the depth of information they require.
- Present at the POTL Community Partnerships Forum (recommencing 19 January 2011) to help gain coordinated feedback on local issues and the engagement process. This mechanism will be a valuable vehicle for sensing community issues and disseminating project information to the wider public.

7.0 Key strategies and principles

7.1 Key strategies

The following are the key strategies for the community and stakeholder engagement program:

- To provide value and efficiencies by leveraging off existing POTL communication tools
- To foster accurate and informative project messaging to build trust and minimise anxiety amongst the community and stakeholders
- To develop POTL and project champions as key communication conduits through effective internal communication.

7.2 Key principles

The following key principles will apply to all project communication:

- **A proactive approach to community engagement will be applied.** There will be a focus on resolving issues as they emerge, through face-to-face discussions with affected parties, to prevent escalation. Potential issues will be identified and responses prepared prior to commencing communication activities. Supporting information to reflect these responses will include an FAQ document, project fact sheets and community information bulletins. Where possible, potential solutions will be presented to the community from the outset, to allay concerns.
- **Respect will be shown at all times.** Respect and empathy for the community and stakeholders will be demonstrated, through project staff responding promptly to concerns raised.
- **Maintain control over messages.** A proactive working relationship with local media will be established to maintain accurate and balanced publicity regarding the project. A small group briefing will be organised at the outset of the project.
- **Maintain constructive relationships with elected representatives.** This will be achieved by the delivery of personal briefings at the outset of the project, and proactively throughout the project as milestones are reached.
- **Maintain regular contact with the community.** Communication with the community must be regular throughout the EIS process to prevent misinformation or uncertainty. This includes providing a more permanent presence of information in the community, i.e. placing posters and fact sheets with key project contact information in local libraries and at council offices throughout all phases of the EIS process.
- **Record all contact with stakeholders.** Accurate and detailed recording of any contact with stakeholders is essential to the EIS process. Existing databases will be used and issues trees tailored as required to ensure a robust management and reporting system.
- **Participate in the Port Community Partnerships Forum (recommencing 2011).** The existing Port Community Partnership Forum has worked well and will be involved in this project. The group can be used to market test new information and messaging that is developed.
- **Deliver regular whole of government briefings** to guide government agencies and authorities through the technical studies undertaken as part of the EIS to develop and maintain shared understanding of key issues and investigation requirements.
- **Identify synergies with the Social Impact Assessment program** to maximise the value of engagement opportunities and to minimise community and stakeholder consultation fatigue.

8.0 Key messages

Key project messages are important tools to assist project staff deliver consistent, pre-approved information. Advice provided in these messages is clear, consistent and pre-approved as part of the risk management approach to issues management.

After further consultation with the project team and POTL Marketing and Customer Relations Officer, key messages will be developed for a range of topics including:

- Project understanding
- Project need
- Project benefits and opportunities
- Project timeframes
- Project processes and studies
- Community and stakeholder concerns (know issues)
- Effect of the project on local environments/activities.

9.0 Stakeholders

Engagement of stakeholders for the PEP will operate across three main groups of stakeholders, as illustrated below in Figure 2.

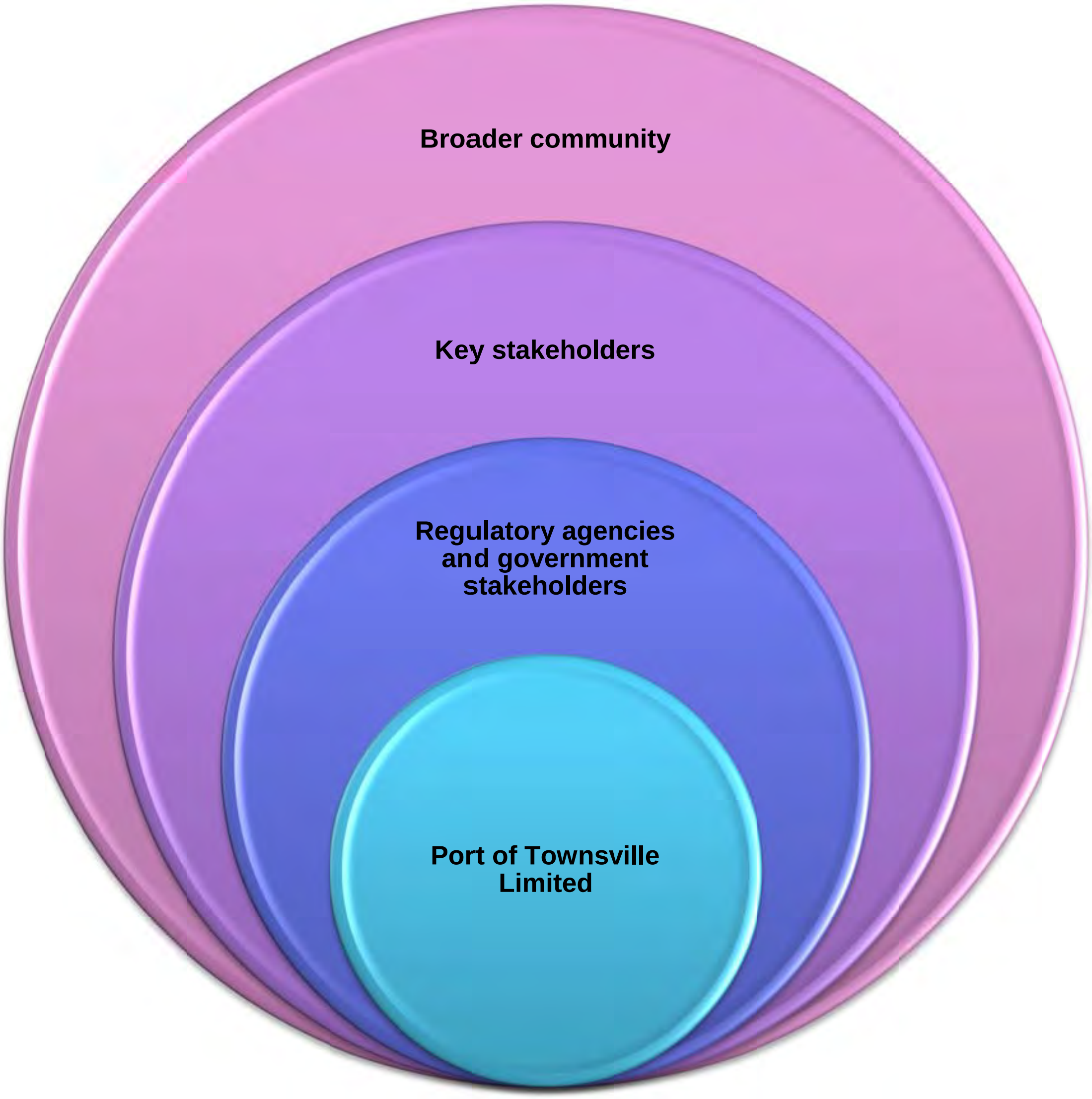


Figure 2 Stakeholder groups

9.1 Regulatory agencies and government stakeholders

A proactive engagement approach to involve local, state and federal government agencies and authorities with an interest in the project, either as a result of their statutory approval responsibilities or related impact and interest perspective, will be implemented.

Regular whole of government briefings will be scheduled at key project milestones and commenced early in the project program. The purpose of the meetings will be to provide project briefings and approval and permit discussions and undertake effective issues management. The intent will be to facilitate an effective and efficient permitting and approvals process and to establish and or strengthen relationships with these critical stakeholders.

Table 3 **Draft regulatory agencies and government stakeholders list**

Agency/Authority
Department of Environment and Natural Resources – Environment Resource Management
Great Barrier Reef Marine Park Authority
Department of Transport and Main Roads and Maritime Safety
QR Network Pty Ltd
Department of Employment, Economic Development and Innovation – Queensland Primary Industries and Fisheries, Trade Queensland
Department of Defence
Australian Government Sustainability, Environment, Water, Population and Communities
Townsville City Council
Department of Communities
Queensland Police Service
Department of Infrastructure and Planning
Queensland Health
Queensland Treasury

9.2 Key stakeholders

Informing and involving key stakeholders early in the project and at key milestones will establish and/or build on existing relationships with POTL. Recognition of the value they add to the engagement process, their contribution to the identification of issues and role in mitigation is an important activity for the PEP team. Investment in key stakeholders will establish critical feedback conduits and establish project champions (key supporters/spokespeople for the project) to provide valuable communication channels to distribute correct and up to date project information.

Key stakeholder briefings (one on one meeting with technical and community engagement representatives of the project team) will be held at the commencement of the project and at key project milestones.

Table 4 **Draft Key stakeholder list**

Key stakeholders
Traditional Owners
Townsville Enterprise Limited
Townsville City Council
Townsville Chamber of Commerce
Burdekin Dry Tropics
MITEZ
Members of the Port of Townsville’s Community Partnerships forum (currently inactive)
Property and business owners in the project vicinity (including Magnetic Island)
Community interest groups including: - Townsville Bird Observers’ Club - North Queensland Conservation Council - Townsville Local Marine Advisory Group (to the Great Barrier reef Marine Park Authority) - Wildlife Preservation Society of Queensland (NQ Branch) - Coastal Dry Tropics Land Care Inc - Commercial Fishers Association - Seagrass Watch

Key stakeholders
- Townsville Wildlife carers - Birds Australia NQ - Sea Turtle Foundation
Impacted port customers and users

9.3 Broader community

The EIS and SIA processes and associated mechanisms will provide opportunities for engagement with the broader community that are likely to have an interest in the project from a number of perspectives including perceived potential impact of the project from a number of perspectives such as visual, noise, environmental, economic, commercial and employment.

Communication with the public needs to be open and honest and interactions need to be clearly recorded and reported to ensure the community has an understanding of the value or impact their input has had on the process. Communication collateral will need to be accessible, written in clear, non-technical language and clearly describe the opportunities for public comment.

The broader community is likely to include, but not be limited to residents outside the project vicinity, businesses in the region, local schools, the communities and businesses of the North East and North West etc.

10.0 Communication protocols

10.1 Link between AECOM and POTL

POTL will remain the public face of communication and engagement for the PEP. AECOM will facilitate the engagement processes however all external communication will be branded as POTL and adhere to corporate communication guidelines, policies and protocols.

AECOM will, as required:

- deliver the approved community and stakeholder engagement program
- develop collateral and briefing notes
- provide advice and associated copy to POTL relating to positive media opportunities.

10.2 Collateral approval process

POTL corporate approval (and where required, shareholding ministers and Board of Director approval) will be required for all public and internal communication collateral for the project. The required timeframes for differing levels of approval will be factored into project timeframes.

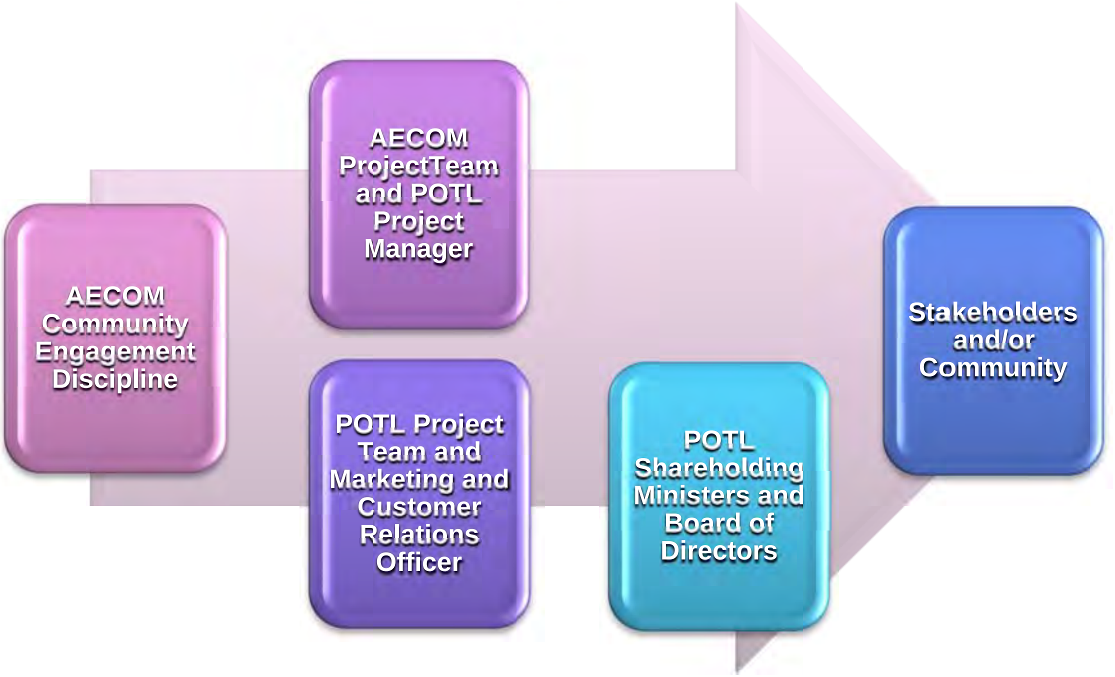


Figure 3 **Communication collateral approval process**

10.3 Media protocols

Project team members and field staff are not under any circumstances to enter the Port of Townsville site without the authority of POTL General Manager, Major Projects Matthew O'Halloran.

The following media protocols apply at all times:

1. No employee or contractor is permitted to speak to the media regarding any of the activities of POTL.
2. If an enquiry is received from the media, staff are to be advised that the following steps should be taken:
   - Ascertain the nature of the enquiry, the person calling and the media group they represent
   - Advise the enquirer that you are not an authorised spokesperson for POTL

- Advise the journalist that you will organise to have the appropriate person contact them as soon as possible
- Record the journalist’s details (name, phone number, organisation they represent, date and time of the enquiry, questions, deadline)
- Resist attempts by the enquirer to draw any further comment
- Inform the AECOM Community Engagement Discipline Leader Kelly Timmerman on 07 4720 1607 or 0488 400 042 immediately after the enquiry, who will liaise with POTL’s Marketing and Community Relations Officer Andrew Strutton or alternatively POTL’s General Manager, Major Projects Matthew O’Halloran.

11.0 Management of Data

When hosting community engagement activities associated with the Port of Townsville Expansion project, it is important to record all issues raised, responses given and stakeholders addressed. Collecting this data will allow the project team to evaluate the pre-engagement planning and to also identify, mitigate and manage identified issues. Legislative requirements of the EIS process will also require sound data management and reporting.

The AECOM community engagement team will use Consultation Manager as a database to capture and record all interactions with stakeholders and members of the community. Submissions and information received from engagement events and the community input phases of the EIS process will be uploaded and linked to the database for future reference.

As the database is web based, all relevant project team members can be provided with security (by password) and the level of interaction with the database can be set by the administration (a community engagement discipline member of the project team).

Data can be sorted and reports generated from the database at regular intervals and will assist with project enquiries, tracking and reporting.

Reports on the community input stages of the EIS process can be monitored and reported to the project team to understand the issues and advice being generated from the submissions process to facilitate early mitigation.

The community engagement discipline will manage all data relating to all community engagement activities and will establish appropriate filing systems to facilitate efficient and effective access to data and to ensure a high level of integrity of data. The project team will have access to all data and reports to facilitate their efforts to identify the need for further engagement activities throughout the life of the project.

12.0 Evaluation

Evaluation is central to securing evidence which demonstrates the effectiveness of the Community and Stakeholder Engagement Plan. The following evaluation methods are suggested to help build the scorecard for assessing communications and engagement activities during the EIS process phase of the PEP.

12.1 Data sources

To evaluate the Community and Stakeholder Engagement Plan and aligned Action Plan, the following data sources are recommended:

- Media Analysis (tone, quantity, positioning)
- Community feedback analysis (e-mails, 1800 number, feedback forms)
- Monthly database reports to Project Manager.

Communication and Community Engagement Strategy evaluation		
Objective	**Community Engagement Measurement**	**Outcome**
Develop a methodology for engaging with the local community	Methodology developed and accepted by POTL	All project partners have a clear understanding and commitment to the community engagement approach
Develop clear, consistent key messages	Key messages for the project developed and accepted by POTL These messages will complement broader POTL messages	Key messages are adopted and used by all project partners and are reflected in media and public comments
Identify key stakeholders and issues	Stakeholder list and profiling completed and accepted by POTL	Relationships are developed with representatives from all key stakeholder groups
Develop an Action Plan for implementation	Action Plan developed and accepted by POTL	Action Plan implemented

Action Plan evaluation		
Objective	**Community Engagement Measurement**	**Outcome**
Provide the local community with timely, accessible, factual information about the project	All identified stakeholders have received project information ahead of public open days Feedback indicates that stakeholders received adequate information on the project and its impacts Feedback indicates the community are satisfied with the level of information/ engagement opportunities	Communities surrounding Port of Townsville are informed about the project and have opportunities to provide feedback
Develop strong stakeholder relationships to build support for the project	Feedback mechanisms have been provided to facilitate community feedback 50% of positive information is reported in local media The media have the information they require to report on project Relationships established with representatives from all identified Government and Key Stakeholder Groups	Community feels they are able to contact the project freely Media coverage is balanced Representatives from key stakeholder groups are happy with the process and accept final outcome
Ensure issues are proactively managed with mitigation strategies to prevent escalation	90% of issues are proactively resolved without escalation beyond the project team All response to enquiries and issues meet project standards	Issues do not impact on project delivery
Ensure POTL's brand and reputation is maintained or improved	Public third party endorsement for the project (peak industry body, local businesses/ residents/ community)	POTL receives positive media and stakeholder attention in relation to the project

13.0 Action Plan

Following is a proposed schedule of activities for the planning and implementation of the community engagement program to support the Townsville Port Expansion project. Additional phases of action plan will be developed as project progresses and further information is available.

13.1 Phase One: Project Establishment (internal)

Purpose: For POTL and AECOM to agree on specific protocols and to establish the required communication channels for project stakeholders.

Communication activity	Target audience	Scope and purpose	Timeframe	Responsibility
Formalise communication plans and protocols, key messages and stakeholders list				
Finalise Community and Stakeholder Engagement Plan	Project team	Agree on approach and positioning Agree on protocols and required activities Agree on broad schedule of activities	Completed	POTL to provide final sign-off
Agree on key messages	All stakeholders	Ensure consistent and accurate information about project, and that the messages are consistent with other POTL projects being conducted Prepare responses	Prior to commencement of engagement activities	AECOM to draft with POTL input POTL to provide final sign-off
Review draft list of key stakeholders and agree on final list	Project team	Ensure targeted information/communication Prepare key messages/responses	Ongoing	AECOM to draft POTL to provide final sign-off
Reinvigorate existing Port Community Forum or open up to new membership	Project team	Agree on approach	Completed	AECOM and POTL
Establish communication mechanisms				
Modify existing project database/establish Consultation Manager if required	Project team	Ensure accurate record keeping of stakeholder engagement activities	Establishment by week ending 17 January 2011 and ongoing	Confirm with POTL
Establish 1800 number and reply paid postal address for comment forms	Project team	Provide feedback mechanism for community members to communicate with the project	Completed	Confirm with POTL
Establish project email feedback	Project team	Provide feedback mechanism for community members to communicate with the project	Completed	Confirm with POTL
Add content to existing website	All stakeholders	Provide a web page with all approved project materials available	Commence by week ending 17 January 2011	POTL to advise of protocols POTL to provide final sign-off on text
Develop background information				
Obtain high-quality, relevant	Internal	Obtain photographs of the project area and port for use in	Commence by week ending 17	Confirm with POTL

Communication activity	Target audience	Scope and purpose	Timeframe	Responsibility
photography of the area		project collateral	January 2011	
Source information on POTL communication policies, protocols and guidelines		Ensure adherence to POTL communication policies, protocols and guidelines	Completed and ongoing	POTL to supply
Develop detailed Q&As for internal use	Project team	Ensure a consistent and agreed position on potential project issues	Commence by week ending 17 January 2011 and ongoing	AECOM to draft POTL to provide final sign-off
Develop FAQ's for public distribution	All stakeholders	Develop consistent, accurate responses to questions likely to be asked	Commence by week ending 17 January 2011 and ongoing	AECOM to draft POTL to provide final sign-off
Draft project collateral (fact sheets and web-copy)	All stakeholders	Provide background information on the project and key issues	Commence by week ending 17 January 2011 and ongoing	AECOM to draft POTL to provide final sign-off

13.2 Phase Two: Initial Consultation (awareness raising)

Purpose: To identify issues for inclusion in the EIS.

Communication activity	Target audience	Scope and purpose	Timeframe	Responsibility
Contact key stakeholders prior to release of newsletter one to the general community.				
Letter to elected representatives, regulatory agencies and government stakeholders introducing the project and offering briefings as required	Local, state and federal government elected representatives and regulatory agencies and government stakeholders	To introduce the project and maintain existing relationships	TBC	AECOM to draft letters POTL to provide final sign-off
Letter to key stakeholders	Environmental Groups, clubs, etc	To advise of the project and its potential impact and to explain the EIS process	TBC	AECOM to draft letters. POTL to provide final sign-off
Hold first WOG briefing	Regulatory agencies and government stakeholders	Hold first WOG briefing	Completed	AECOM to draft letters. POTL to provide final sign-off
Participate in first CRG meeting	Port Community Form members (TBC)	Hold first CRG meeting	January 2011	POTL to host meeting, information for presentation to be signed off by POTL
Distribute community information bulletin 1	All stakeholders	Mail information bulletin with personally addressed letters to key stakeholder groups Place bulletins in agreed	TBA	AECOM to arrange distribution on behalf of POTL

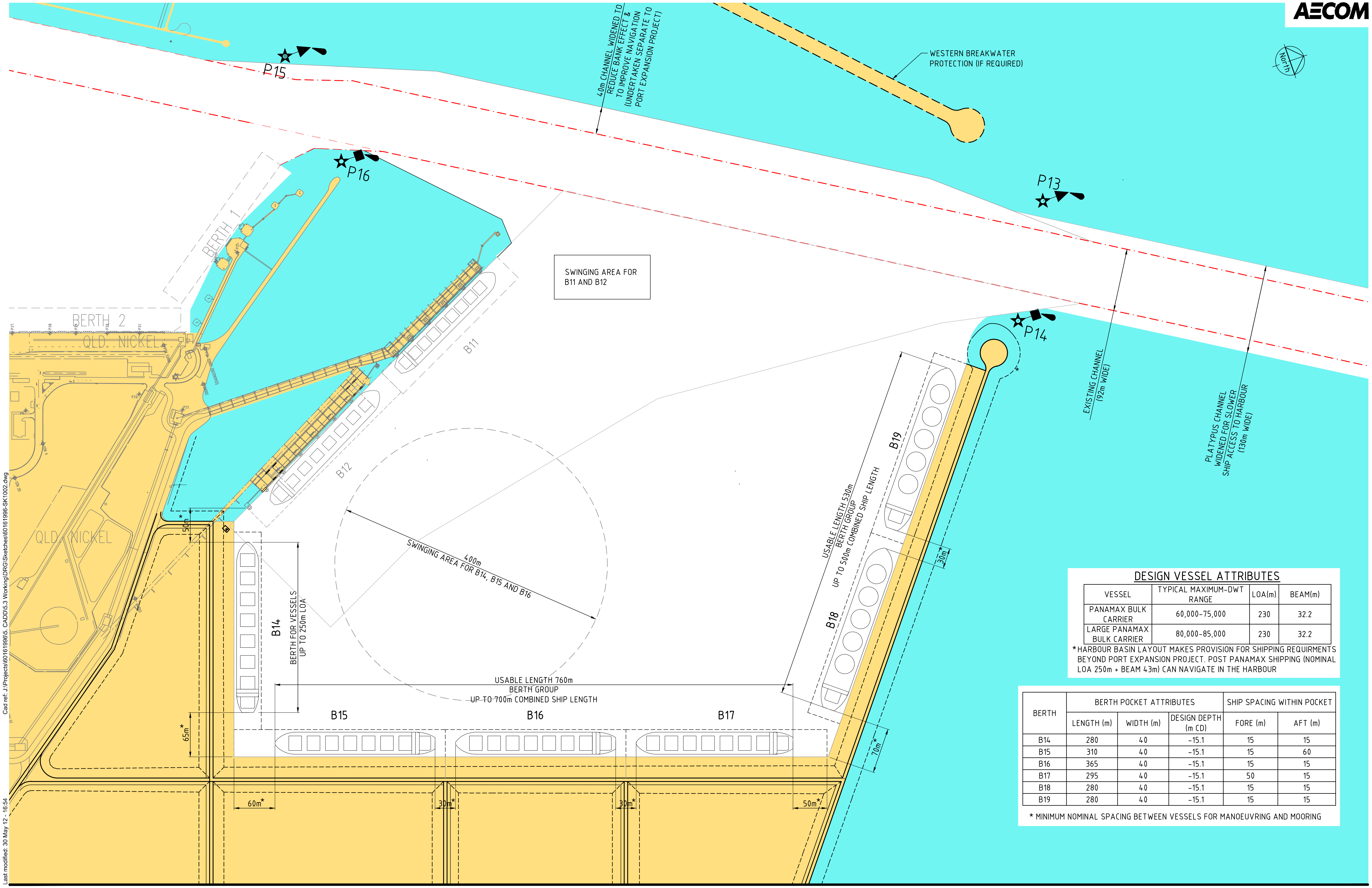
Communication activity	Target audience	Scope and purpose	Timeframe	Responsibility
Contact key stakeholders prior to release of newsletter one to the general community.				
		positions to increase dissemination of information		
Initial public display/community information day	Broader community	Provide information about the project and collect issues from the community	TBA	AECOM to manage process, POTL to provide final sign-off
Place advertisements for public display/community information day	All stakeholders	Advertisements to invite people to attend agreed public displays	TBA	AECOM to manage process, POTL to provide final sign-off
Consultation Report for this phase	Project team, POTL and DERM	Provide evidence of engagement activities	TBA	AECOM

Additional phases will be developed as the project progresses.

Port Expansion Project EIS

Appendix E2

Engineering Drawings



DESIGN VESSEL ATTRIBUTES

VESSEL	TYPICAL MAXIMUM-DWT RANGE	LOA(m)	BEAM(m)
PANAMAX BULK CARRIER	60,000-75,000	230	32.2
LARGE PANAMAX BULK CARRIER	80,000-85,000	230	32.2

*HARBOUR BASIN LAYOUT MAKES PROVISION FOR SHIPPING REQUIRMENTS BEYOND PORT EXPANSION PROJECT. POST PANAMAX SHIPPING (NOMINAL LOA 250m + BEAM 43m) CAN NAVIGATE IN THE HARBOUR

BERTH	BERTH POCKET ATTRIBUTES			SHIP SPACING WITHIN POCKET	
	LENGTH (m)	WIDTH (m)	DESIGN DEPTH (m CD)	FORE (m)	AFT (m)
B14	280	40	-15.1	15	15
B15	310	40	-15.1	15	60
B16	365	40	-15.1	15	15
B17	295	40	-15.1	50	15
B18	280	40	-15.1	15	15
B19	280	40	-15.1	15	15

* MINIMUM NOMINAL SPACING BETWEEN VESSELS FOR MANOEUVRING AND MOORING

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Last modified: 30 May 12 - 16:54

60161996
REV B

SCALE Y 0 50 100 125m
1 : 5000 (A3) 1 : 2500 (A1)

TOWNSVILLE PORT EXPANSION PROJECT
CONCEPT NAVIGATION PLAN
HARBOUR BASIN
60161996-SK1002

Cad ref: J:\Projects\60161996\5. CADD\5.3 Working\DRG\Sketches\60161996-SK1004.dwg

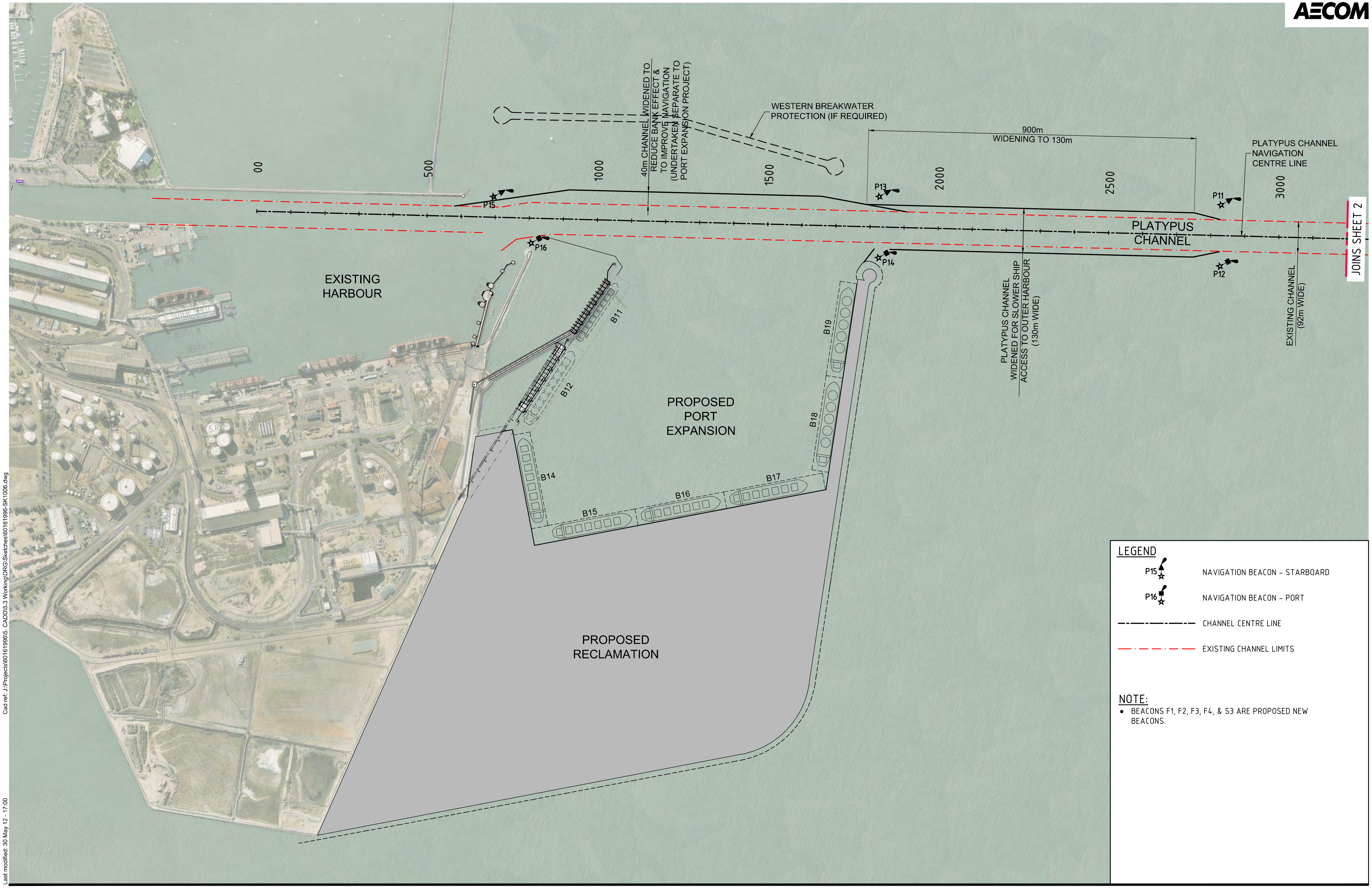
Last modified: 30 May 12 - 16:54

60161996
REV B

AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
PORT
GENERAL ARRANGEMENT
60161996-SK1004



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Last modified: 30 May 12 - 17:00

60161996
REV D

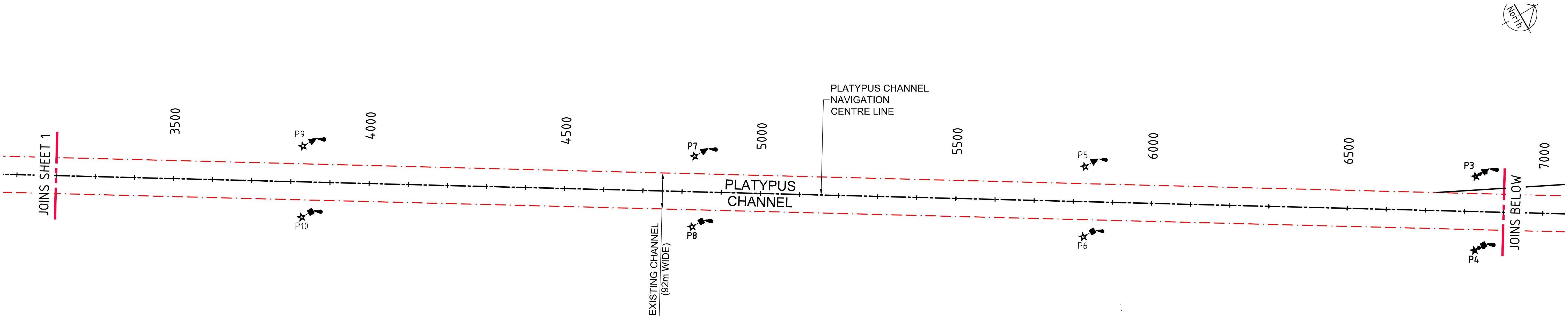
SCALE X 0 100 200 250m
1 : 10000 (A3) 1 : 5000 (A1)

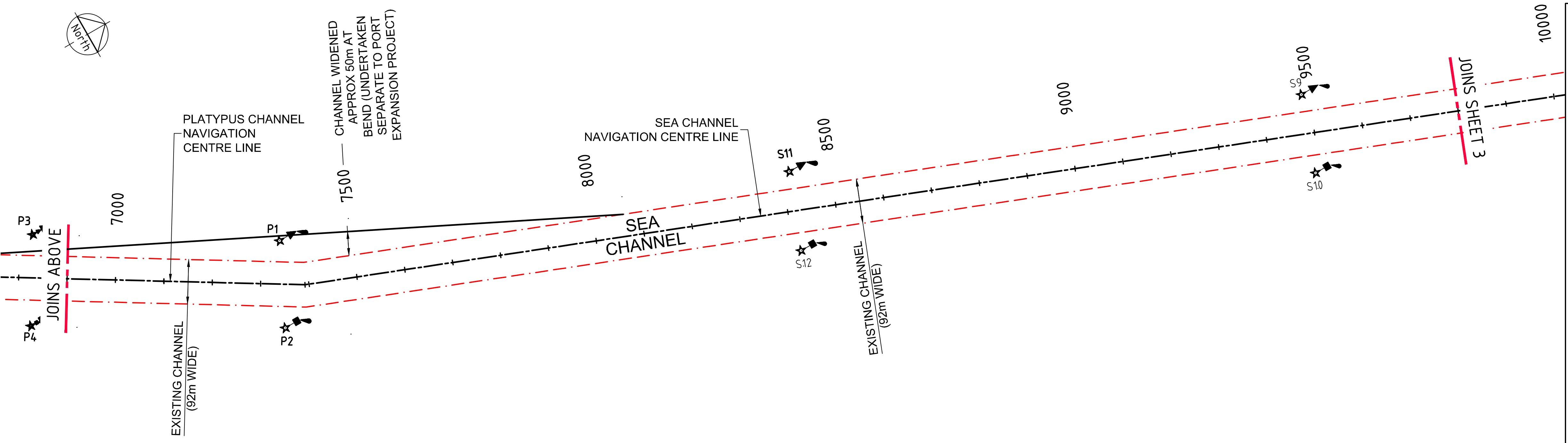
AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
CHANNEL
CHANNEL LAYOUT - Sheet 1 of 4
60161996-SK1006

AECOM





LEGEND

P15	NAVIGATION BEACON - STARBOARD
P16	NAVIGATION BEACON - PORT
—·—·—	CHANNEL CENTRE LINE
—·—·—	EXISTING CHANNEL LIMITS

NOTE:

- BEACONS F1, F2, F3, F4, & S3 ARE PROPOSED NEW BEACONS.

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Last modified: 30 May 12 - 10:07

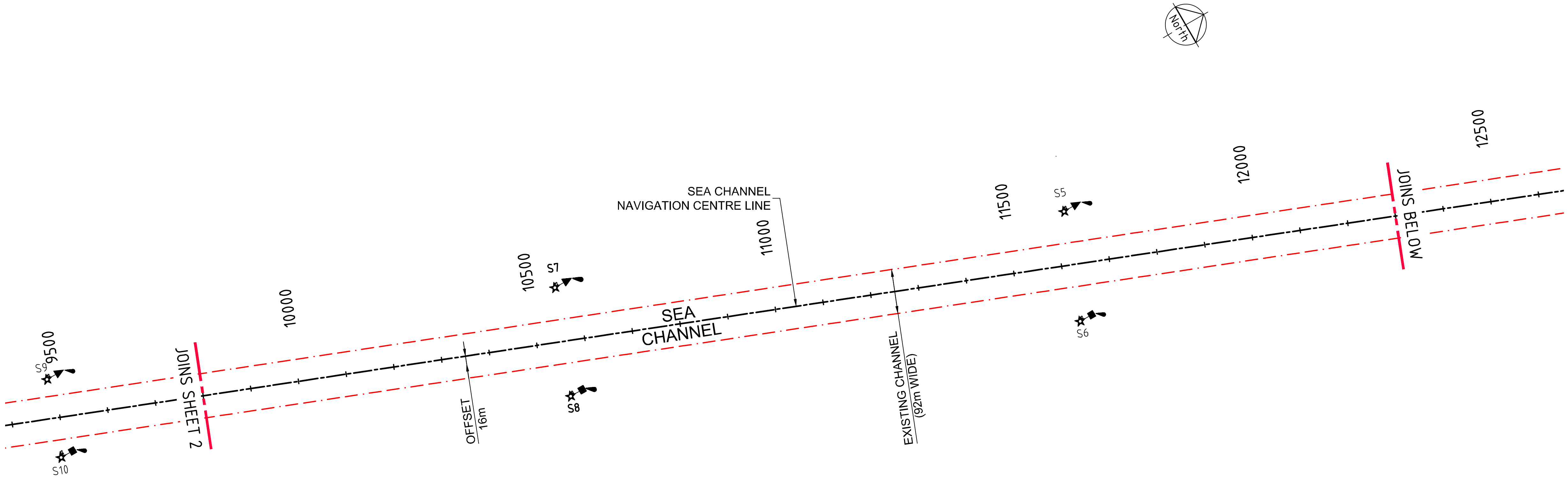
60161996
REV B

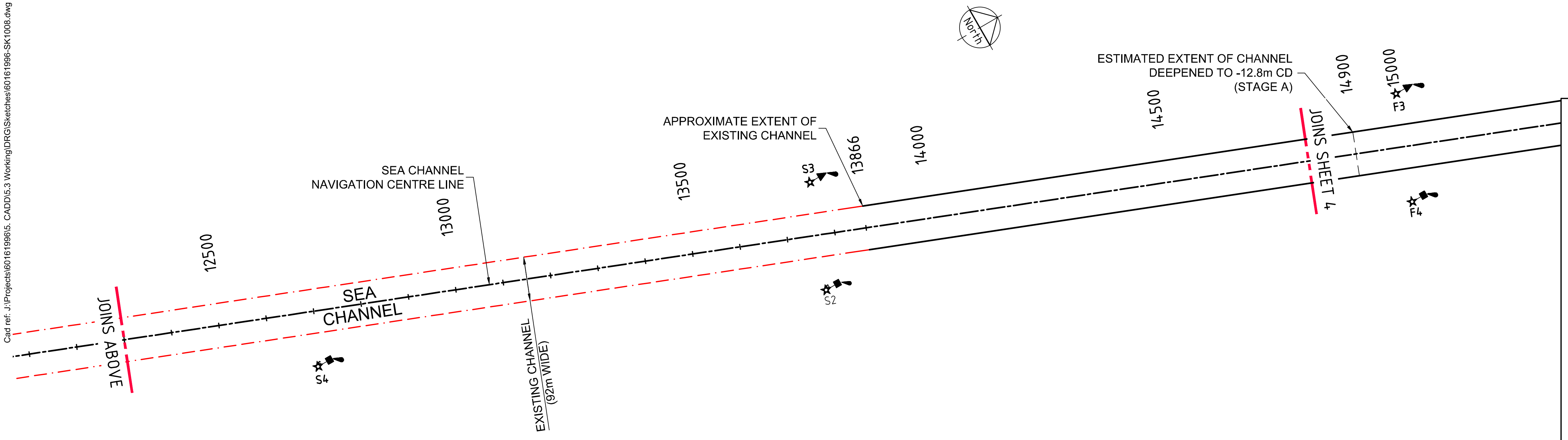
SCALE W
0 100 200 250m
1 : 10000 (A3) 1 : 5000 (A1)

AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
CHANNEL
CHANNEL LAYOUT - Sheet 2 of 4
60161996-SK1007





LEGEND

P15	NAVIGATION BEACON - STARBOARD
P16	NAVIGATION BEACON - PORT
—·—·—	CHANNEL CENTRE LINE
—·—·—	EXISTING CHANNEL LIMITS

NOTE:

- BEACONS F1, F2, F3, F4, & S3 ARE PROPOSED NEW BEACONS.

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Last modified: 30 May 12 - 09:44

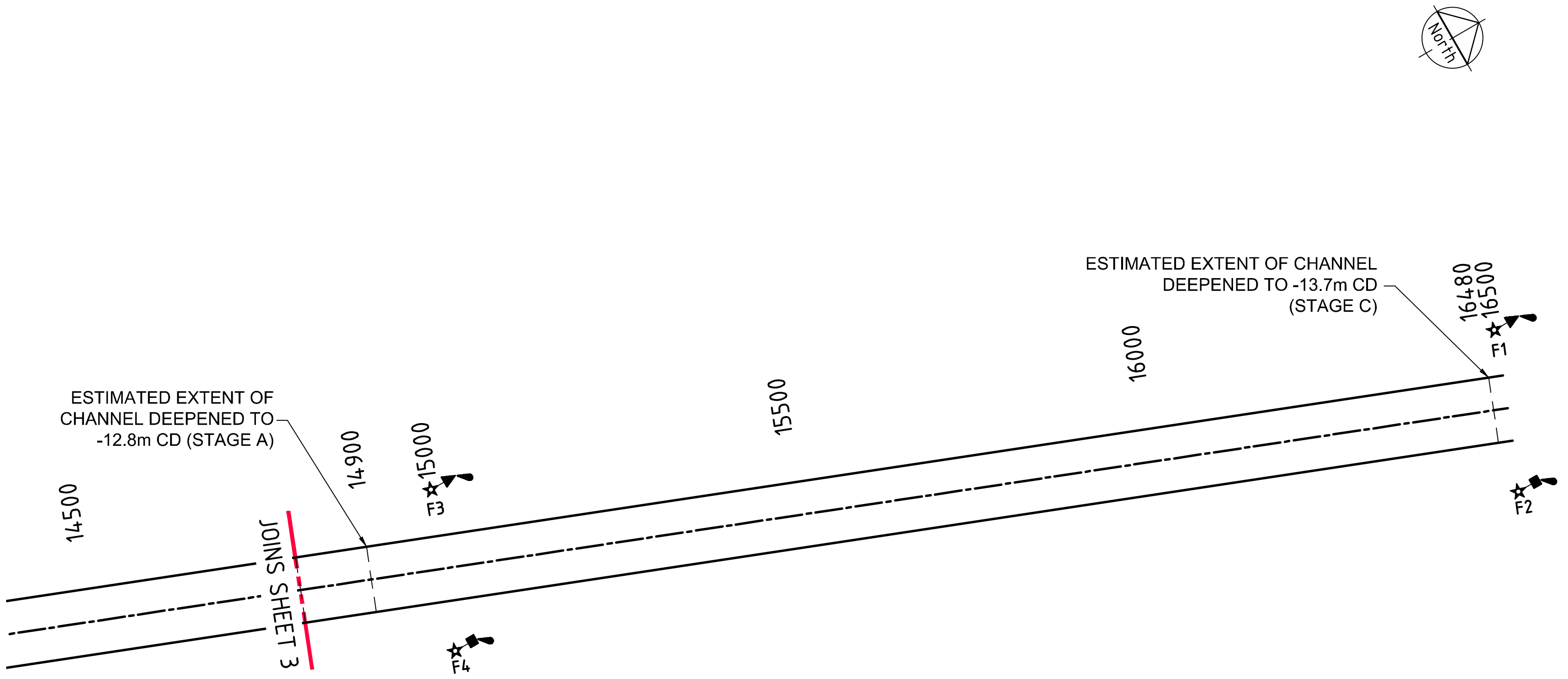
60161996
REV C

SCALE X 0 100 200 250m
1 : 10000 (A3) 1 : 5000 (A1)

AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
CHANNEL
CHANNEL LAYOUT - Sheet 3 of 4
60161996-SK1008



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Last modified: 30 May 12 - 09:44

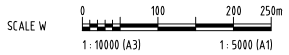
LEGEND

P15	NAVIGATION BEACON – STARBOARD
P16	NAVIGATION BEACON – PORT
—·—·—·—	CHANNEL CENTRE LINE
—·—·—·—	EXISTING CHANNEL LIMITS

NOTE:

- BEACONS F1, F2, F3, F4, & S3 ARE PROPOSED NEW BEACONS.

60161996
REV C



AECOM

PORT of TOWNSVILLE

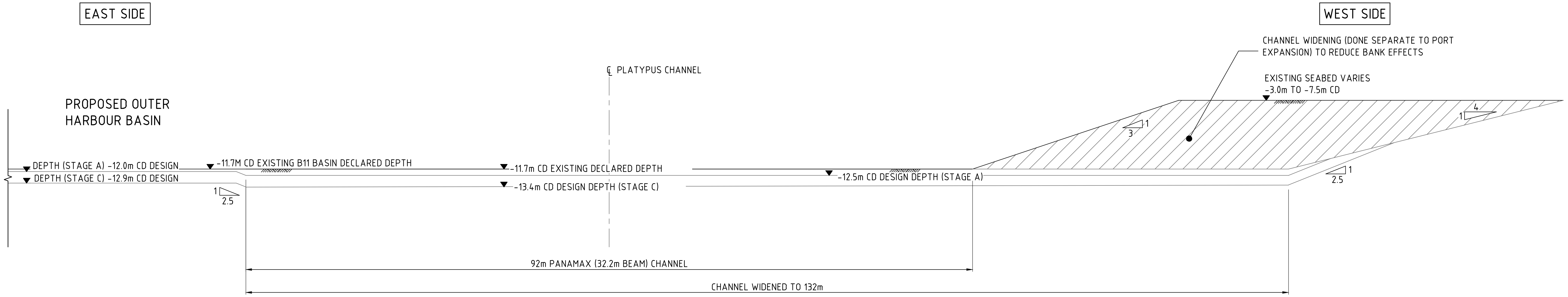
TOWNSVILLE PORT EXPANSION PROJECT
CHANNEL
CHANNEL LAYOUT - Sheet 4 of 4
60161996-SK1009

NOTES

1. DEPTHS ARE TO CHART DATUM WHICH IS LAT AT TOWNSVILLE PORT.
2. DEPTHS SHOWN ARE DESIGNED DEPTHS FOR NAVIGATION. THESE DEPTHS WILL NEED TO BE VERIFIED IN THE DETAILED DESIGN.
3. ACTUAL DREDGE DEPTHS ARE TO INCLUDE AN ALLOWANCE FOR DREDGING TOLERANCES, SEDIMENTATION ALLOWANCE AND SOUNDING ACCURACY.
4. ADOPTED UNDERKEEL CLEARANCE (UKC) FOR PANAMAX VESSELS:

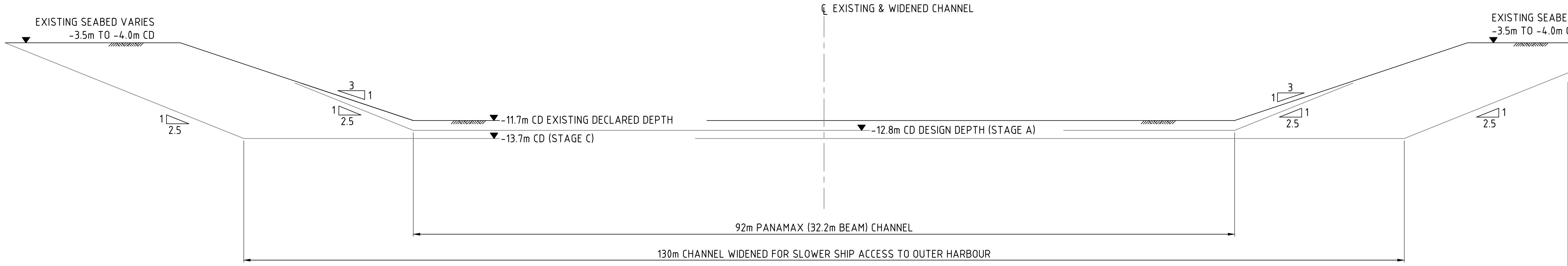
CHANNEL	CHAINAGE	UKC	MAXIMUM SPEED
PLATYPUS CHANNEL	1000 TO 1850	1.7m	8 KNOTS
PLATYPUS CHANNEL	1850 TO 7500	1.7m	9.5 KNOTS
SEA CHANNEL	7500 TO END	1.4m	9.5 KNOTS

THESE UKC'S ARE TO BE VERIFIED DURING THE DETAILED DESIGN.



PLATYPUS CHANNEL (CHAINAGE 1000 TO 1850)
TYPICAL SECTION

SCALE C



PLATYPUS CHANNEL (CHAINAGE 1850 TO 2750)
TYPICAL SECTION

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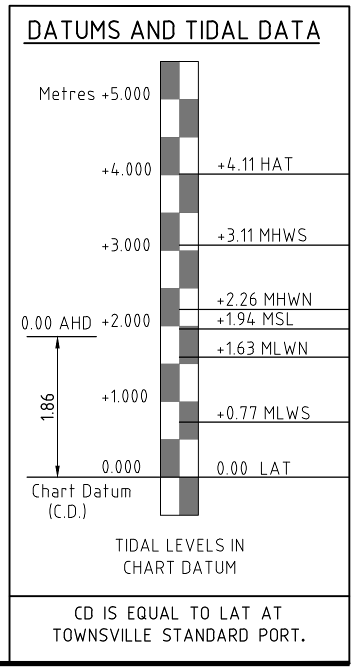

CD IS EQUAL TO LAT AT TOWNSVILLE STANDARD PORT.

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Last modified: 30 May 12 - 09:44

60161996
REV B

SCALE C 0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

PORT of TOWNSVILLE

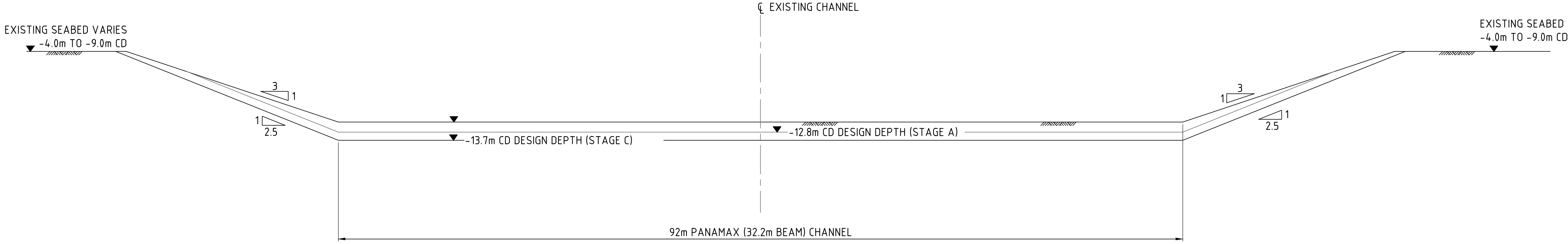
TOWNSVILLE PORT EXPANSION PROJECT
CHANNEL
TYPICAL SECTIONS - Sheet 1 of 2
60161996-SK1010

NOTES

1. DEPTHS ARE TO CHART DATUM WHICH IS LAT AT TOWNSVILLE PORT.
2. DEPTHS SHOWN ARE DESIGNED DEPTHS FOR NAVIGATION. THESE DEPTHS WILL NEED TO BE VERIFIED IN THE DETAILED DESIGN.
3. ACTUAL DREDGE DEPTHS ARE TO INCLUDE AN ALLOWANCE FOR DREDGING TOLERANCES, SEDIMENTATION ALLOWANCE AND SOUNDING ACCURACY.
4. ADOPTED UNDERKEEL CLEARANCE (UKC) FOR PANAMAX VESSELS:

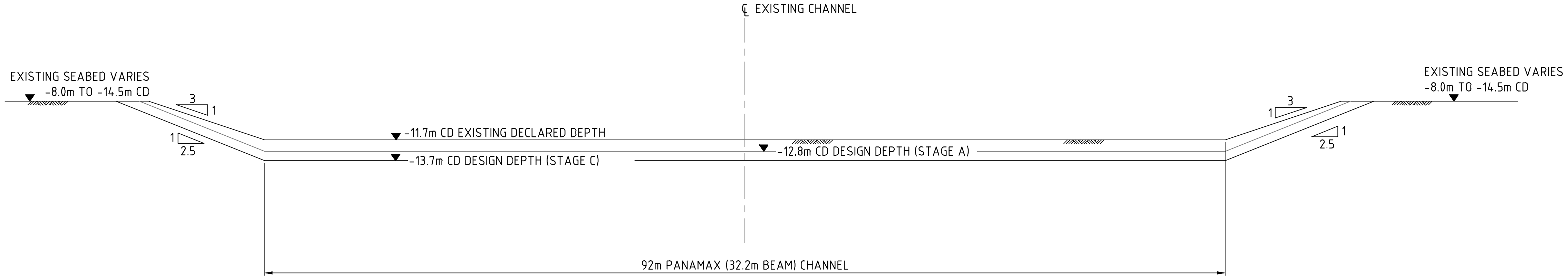
CHANNEL	CHAINAGE	UKC	MAXIMUM SPEED
SEA CHANNEL	7500 TO END	1.7m	9.5 KNOTS
PLATYPUS CHANNEL	1850 TO 7500	1.7m	9.5 KNOTS
PLATYPUS CHANNEL	1000 TO 1850	1.4m	8 KNOTS

THESE UKC'S ARE TO BE VERIFIED DURING THE DETAILED DESIGN.



SEA CHANNEL - TYPICAL SECTION

SCALE C



PLATYPUS CHANNEL (CHAINAGE 2750 TO 7500) -TYPICAL SECTION

SCALE C

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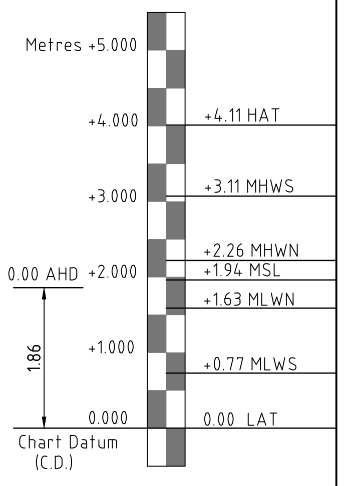
Last modified: 30 May 12 - 09:44

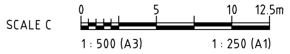
DATUMS AND TIDAL DATA



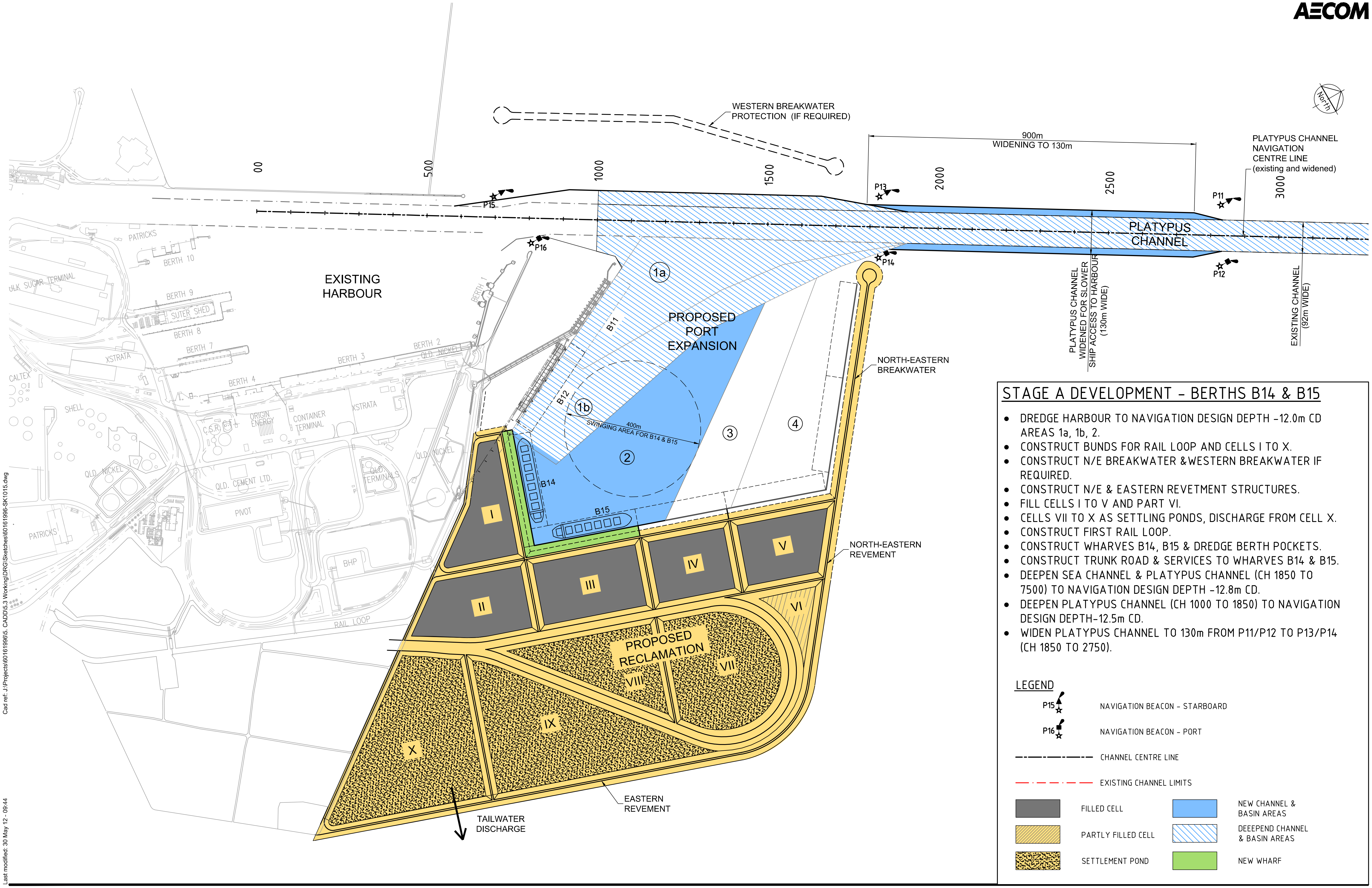
TIDAL LEVELS IN
CHART DATUM

CD IS EQUAL TO LAT AT
TOWNSVILLE STANDARD PORT.

60161996
REV B



TOWNSVILLE PORT EXPANSION PROJECT
CHANNEL
TYPICAL SECTIONS - Sheet 2 of 2
60161996-SK1011



STAGE A DEVELOPMENT – BERTHS B14 & B15

- DREDGE HARBOUR TO NAVIGATION DESIGN DEPTH -12.0m CD AREAS 1a, 1b, 2.
- CONSTRUCT BUNDS FOR RAIL LOOP AND CELLS I TO X.
- CONSTRUCT N/E BREAKWATER &WESTERN BREAKWATER IF REQUIRED.
- CONSTRUCT N/E & EASTERN REVETMENT STRUCTURES.
- FILL CELLS I TO V AND PART VI.
- CELLS VII TO X AS SETTLING PONDS, DISCHARGE FROM CELL X.
- CONSTRUCT FIRST RAIL LOOP.
- CONSTRUCT WHARVES B14, B15 & DREDGE BERTH POCKETS.
- CONSTRUCT TRUNK ROAD & SERVICES TO WHARVES B14 & B15.
- DEEPEN SEA CHANNEL & PLATYPUS CHANNEL (CH 1850 TO 7500) TO NAVIGATION DESIGN DEPTH -12.8m CD.
- DEEPEN PLATYPUS CHANNEL (CH 1000 TO 1850) TO NAVIGATION DESIGN DEPTH-12.5m CD.
- WIDEN PLATYPUS CHANNEL TO 130m FROM P11/P12 TO P13/P14 (CH 1850 TO 2750).

LEGEND

P15	NAVIGATION BEACON - STARBOARD
P16	NAVIGATION BEACON - PORT
—·—·—	CHANNEL CENTRE LINE
—·—·—	EXISTING CHANNEL LIMITS
■	FILLED CELL
▨	PARTLY FILLED CELL
▒	SETTLEMENT POND
■	NEW CHANNEL & BASIN AREAS
▨	DEEEPEND CHANNEL & BASIN AREAS
■	NEW WHARF

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Last modified: 30 May 12 - 09:44

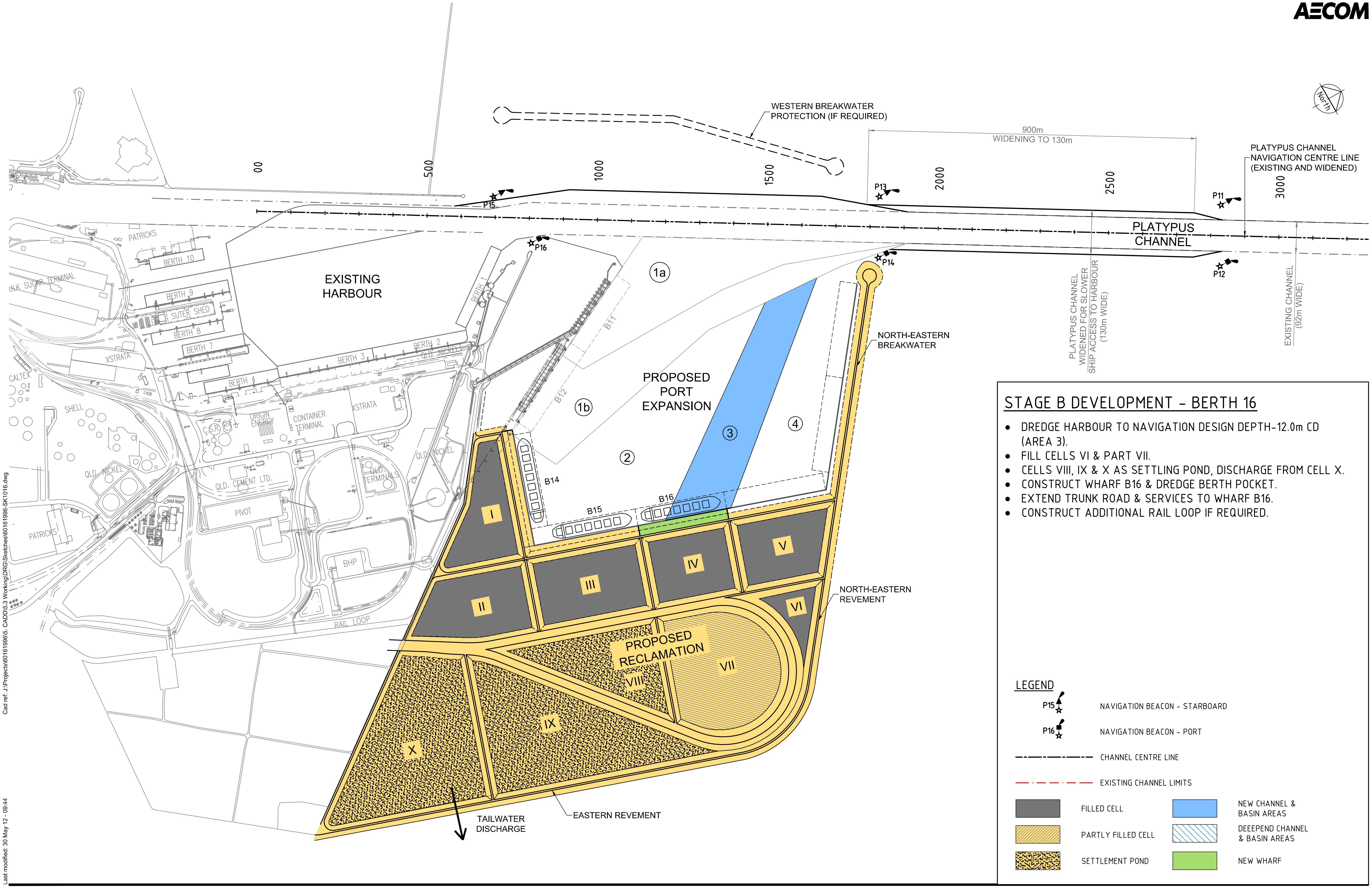
60161996
REV D

SCALE X 0 100 200 250m
1 : 10000 (A3) 1 : 5000 (A1)

AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
PORT DEVELOPMENT STAGING
STAGE A
60161996-SK1015



STAGE B DEVELOPMENT – BERTH 16

- DREDGE HARBOUR TO NAVIGATION DESIGN DEPTH-12.0m CD (AREA 3).
- FILL CELLS VI & PART VII.
- CELLS VIII, IX & X AS SETTLING POND, DISCHARGE FROM CELL X.
- CONSTRUCT WHARF B16 & DREDGE BERTH POCKET.
- EXTEND TRUNK ROAD & SERVICES TO WHARF B16.
- CONSTRUCT ADDITIONAL RAIL LOOP IF REQUIRED.

LEGEND

P15 NAVIGATION BEACON – STARBOARD

P16 NAVIGATION BEACON – PORT

–·–·–·– CHANNEL CENTRE LINE

–·–·–·– EXISTING CHANNEL LIMITS

■	FILLED CELL	■	NEW CHANNEL & BASIN AREAS
▨	PARTLY FILLED CELL	▨	DEEEPEND CHANNEL & BASIN AREAS
▒	SETTLEMENT POND	🟩	NEW WHARF

Cad ref: J:\Projects\60161996\5. CADD\5.3 Working\DRG\Sketches\60161996-SK1016.dwg

Last modified: 30 May 12 - 09:44

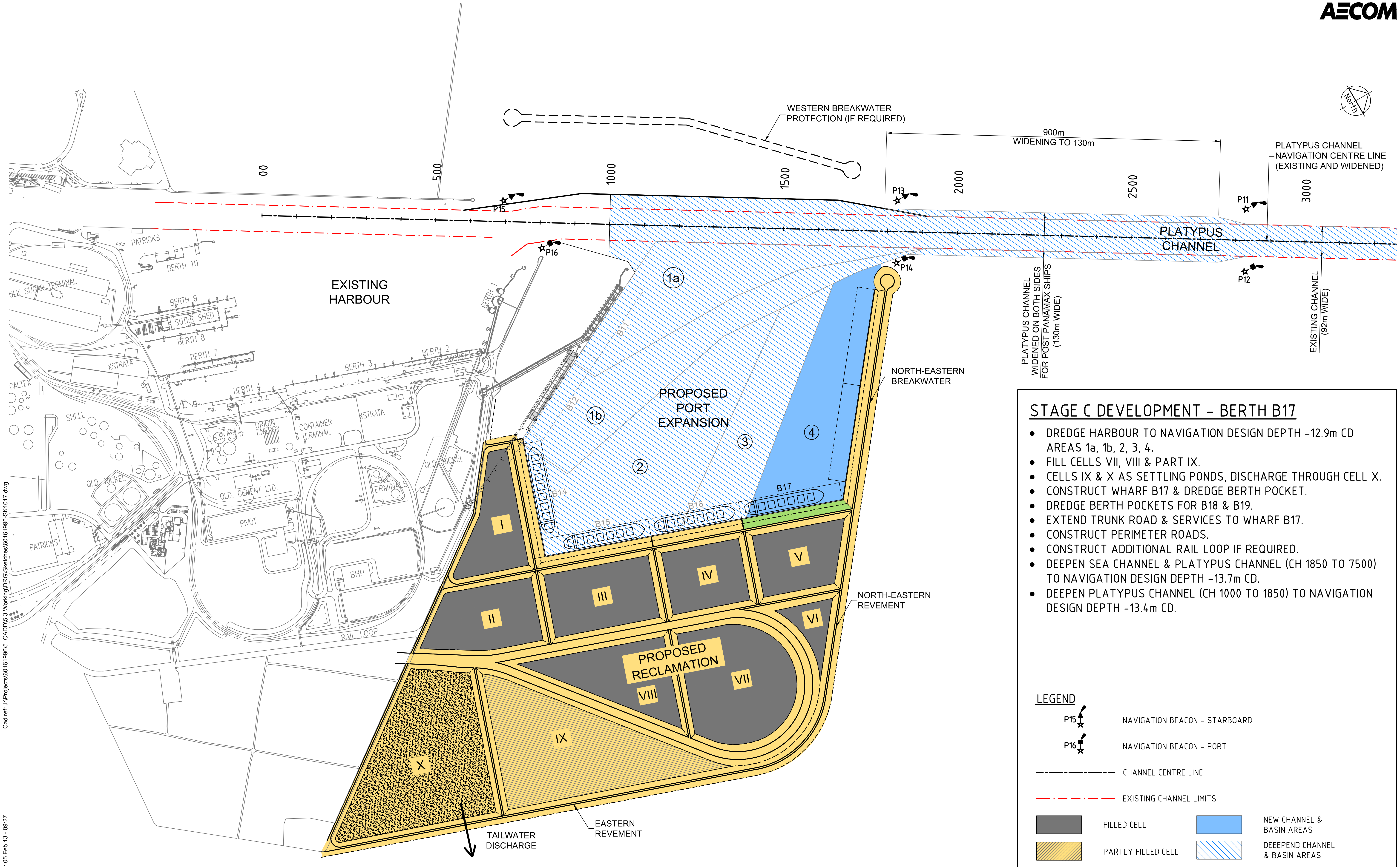
60161996
REV D

SCALE X 0 100 200 250m
1 : 10000 (A3) 1 : 5000 (A1)

AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
PORT DEVELOPMENT STAGING
STAGE B
60161996-SK1016



STAGE C DEVELOPMENT – BERTH B17

- DREDGE HARBOUR TO NAVIGATION DESIGN DEPTH –12.9m CD AREAS 1a, 1b, 2, 3, 4.
- FILL CELLS VII, VIII & PART IX.
- CELLS IX & X AS SETTLING PONDS, DISCHARGE THROUGH CELL X.
- CONSTRUCT WHARF B17 & DREDGE BERTH POCKET.
- DREDGE BERTH POCKETS FOR B18 & B19.
- EXTEND TRUNK ROAD & SERVICES TO WHARF B17.
- CONSTRUCT PERIMETER ROADS.
- CONSTRUCT ADDITIONAL RAIL LOOP IF REQUIRED.
- DEEPEN SEA CHANNEL & PLATYPUS CHANNEL (CH 1850 TO 7500) TO NAVIGATION DESIGN DEPTH –13.7m CD.
- DEEPEN PLATYPUS CHANNEL (CH 1000 TO 1850) TO NAVIGATION DESIGN DEPTH –13.4m CD.

LEGEND

P15	NAVIGATION BEACON – STARBOARD
P16	NAVIGATION BEACON – PORT
—·—·—	CHANNEL CENTRE LINE
—·—·—	EXISTING CHANNEL LIMITS

■	FILLED CELL	■	NEW CHANNEL & BASIN AREAS
▨	PARTLY FILLED CELL	▨	DEEEPEND CHANNEL & BASIN AREAS
▒	SETTLEMENT POND	■	NEW WHARF

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Last modified: 05 Feb 13 - 09:27

60161996
REV E

SCALE X 0 100 200 250m
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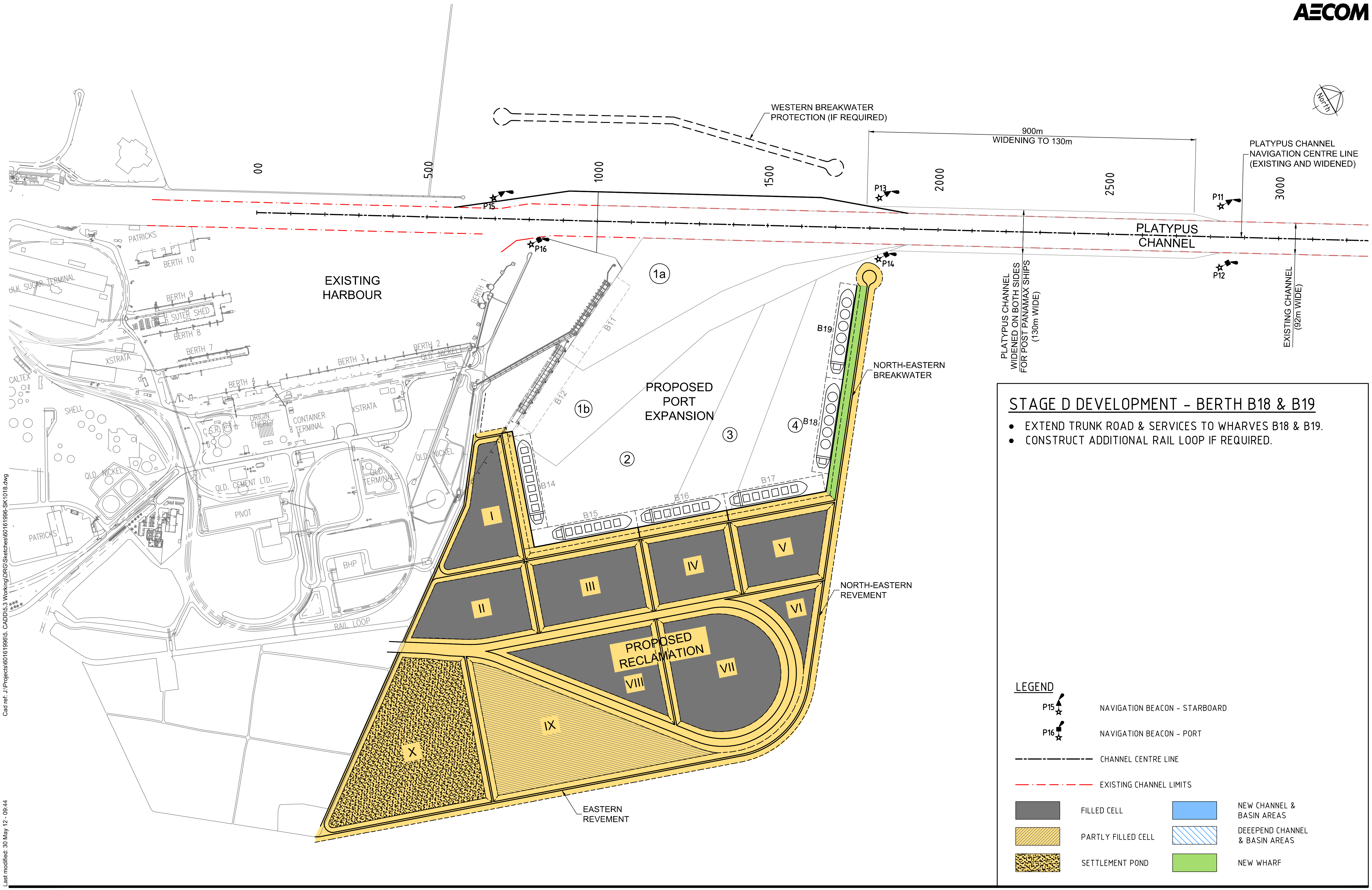
AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
PORT DEVELOPMENT STAGING
STAGE C
60161996-SK1017



STAGE D DEVELOPMENT - BERTH B18 & B19

- EXTEND TRUNK ROAD & SERVICES TO WHARVES B18 & B19.
- CONSTRUCT ADDITIONAL RAIL LOOP IF REQUIRED.

LEGEND

P15	NAVIGATION BEACON - STARBOARD
P16	NAVIGATION BEACON - PORT
—·—·—	CHANNEL CENTRE LINE
—·—·—	EXISTING CHANNEL LIMITS
■	FILLED CELL
▨	PARTLY FILLED CELL
▩	SETTLEMENT POND
🟦	NEW CHANNEL & BASIN AREAS
▨	DEEEPEND CHANNEL & BASIN AREAS
🟩	NEW WHARF

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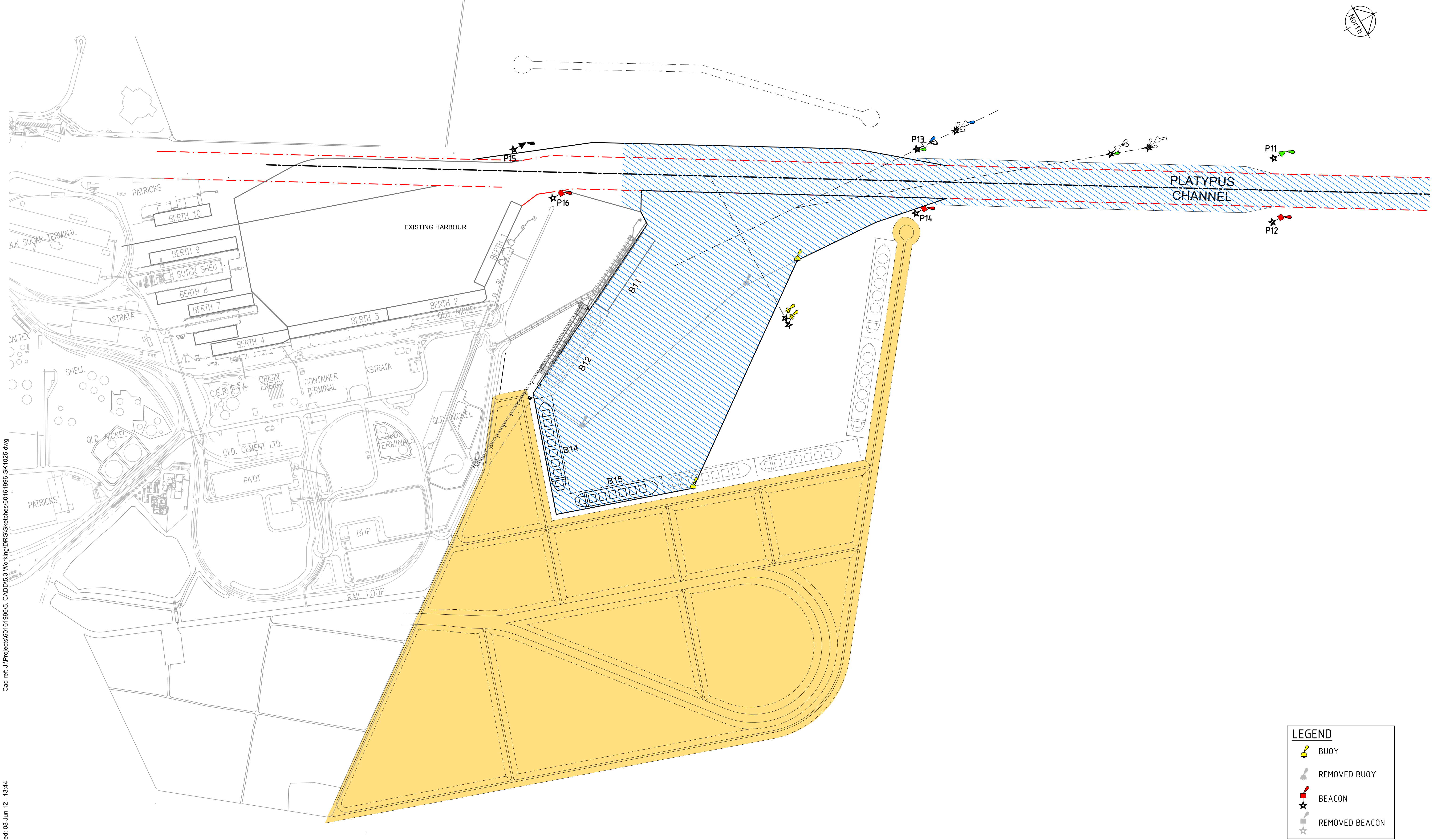
Last modified: 30 May 12 - 09:44

60161996
REV D

SCALE X 0 100 200 250m
1 : 10000 (A3) 1 : 5000 (A1)

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
PORT DEVELOPMENT STAGING
STAGE D
60161996-SK1018



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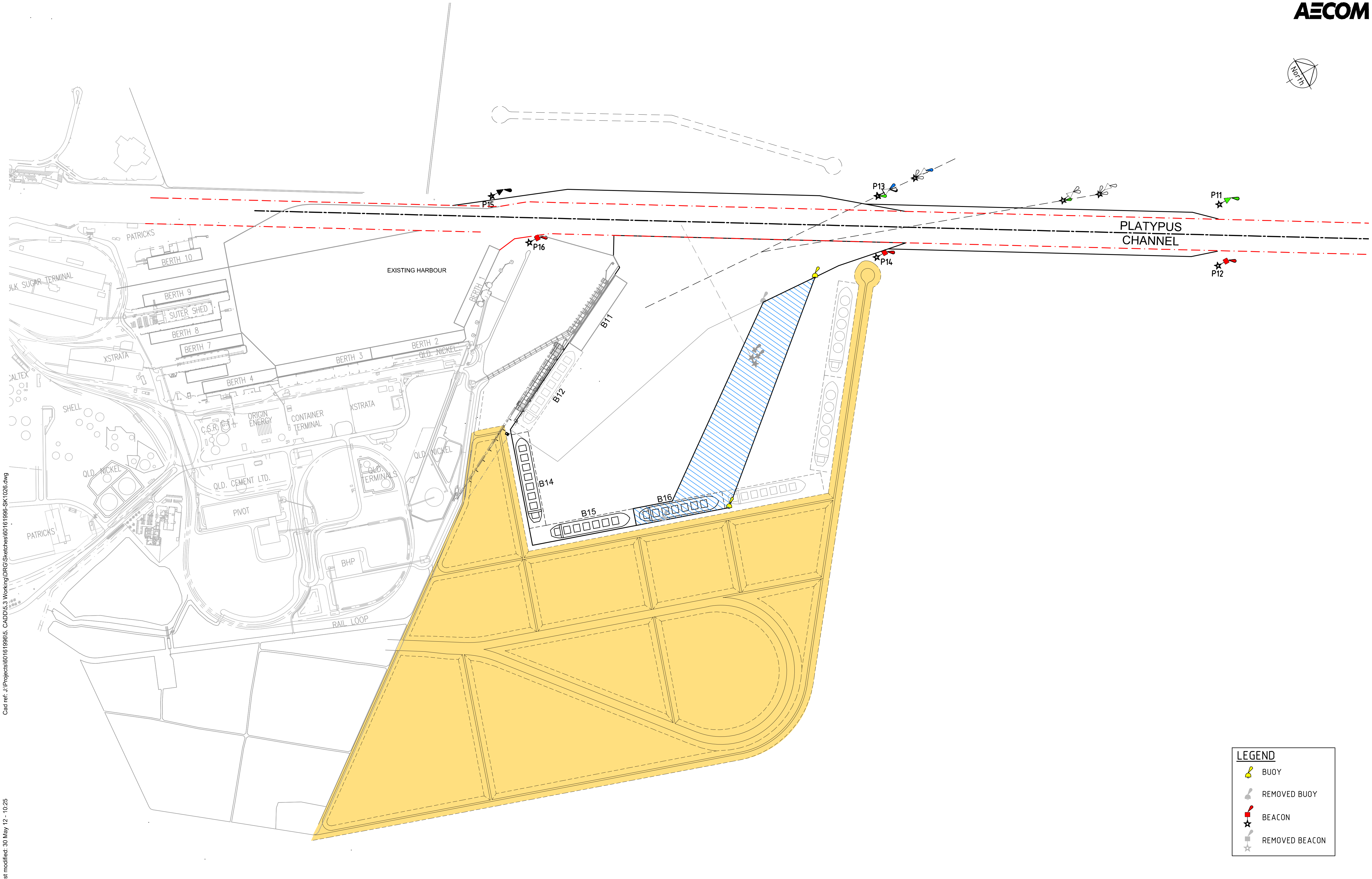
Last modified: 08 Jun 12 - 13:44

60161996
REV C

TOWNSVILLE PORT EXPANSION PROJECT
NAVIGATION ARRANGEMENT
HARBOUR STAGE A (B14+B15)
60161996-SK1025



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REV C

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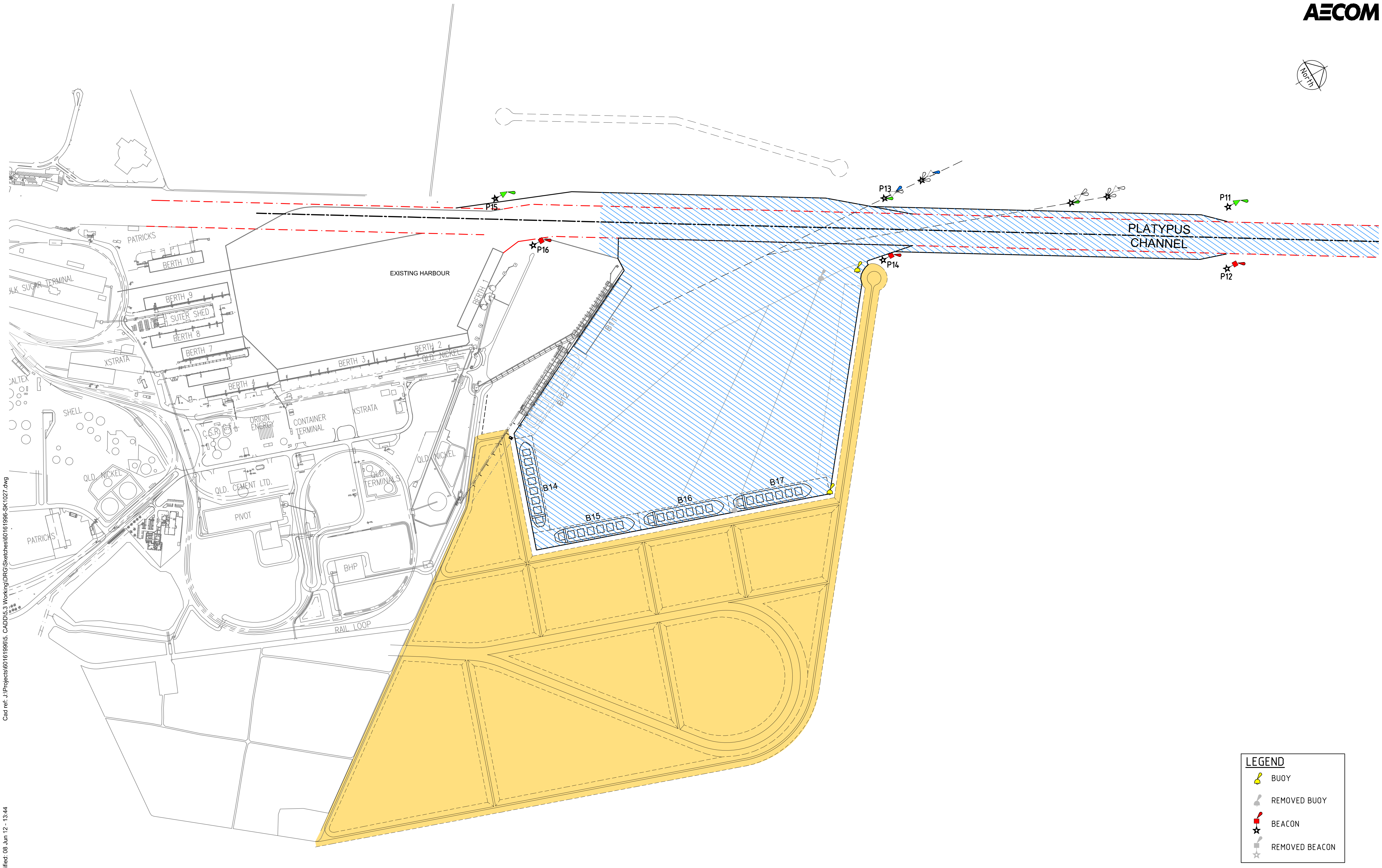
NAVIGATION ARRANGEMENT
HARBOUR STAGE B (B16)
60161996-SK1026



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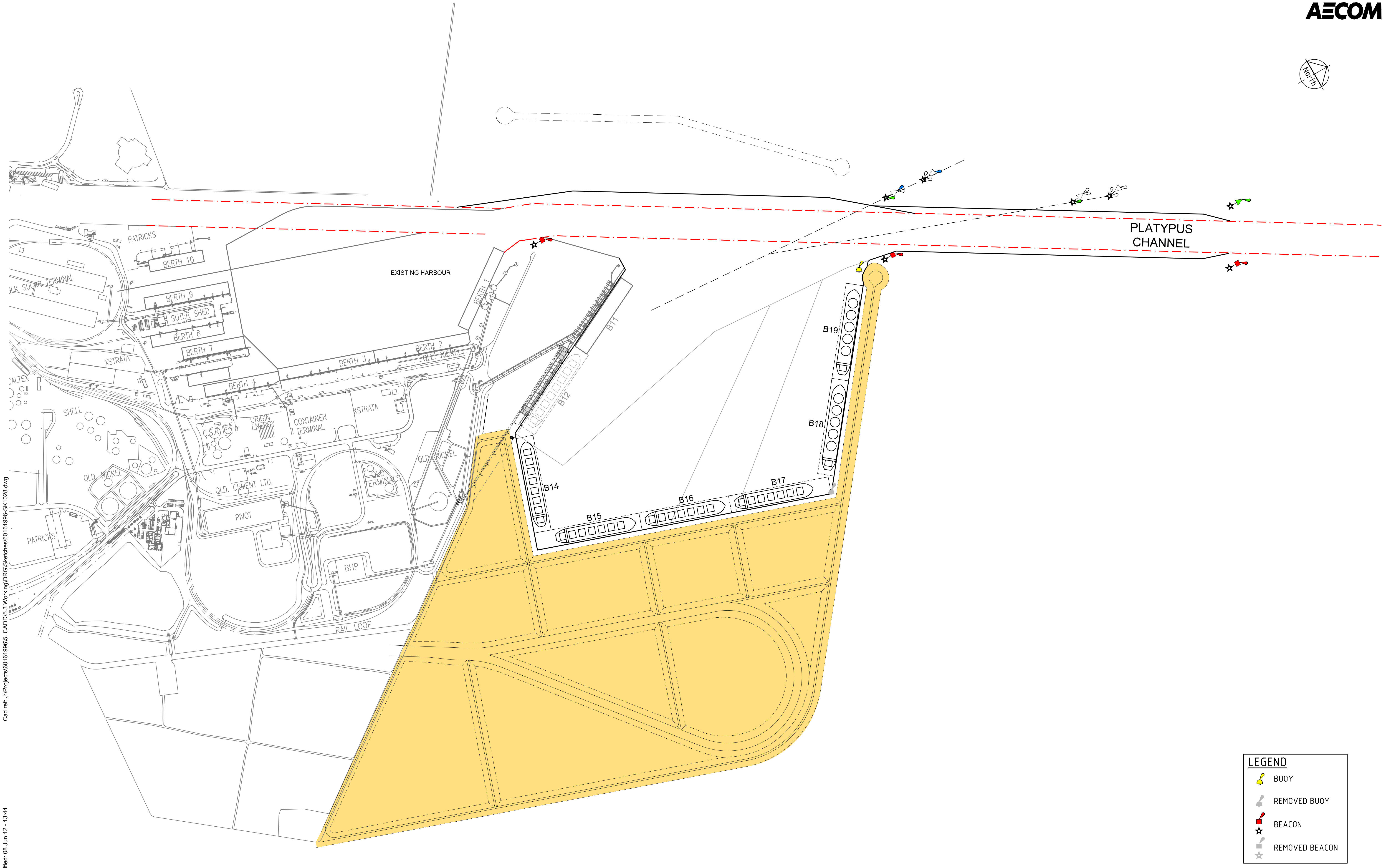
TOWNSVILLE PORT EXPANSION PROJECT
NAVIGATION ARRANGEMENT
HARBOUR STAGE C (B17)
60161996-SK1027



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NAVIGATION ARRANGEMENT
HARBOUR STAGE D (B18+B19)
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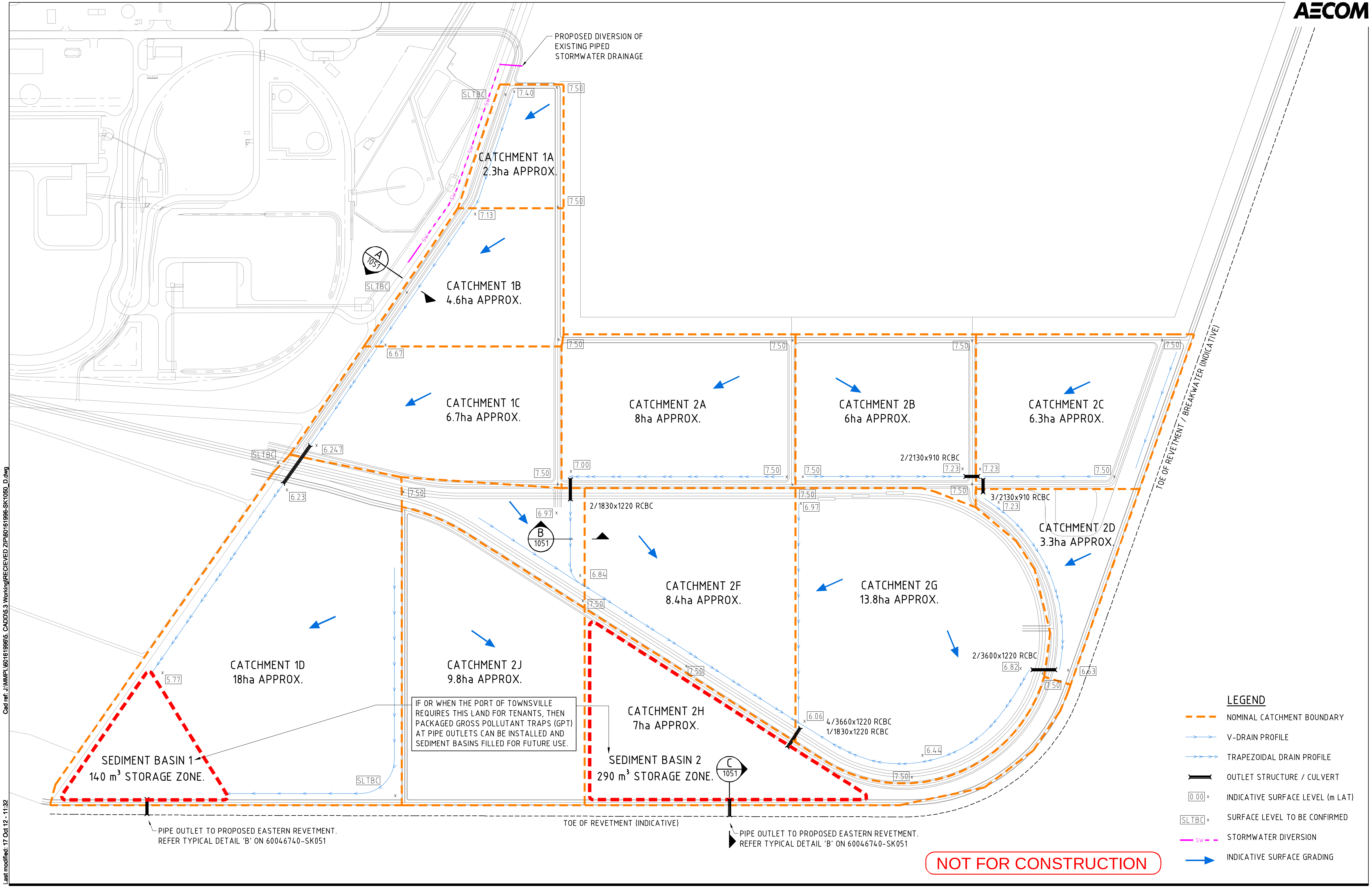

IF OR WHEN THE PORT OF TOWNSVILLE REQUIRES THIS LAND FOR TENANTS, THEN PACKAGED GROSS POLLUTANT TRAPS (GPT) AT PIPE OUTLETS CAN BE INSTALLED AND SEDIMENT BASINS FILLED FOR FUTURE USE.

NOT FOR CONSTRUCTION

60161996
REV D

SCALE Y 0 50 100 125m
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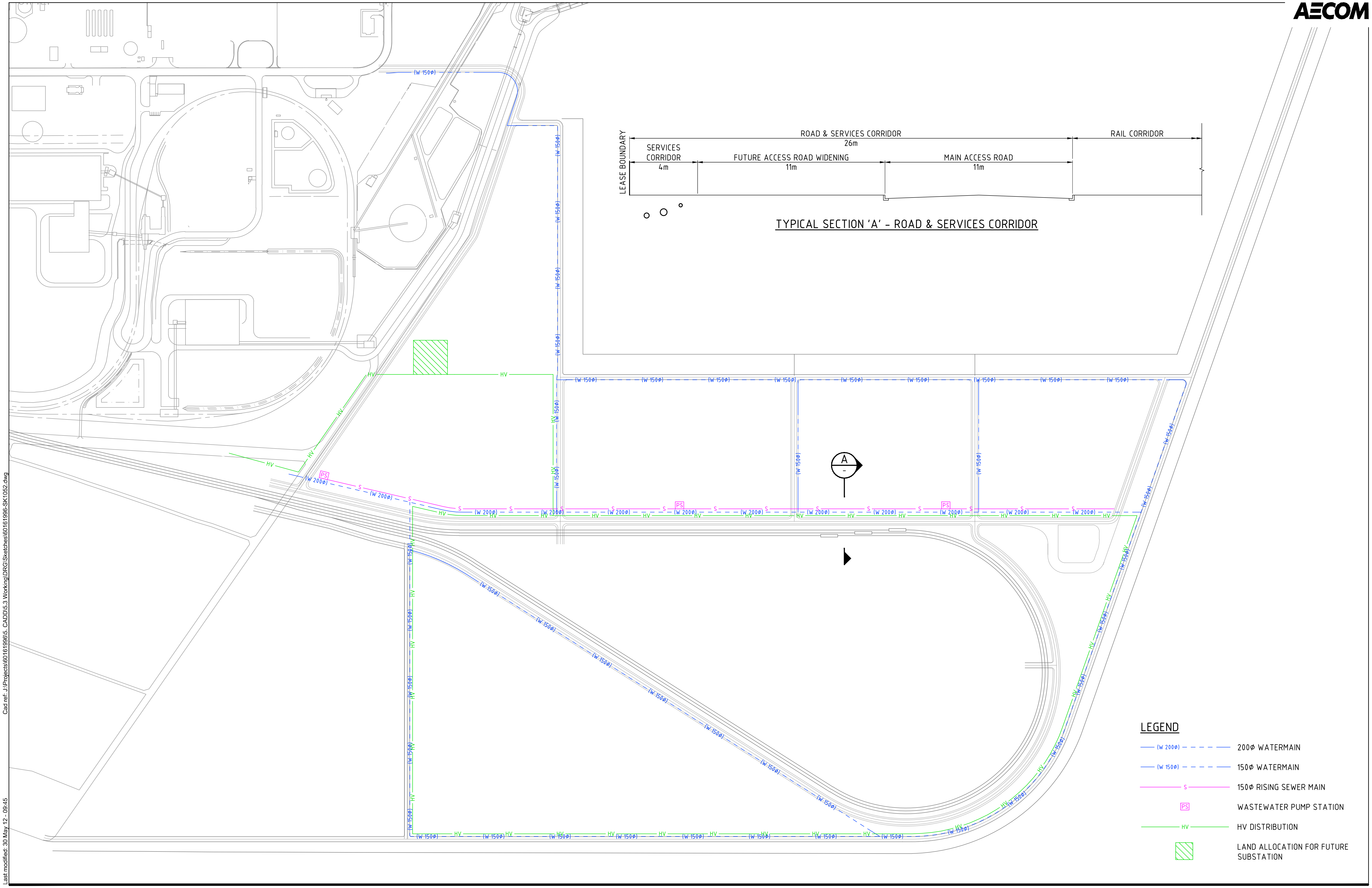
AECOM

PORT of TOWNSVILLE

TOWNSVILLE PORT EXPANSION PROJECT
CONCEPT DRAINAGE LAYOUT

60161996-SK1050



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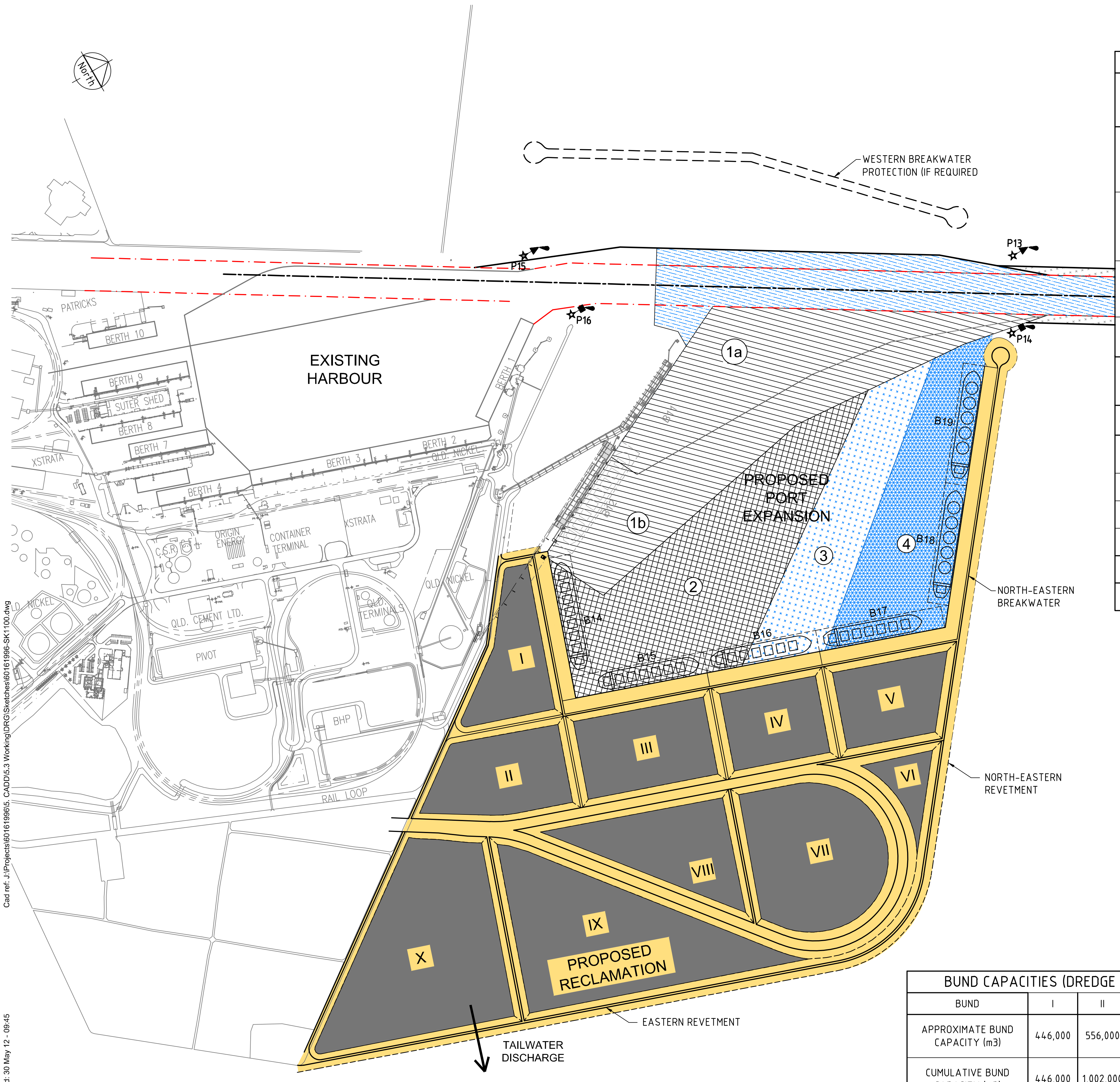
REV A

TOWNSVILLE PORT EXPANSION PROJECT
SERVICES INFRASTRUCTURE LAYOUT

60161996-SK1052



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OUTER HARBOUR DREDGING AND RECLAMATION STAGING

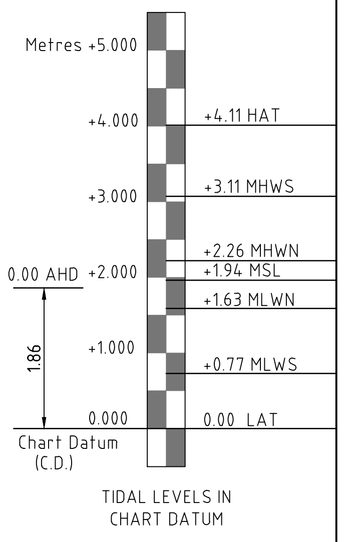
CONSTRUCTION CAMPAIGN	NAVIGATION DESIGN DEPTH (m CD)	AVERAGE DREDGE DEPTH (m CD)	BERTH POCKET DESIGN DEPTH (m CD)	NAVIGATION AREAS DREDGED	RECLAMATION / SETTLING POND AREAS	COMMENTS
STAGE A B14 & B15	-12.0	-12.7	-15.1	AREAS 1A & 1B DEEPENED NEW AREA 2	FILL I TO V, PART FILL VI, SETTLING VII,VIII,IX, X TAILWATER DISCHARGE X	RECLAMATION BUNDS & BKWTS CONSTRUCTED. CHANNEL DEEPEND TO DESIGN DEPTH -12.8m CD.
STAGE B B16	-12.0	-12.7	-15.1	NEW AREA 3	FILL VI, PART FILL VII, SETTLING VIII, IX, X TAILWATER DISCHARGE X	NONE
STAGE C B17	-12.9	-13.6	-15.1	AREAS 1 TO 3 DEEPENED NEW AREA 4	FILL VII & VIII, PART FILL IX, SETTLING IX, X TAILWATER DISCHARGE X	CHANNEL DEEPENED TO DESIGN DEPTH -13.7m CD. BERTH POCKETS DREDGED FOR B18 & B19.
STAGE D B18 & B19	-12.9	-13.6	-15.1	NO DREDGING	NO DREDGING	NO DREDGING

OUTER HARBOUR DREDGING WORKS

AREA	CONSTRUCTION CAMPAIGN	MAIN MATERIAL TYPES	INSITU VOL (m3)	REFERENCE DREDGE TYPE	RELOCATION
BASIN AREAS 2 TO 5	STAGES A TO C	SOFT SEDIMENTS	425,000	MECHANICAL DREDGE WITH HOPPER BARGES / SMALL TRAILER CUTTER SUCTION HOPPER DREDGE	OFFSHORE
BUNDS I TO X & BREAKWATER FOOTPRINTS	STAGE A	SOFT SEDIMENTS	1,056,000		
BASIN AREAS 1 & 2	STAGE A	STIFF/ VERY STIFF SANDY CLAYS, MEDIUM DENSE CLAYEY SANDS	1,849,000	CUTTER SUCTION DREDGE	RECLAMATION
BASIN AREA 3	STAGE B		816,000	CUTTER SUCTION DREDGE	RECLAMATION
BASIN AREAS 1, 2, 3 & 4	STAGE C		1,725,000	CUTTER SUCTION DREDGE	RECLAMATION

NOTE: INSITU DREDGE VOLUMES ARE CALCULATED FOR DESIGN DREDGE DEPTH WHICH INCLUDES AN ALLOWANCE FOR DREDGING AND SURVEY TOLERANCES.

DATUMS AND TIDAL DATA



CD IS EQUAL TO LAT AT TOWNSVILLE STANDARD PORT.

BUND CAPACITIES (DREDGE FILL TO +6.0m CD, SETTLEMENT PONDS IX & X TO +5m CD)

BUND	I	II	III	IV	V	VI	VII	VIII	IX	X
APPROXIMATE BUND CAPACITY (m3)	446,000	556,000	627,000	487,000	540,000	226,000	1,054,000	636,000	1,262,000	1,207,000
CUMULATIVE BUND CAPACITY (m3)	446,000	1,002,000	1,629,000	2,116,000	2,656,000	2,882,000	3,936,000	4,572,000	5,834,000	7,041,000

60161996
REV D

SCALE X 0 100 200 250m
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TOWNSVILLE PORT EXPANSION PROJECT
DREDGING AND RECLAMATION
PORT
60161996-SK1100

Port Expansion Project EIS

Appendix E3

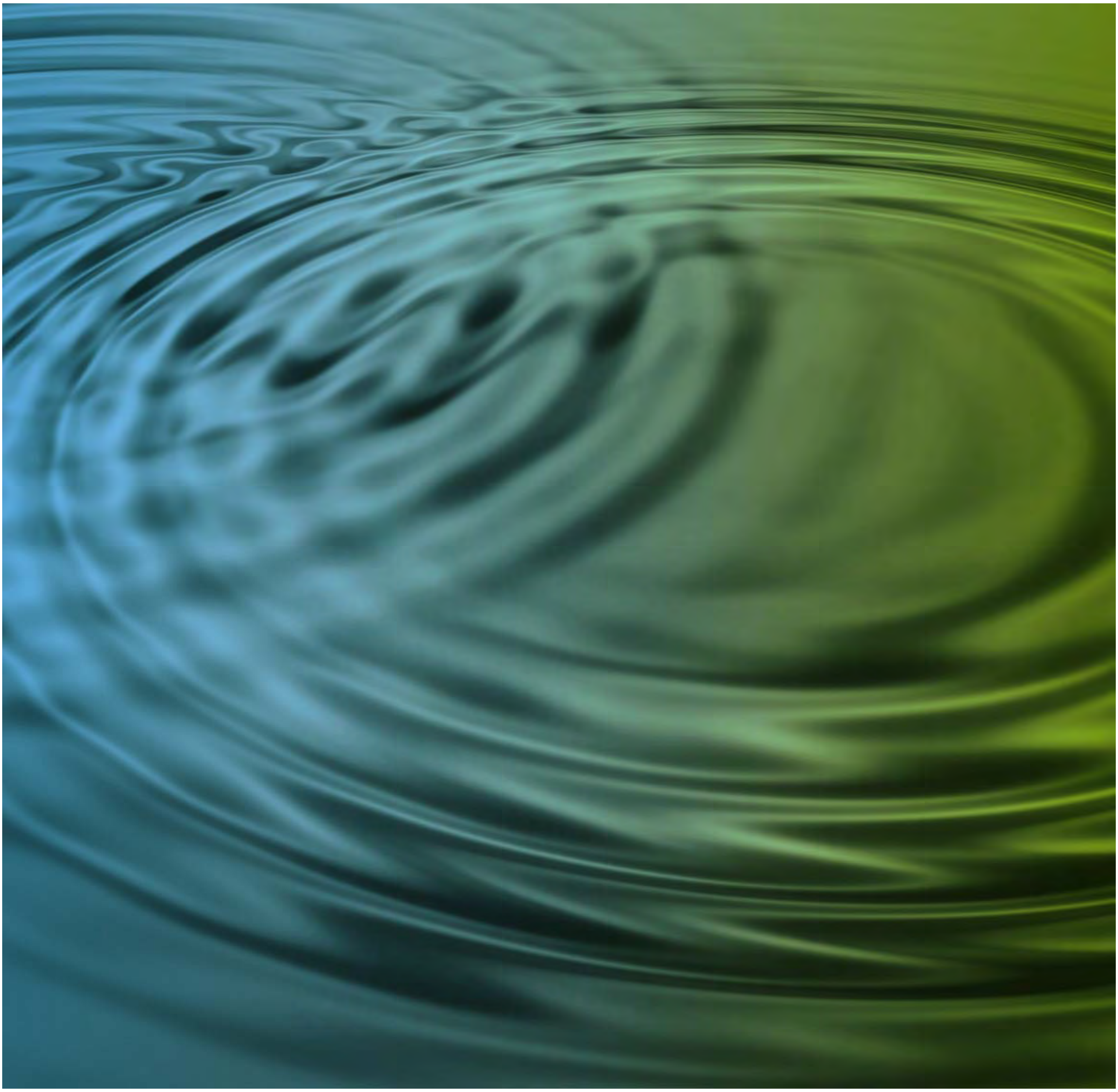
Wave Analysis Report

AECOM BMT WBM

Port of Townsville Limited
04 Oct 2012
Document No. 60161996-REP-Wave Analysis

Townsville Port Expansion Project EIS

Wave Analysis



Townsville Port Expansion Project EIS

Wave Analysis

Contract 648

Prepared for

Port of Townsville Limited

Prepared by

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04 Oct 2012

60161996

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Quality Information

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Prepared by	L Nielsen, S Aijaz, R Bonner, T Dam, S Bettington
Reviewed by	S Ward, N Ducray

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	1-Mar-2011	Draft for Information	Peter Burton Project Manager	
0	30-May-2012	Final Issue	Glenn Stephens Project Manager	
1	04-Oct-2012	Final Issue	Glenn Stephens Project Manager	

Table of Contents

1.0 Introduction

The purpose of this study was to provide wave data for the concept design of breakwaters and revetment structures for the proposed Port Expansion Project (PEP) (refer Figure 1-1), for purposes of determining:

- Structural stability of breakwaters and revetments during storm events.
- Crest levels of wharves, breakwaters and revetments and acceptable wave overtopping volumes for operational and structural requirements.
- Harbour calmness assessment for operational requirements.
- The berthing and mooring considerations during potential long wave events.

Figure 1-1 Proposed Port Expansion layout

The work comprised the transformation of offshore wave data measured near Cape Cleveland as well as extreme wave hindcast events (cyclone events) to the study site and within the harbour, to satisfy the tasks outlined above, using SWAN and Boussinesq wave generation and transformation models.

SWAN modelling was used for the regional transformation of waves that approach from the north-east (NE) and north-west (NW) to the study site. The two-dimensional Boussinesq model, developed as part of the Preliminary Engineering and Environment Study (PEES), was used to identify the wave climate within the harbour and to assist in developing the design wave criteria for the breakwaters and revetments. The following tasks were undertaken as part of the offshore wave transformation:

- Develop SWAN wave models to include influences of features such as the dredged shipping channel.
- Calibrate and validate SWAN models using wave data collected during PEES.
- Propagate waves from the NE using offshore Department of Environment and Heritage Protection (EHP) Waverider buoy data.
- Propagate waves from the NW using wind hindcasting techniques within the SWAN modelling suite.

The following tasks were undertaken as part of the nearshore, short wave assessment:

- Wave output from the SWAN models was used as input to the fine grid (10m x 10m) BOUSS2D model, which was capable of assessing wave refraction, diffraction and reflection processes that are prominent in the near-shore as waves propagate over the dredged shipping channel and through the harbour entrance.
- Harbour calmness for shipping operations was assessed using prevailing wave climate parameters from the NE and NW sectors and compared with acceptable vessel operating criteria to estimate the annual average down time and/or the frequency of disruption to vessel operations.

The following tasks were undertaken as part of the nearshore, long wave assessment:

- Analysis of existing wave data to identify if any long wave activity is present within Cleveland Bay.
- General assessment of the susceptibility of the proposed harbour configuration to seiching.

2.0 Site Data

2.1 Location

The Port of Townsville is located on the western shores of Cleveland Bay, North Queensland, and is accessed by shipping to deep water by the Sea and Platypus channels (refer Figure 2-1).

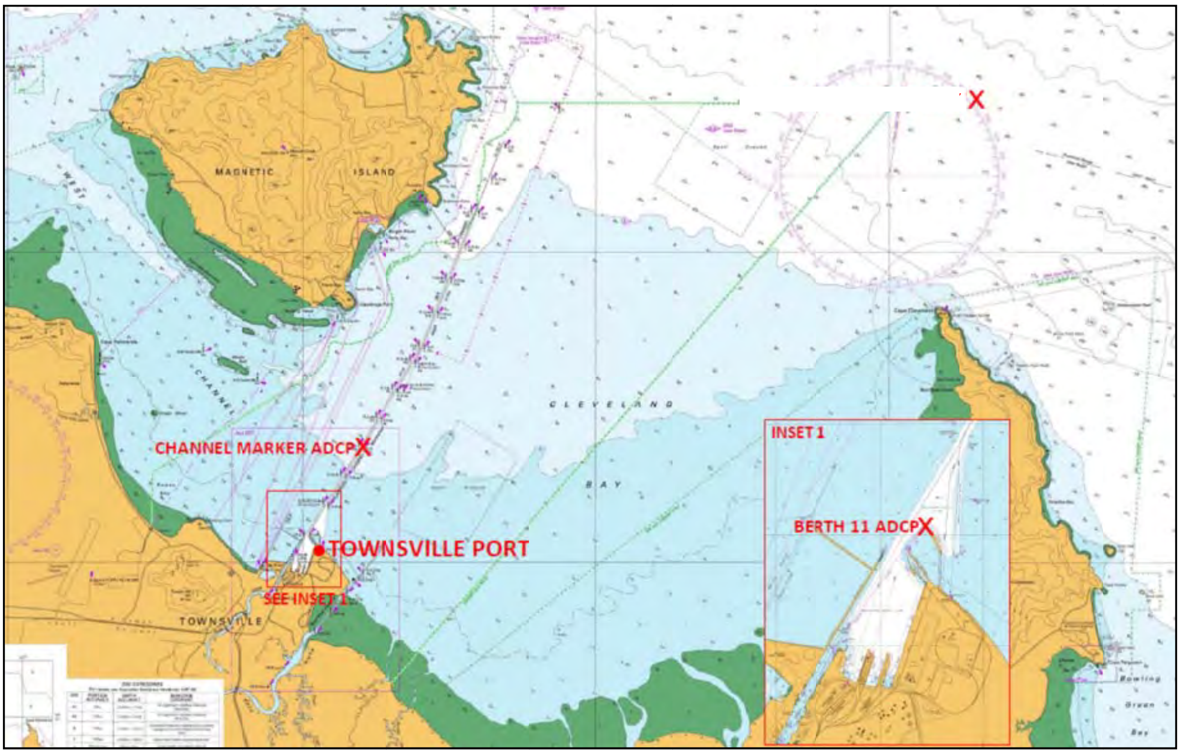


Figure 2-1 Port of Townville and the location of EHP Waverider buoy

2.2 Tidal Planes

The Port of Townsville Datum is 1.856m below Australian Height Datum (AHD). The key tide levels in relation to Port Datum (Lowest Astronomical Tide - LAT) are shown in Table 2-1. The port has a complex tidal regime with a large difference in the tidal range for spring and neap tides. The spring tidal range is 2.34m and the neap range is 0.63m. The location of Townville is between diurnal and semidiurnal tide zones, the semidiurnal tides are the more dominant type.

Table 2-1 Tidal levels relative to Townsville Port Datum (Semidiurnal Tidal Plane)

Tidal Planes	Level to LAT (m)
Highest Astronomical Tide (HAT)	4.11
Mean High Water Springs (MHWS)	3.11
Mean High Water Neaps (MHWN)	2.26
Mean Sea Level (MSL)	1.94
Mean Low Water Neaps (MLWN)	1.63
Mean Low Water Springs (MLWS)	0.77
Lowest Astronomical Tide (LAT) (Port Datum)	0.00

Source: Semidiurnal Tidal Planes, Queensland Tide Tables 2011, Maritime Safety Queensland

2.3 Tidal Currents

The Port Procedures Manual - Townsville (MSQ, July 2010) explains that Cleveland Bay is filled from the NE with flood tides, resulting in tidal currents across the entrance of the harbour in a westerly direction of up to 0.5 knots. This effect is reversed during ebb tides, however, with less noticeable cross currents.

Except for periods of slack water, there are tidal flows across the direction of the access channel. This occurs especially near the breakwater entrance, which affects navigational access to Berth 11. When vessels enter or leave the inner harbour, allowance needs to be made for the cross currents, but they do not restrict traffic movements.

However, at Berth 11, which is in effect in an open seaway and has limited manoeuvring room, vessels are not berthed on a flood tide because of the currents. Effectively there is a shut out period for berth access approaching 50% each day when the flood tide flows with reasonable strength across the berth area. The ebb tide effect has a reduced impact as it is deflected by the port’s western breakwater and vessels can be berthed at any time.

2.4 Bathymetry

Bathymetric data was required for preparation of a digital model of the seabed and coastline over a large region of coastline near and far from Townsville. More detail was required nearer Townsville, within Cleveland Bay, than further away where coarser model grids were used. Hence the bathymetry of the study area has been based on the following Australian Admiralty Charts and data:

- Nautical chart AUS 256: Cleveland Bay and Approaches.
- Nautical chart AUS 827: Cape Bowling Green to Palm Isles.
- Geosciences Australia digital data on 1km grid to datum AHD.
- Charts AUS 256 and AUS 827 were digitised and adjusted to AHD from lowest astronomical tide (LAT) datum using a difference of 1.8m, which is applicable in the Townsville region. While this parameter varies over the wave model area, the value adopted relates more closely to Townsville tides than tides at more distant locations.
- Digital elevation model developed by BMT WBM (2009), the data being available on a rectangular grid of size 50m.

2.5 Wind

Townsville is an all weather port other than during specific events during the cyclone season, which extends from 1 November through to 1 April each year. The wind conditions for the wet season (October to April) are dominated by winds from the SE to east direction throughout the day. During the dry season (May to September) the morning conditions are relatively calm with light winds mainly from the south to SE direction, with stronger NE winds picking up in the afternoon.

For wave modelling (Appendix A), hindcast wind parameters for locations offshore of Cape Cleveland and the Great Barrier Reef were obtained from the global wave model, AUSWAM, developed by the Australian Bureau of Meteorology (BoM).

2.6 Waves

2.6.1 Introduction

The wave climate relevant to port operations comprises swell waves, locally-generated wind waves and long (infragravity) waves.

The deepwater swell waves are altered by refraction and shoaling as they cross Cleveland Bay to the area seaward of the Port of Townsville breakwaters. Typically, they have wave periods of around 7 to 10 s.

The wave climate closer to the port is dominated by local wind generated waves ($T < 6$ s). Wave heights with short wave periods do not have a large impact on commercial shipping either during navigation or for cargo handling operations under normal weather conditions.

The wave climate during cyclone events is far more severe and the port has an evacuation plan to deal with these conditions.

Infragravity waves can be generated within Cleveland Bay by the shoaling and dissipation of swell wave sets, which occurs during storms. Typically, such waves have periods of around one to three minutes (60 to 200 s). The presence of these waves has the potential to cause harbour resonance.

2.6.2 Offshore Wave Data

Wave data is provided by the Queensland Department of Environment and Heritage Protection (EHP) from their Cape Cleveland Waverider buoy installation (Figure 2-1). Data has been recorded in a depth of about 20m AHD since July 1975. Initially, only two records per day were recorded. Since 12 October 2000 data has been recorded at hourly intervals and includes wave direction (magnetic north) for the peak spectral ordinate.

The Waverider buoy data has been analysed and time series of wave parameters (H_s, T_z and direction) for both sea and swell energy bands have been prepared (CLT, 2009). This task was undertaken only on the basis of the directional Waverider buoy data because the more recent data provided an opportunity to prepare time series of sea and swell directions more reliably. Including the older less frequent data records would have contaminated the better data set. Although eight years of data was available, peak direction was provided only for a period from 2000 to 2004. Nevertheless, this provided a reliable operational wave climate data base. A wave height rose is presented in Figure 2-2.

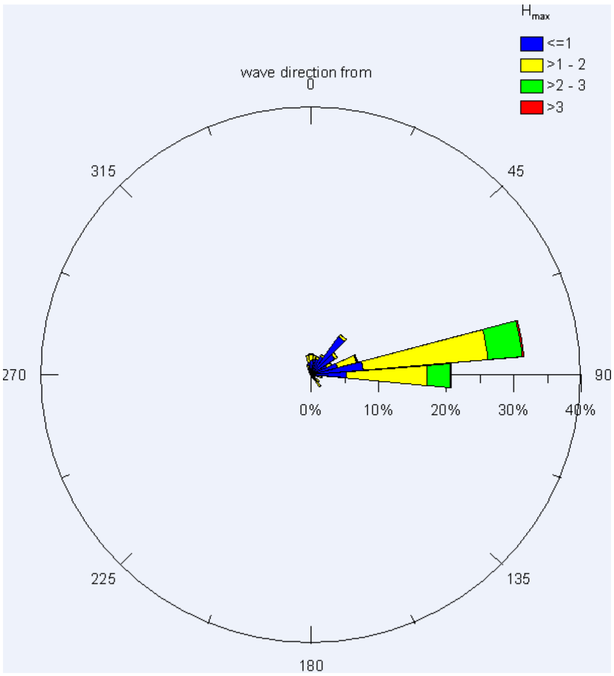


Figure 2-2 Cleveland Bay Waverider buoy wave height rose (EHP)

In their report, CLT (2009) indicated that, generally, larger waves emanated from the east and occasionally from the north. Longer period waves emanated mainly from the north.

In addition to Waverider buoy data, other wave data was also obtained from the WaveWatch III system operated by NOAA. About eleven years of data from a deep water location (18.0°S; 148.75°E) seaward of the Great Barrier Reef at Townsville was analysed by CLT. This data included H_s, T_z and direction, as well as ocean wind speed and direction. This data demonstrated that offshore waves, which would propagate to Townsville as swell, typically have a direction of east-south-east during the SE trade season.

The probability of exceedance analysis was undertaken by CLT (2009) using the Waverider buoy data from 1975 to 2008. Over these 34 years the data was sampled at various time steps: that is, the data was recorded every 12 hours from 1975 to 1982, then on a 3-hourly basis from 1982 to the end 1991, then on an hourly basis from 1992 to 2000 and finally on a half-hourly basis from 2001 to 2008.

Figure 2-3 presents the probability of exceedance in terms of the significant wave height for the 1975-2008 and 2001-2008 periods. Probability of exceedance calculation was undertaken considering each record as an event.

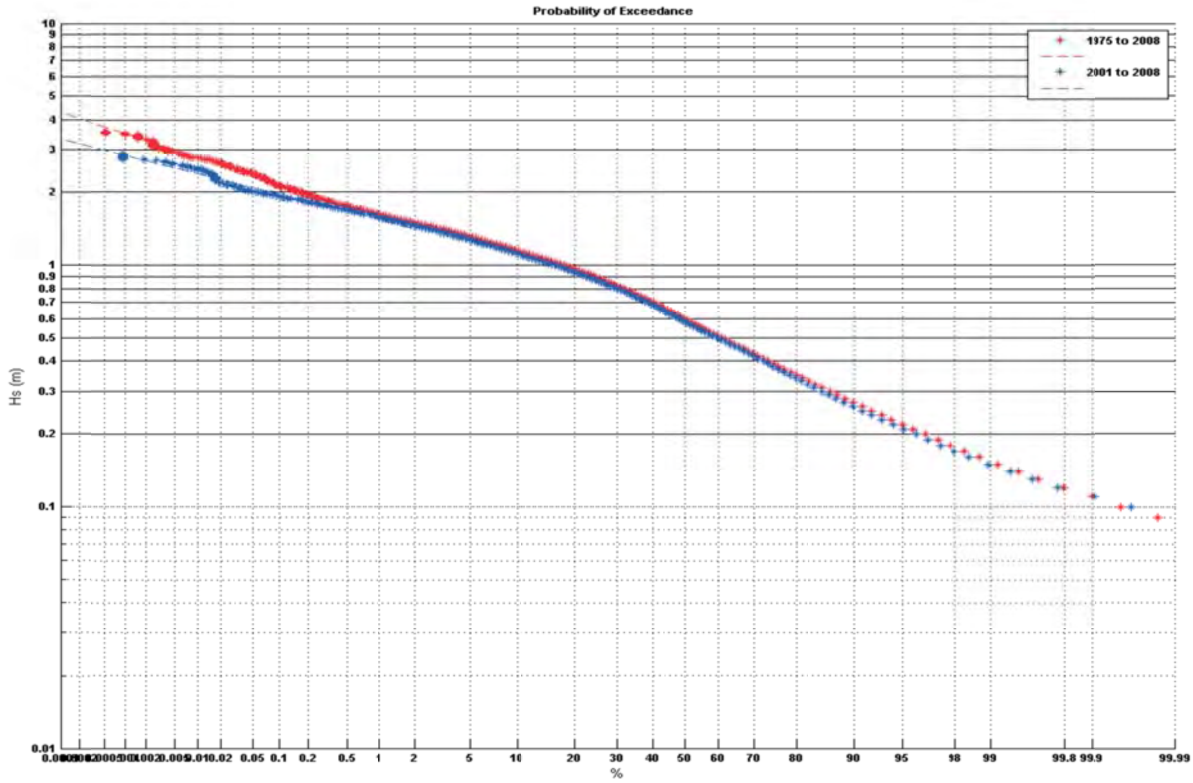


Figure 2-3 **Probability of exceedance in terms of the significant wave height (EHP Waverider buoy data 1975-2008)**

The wave persistence and event duration analysis was undertaken using the half hourly data record from 2001-2008. Results are presented in Table 2-2. The ARI in terms of the significant wave height for selected event durations (that is, 1hour, 6hours, 12hours, 24hours, 48hours and 72hours) were calculated based on the EHP Waverider buoy data from 1992 to 2008 (hourly records). The number of events exceeding a threshold for a selected duration was converted into an average return period.

Figure 2-4 describes the ARI versus duration relationship for the 1hour, 6hours, 12hours, 24hours, 48hours and 72hours wave event duration cases. The EHP Waverider buoy data showed that, for instance, the 100 years ARI significant wave height for 6hours storm duration is around 3.0m.

Table 2-2 **Wave persistence and event duration for the EHP Waverider buoy data 2001-2008 (CLT 2009)**

H_s (m)	Number of events per annum (1/2 hourly record)	Number of events per annum (Duration ≥ 1 hr)	Number of events per annum (Duration ≥ 6 hrs)	10% Duration (hrs)	Average duration (hrs)	90% Duration (hrs)
0.25	152.0	140.9	108.5	1.0	58.3	156.0
0.50	211.3	190.5	132.4	1.0	28.1	71.0
0.75	188.7	170.1	111.3	1.0	18.6	47.0
1.00	160.2	141.4	79.4	1.0	10.4	22.5
1.50	34.7	29.3	8.6	0.5	4.6	11.1
2.00	1.9	1.5	0.2	0.9	3.0	7.2
2.50	0.3	0.2	0.2	0.5	3.8	7.0
3.00	0.0	0.0	0.0	0.0	0.0	0.0

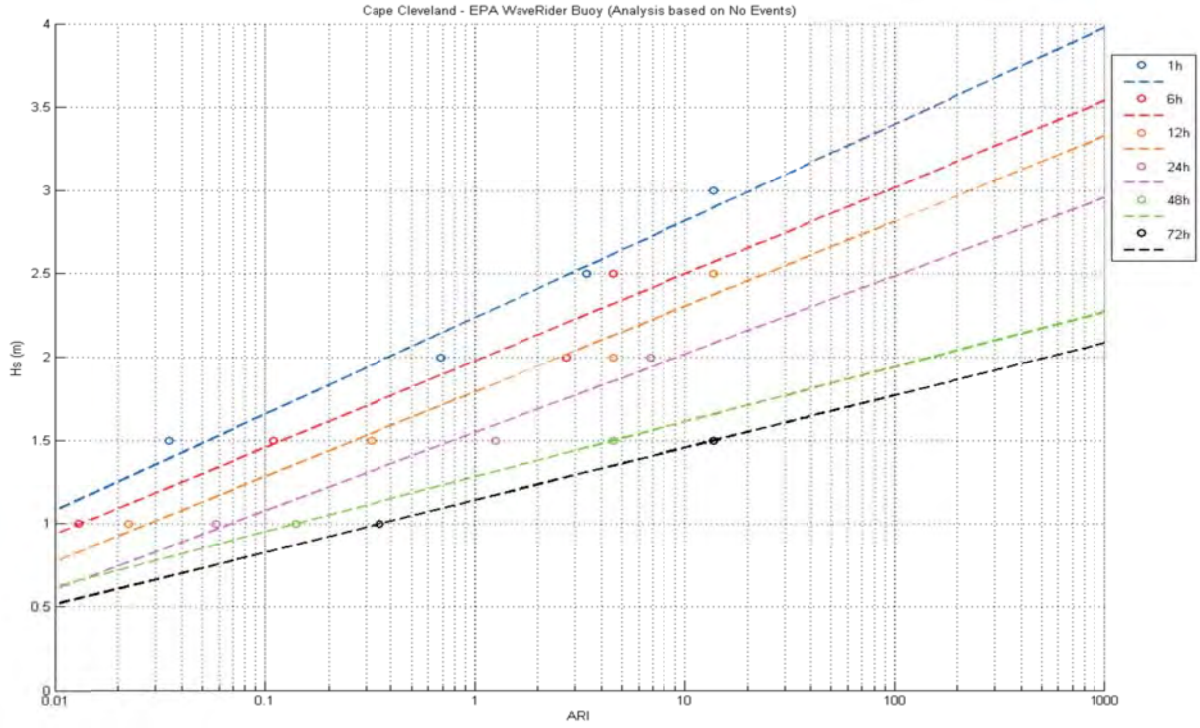


Figure 2-4 Average return period in terms of the significant wave height (EHP Waverider buoy data 1975-2008)

2.6.3 Nearshore Wave Data

Wave data were available at two nearshore locations from the deployment of Acoustic Doppler Current Profilers (ADCP), which were used for model validation and for the investigation of long wave processes. The locations were:

- At a starboard channel marker for the Platypus Channel at a depth of 5.5m CD (Figure 2-1) from September 2008 to February 2009 (Appendix A).
- At the northern mooring dolphin of Berth 11 located outside the eastern breakwater of the port (see Figure 2-1, inset), intermittently from March 2006 to March 2007 (Appendix B).

These data have been used extensively for the validation of the numerical wave transformation modelling (Appendix A and Appendix B) and for the assessment of infragravity waves.

There have been no nearshore measurements made of any severe or extreme wave conditions emanating from the westerly direction.

2.6.4 Long (Infragravity) Waves

Long (infragravity) waves with periods of several minutes can be generated within Cleveland Bay during storms. These waves result from the energy dissipation of swell wave sets on spending beaches around the Bay. Depending upon harbour geometry, such long waves can cause harbour resonance, which may have adverse impacts on shipping operations and berthing conditions.

During a storm that occurred on 13 January 2009, some sea surface displacement data were captured near the port at the starboard channel marker for the Platypus Channel at a depth of 5.5m CD. While the record lengths available for long wave analysis were somewhat short at 17 minutes (ideally, for long waves a record length of 68 minutes is desirable), several records, both storm and non-storm, were analysed for long wave frequencies. The results are presented in Figure 2-5.

The data show that, during the storm of 13 to 14 January 2009, long wave energy was found to peak at frequencies of around 0.006 Hz (170s), 0.009 Hz (110s) and 0.013 Hz (80s) (Figure 2-5`). Long wave heights were in the order of 10cm. These conditions were generated by this storm, which had a *significant* wave height of

1.5m of duration around 37hours. This has a recurrence interval of 2 years (Figure 2-4). Other storm conditions have yet to be investigated.

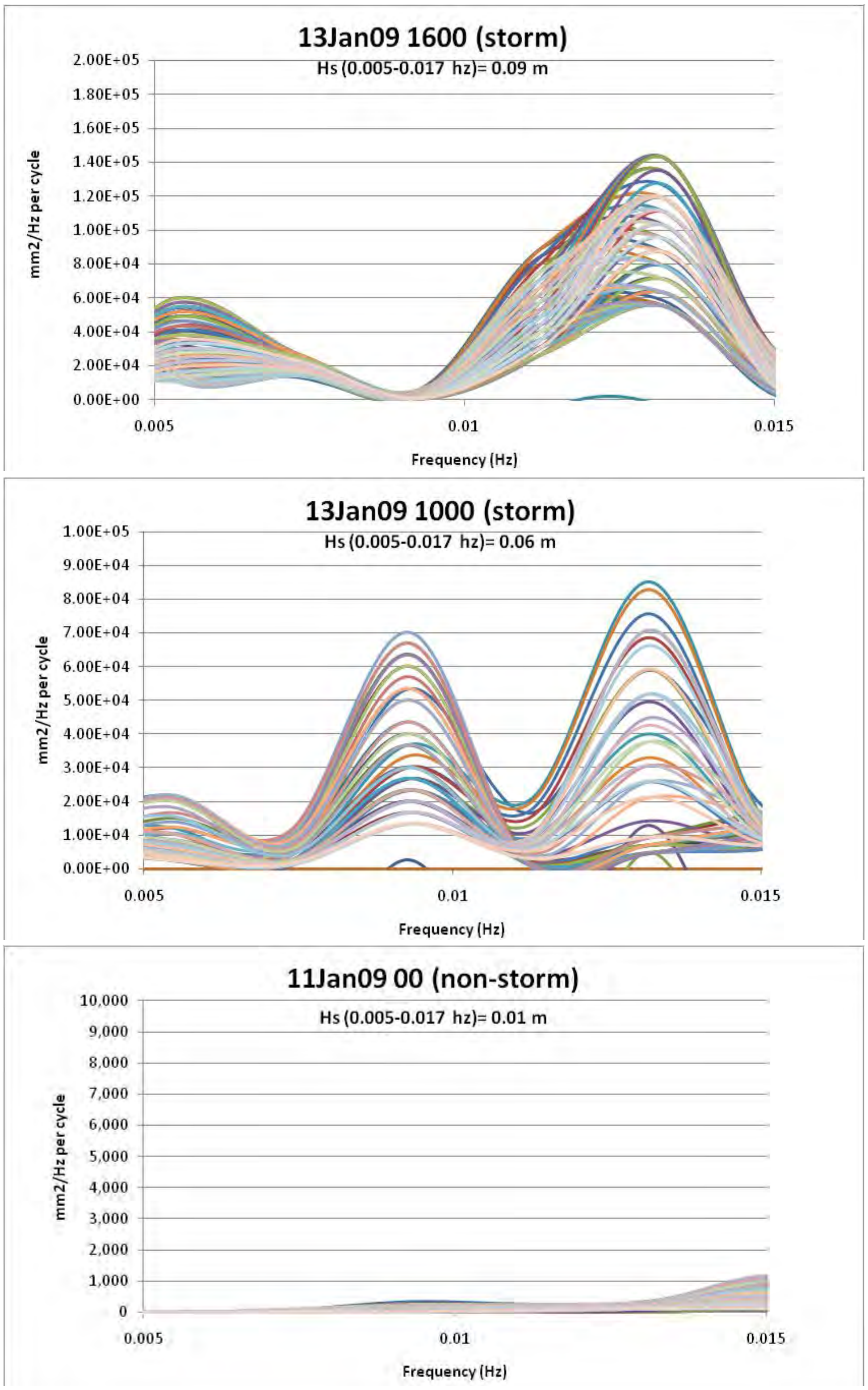


Figure 2-5 Infragravity wave spectra during storm conditions (top & middle) and non-storm conditions (bottom)

3.0 Wave Assessment for Port Development

3.1 Wave Limitations for Cargo Operation

Indicative limiting wave heights for cargo operations are presented in Table 3-1. Generally, for beam seas, limiting wave heights for cargo operations are from 0.8m to 1.4m. For head seas, the limiting wave heights are higher, ranging from 1m to 2m. These limiting wave heights are for waves of periods 7s or greater, which have a wavelength of around 80m in around 15m water depth. This wavelength is large compared with the vessel beam (28m to 32m) and, therefore, could cause the vessel to roll. Waves with shorter periods and, hence, wavelengths would have a reducing impact on vessels.

Table 3-1 Limiting Wave Heights for Cargo Operations (Wave period range 7 to 12 seconds) (Thoresen, 2003)

Wave Direction to Vessel	Vessel Type	Limiting Wave Height (H_s) (m)
Head or stern on - 0°	General cargo vessels	1.0
	Container and Ro-Ro	0.5
	Dry bulk (30,000 - 100,000 DWT) - loading	1.5
	Dry bulk (30,000 - 100,000 DWT) - unloading	1.0
	Tankers (30,000 DWT)	1.5
	Tankers (30,000 - 200,000 DWT)	1.5 - 2.5
45° - 90°	General cargo vessels	0.8
	Dry bulk (30,000 - 100,000 DWT) - loading	1.0
	Dry bulk (30,000 - 100,000 DWT) - unloading	0.8 - 1.0
	Tankers (30,000 - 200,000 DWT)	1.0 - 1.2

Acceptable limiting wave conditions adopted for this environmental impact assessment were H_s = 1m for head seas and H_s = 0.8m for beam/quartering seas for waves with periods 7s to 12s.

For shorter wave periods, these limiting wave heights decrease. Once the wavelength becomes smaller than the ship's dimensions, the ship will no longer respond to the wave pressures. For beam seas, therefore, the limiting wavelength would be around 32m, which approximates the beam of the design ships (Panamax) and of those of the 28,000 to 55,000 DWT cargo vessels currently using the port (27m to 32m). This wavelength would correspond to a wave period of 4.5s. Therefore, waves of period 4.5s or less would not disturb operating conditions within the port.

3.2 Nearshore Wave Transformation Processes

Waves approach Cleveland Bay from a narrow range of easterly offshore directions (Figure 2-2). The Platypus Channel and the dredged configuration for Berth 11 are of such orientation and of such dimensions that they cause wave reflection, as depicted in Figure 3-1, which is evidenced by available wave data, photographs taken during storm events (Figure 3-2) and on vertical aerial photographs (Figure 3-3).

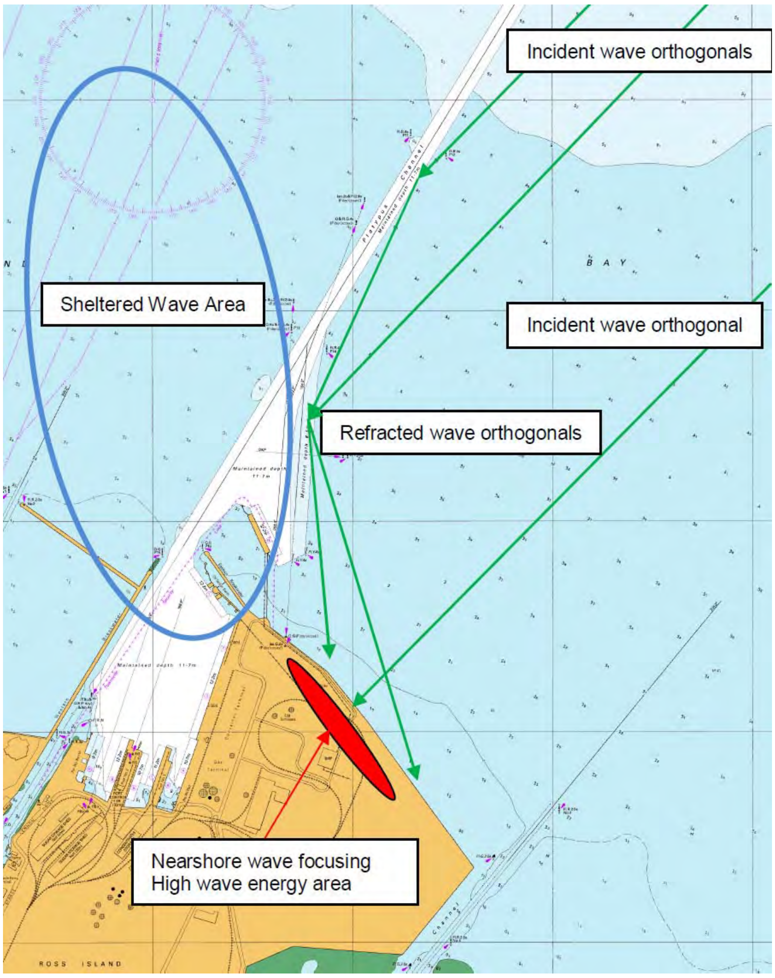


Figure 3-1 Diagram depicting wave orthogonal reflection off the dredged channels

These wave reflection characteristics of the Platypus Channel and Berth 11 dredged configuration have been investigated in detail in Appendix B. They are critical for the proper evaluation of nearshore wave conditions for the assessment of requisite armour stone grading for breakwaters and revetments and for the assessment of harbour calmness.

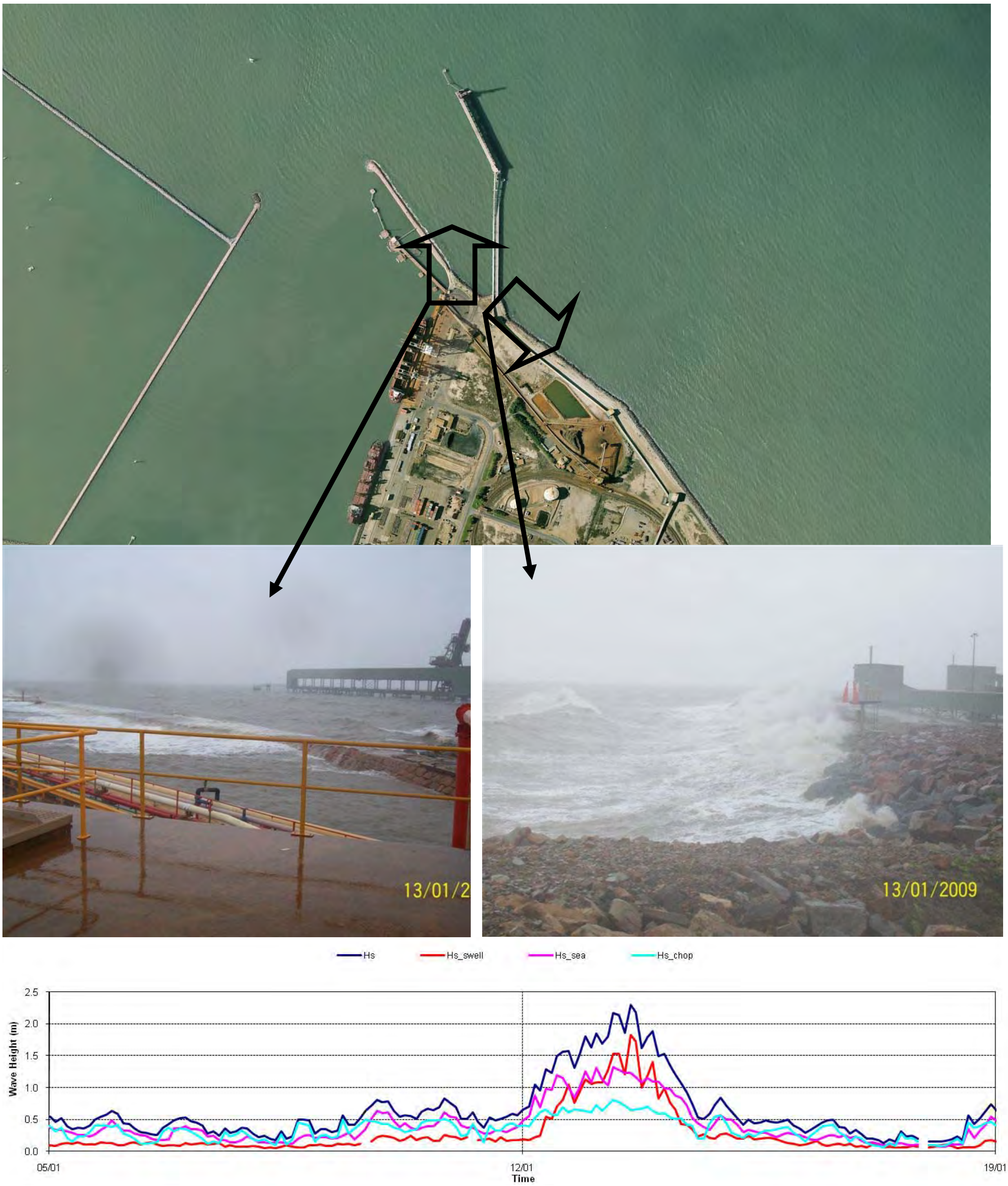


Figure 3-2 For a storm on 13/1/2009, photographs showing the wave conditions at and behind Berth 11, on the reclamation revetment and incident wave heights measured at the ADCP site adjacent to the Platypus Channel

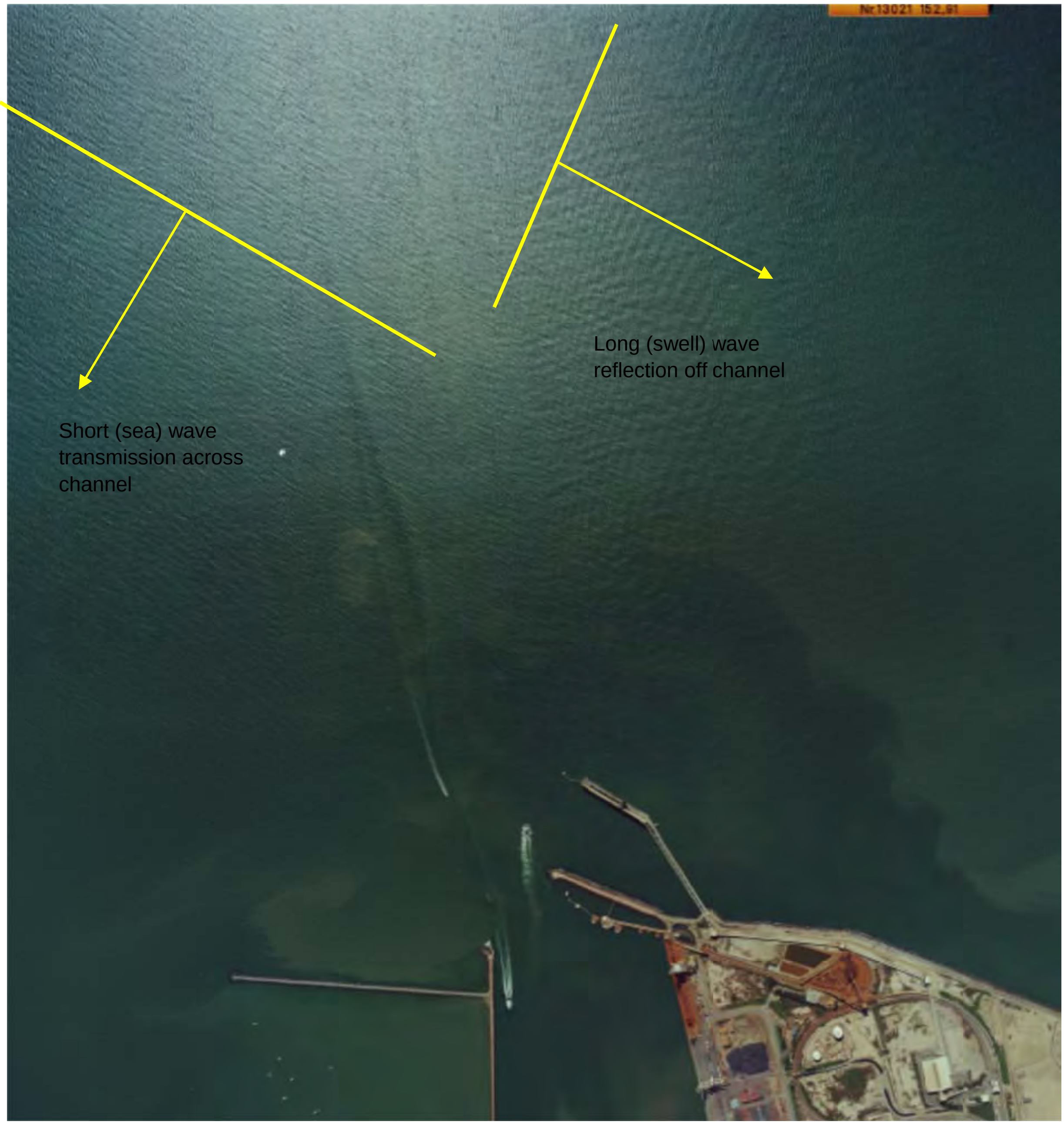


Figure 3-3 **Aerial photograph 31 May 2006 depicting swell wave reflection off the dredged channel and short sea transmission across the channel (photo courtesy AAMH)**

3.3 North-Easterly Wave Conditions

3.3.1 Existing Conditions at Berth 11

For NE wave conditions, the existing dredged channel and basin configuration affords wave sheltering at Berth 11 for waves of periods around 6s or greater. Here the wave height coefficient for incident waves, as measured at the Waverider buoy and at the northern-most mooring dolphin for Berth 11, is around 0.44 (Appendix B). For an acceptable quartering sea of 1.0m, say, the wave height at the Waverider buoy would need to be 2.3m. Such wave conditions may be exceeded some 0.05% of the time (Figure 2-3), which equates to some 4hrs per year on average. For unacceptable wave height duration of 6 hours for these conditions, say, the Recurrence Interval would be 4 years (Figure 2-4). This indicates that operational conditions existing at Berth 11 are acceptable for dry bulk out-loading, which raises the possibility of providing the requisite sheltered operational conditions at the proposed developed berths utilising a designed dredging configuration in *lieu* of another northern breakwater.

3.3.2 Wave Conditions for the PEP development

Nearshore wave conditions for the PEP have been derived using the validated BOUSS2D model (Appendix B). Wave height coefficients for the northern breakwater, reclamation revetment and berths, as outlined in Figure 3-4, are presented in Figure 3-5, Figure 3-6 and Figure 3-7.

Figure 3-4 Locations of wave height coefficients presented in Figure 3-5, Figure 3-6 and Figure 3-7

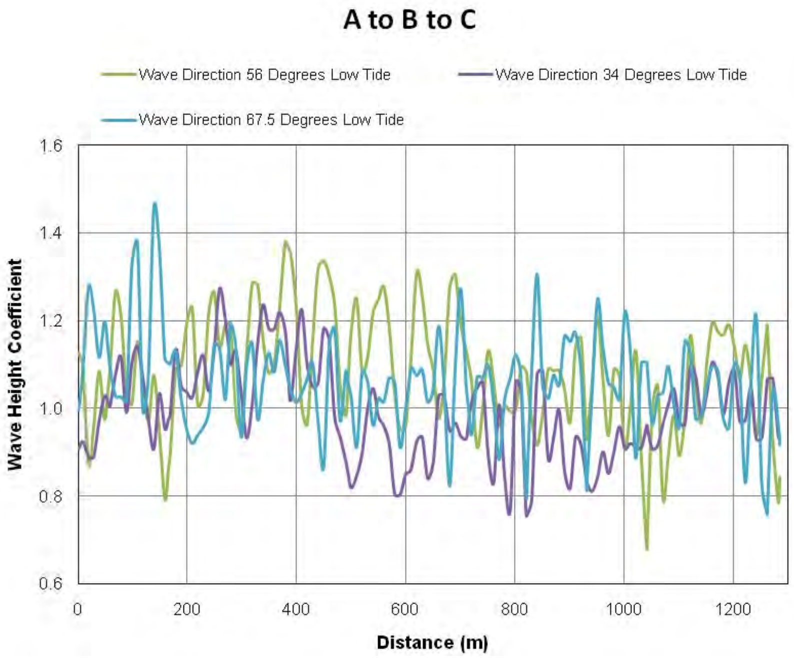


Figure 3-5 Wave height coefficients along the northern breakwater and reclamation revetment along the lines presented in Figure 3-4 for incident waves defined at the channel marker ADCP (Appendix A, Figure 1)

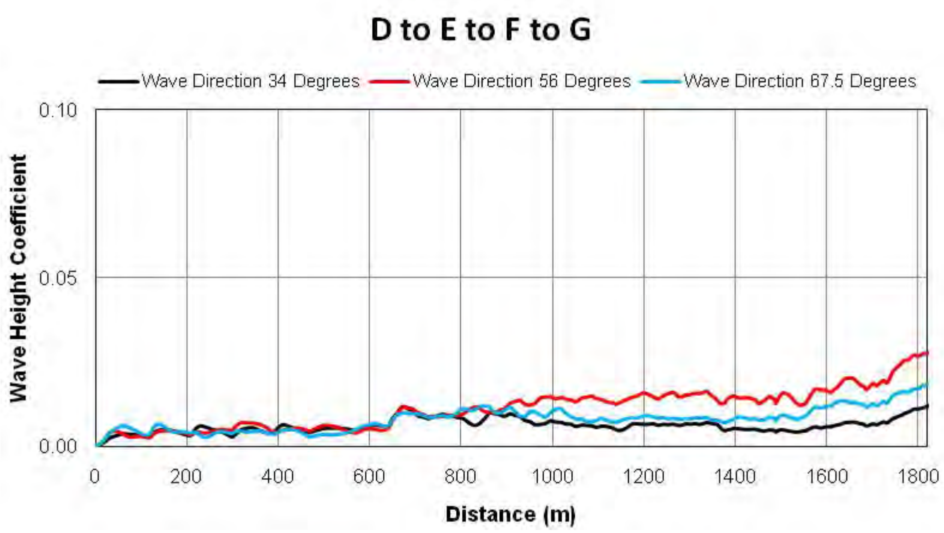


Figure 3-6 Wave height coefficients along the berth lines presented in Figure 3-4 for incident waves defined at the channel marker ADCP (Appendix A, Figure 1) – see Figure 3-5 for legend

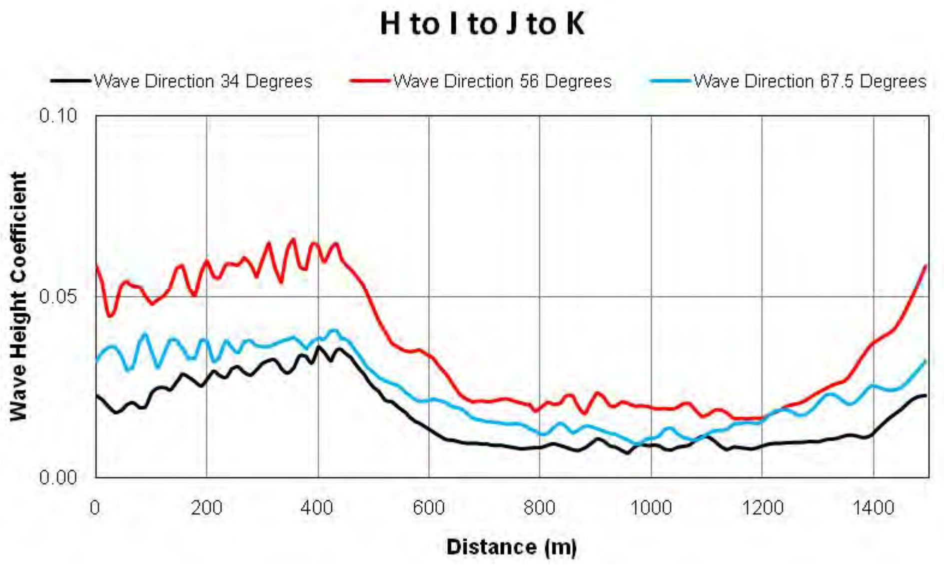
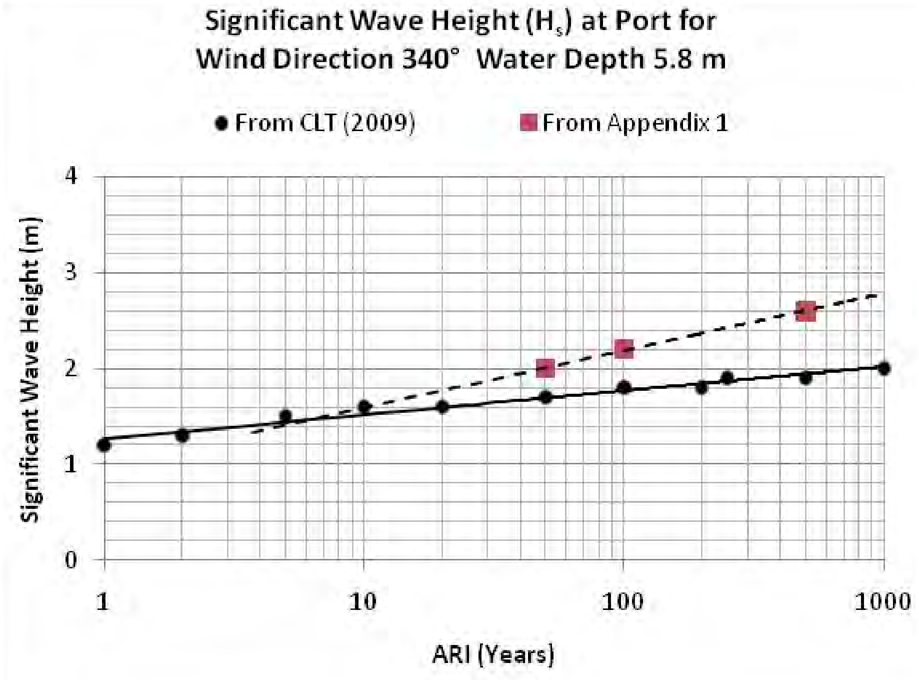


Figure 3-7 Wave height coefficients within the port along the lines presented in Figure 3-4 for incident waves defined at the channel marker ADCP (Appendix A, Figure 1)

The modelling confirms the wave focussing processes that have been observed along the existing reclamation revetment (Section 4.1) and quantifies the degree of focussing that would need to be considered in design. For this design case, an unrefracted offshore (at the channel marker ADCP site) wave height coefficient of 1.4 is indicated (Figure 3-5), which suggests that some 100% of the incident wave energy would be reflected off the dredged discontinuity of the Platypus Channel and onto the breakwater and revetment. Along the proposed berths and within the port precincts the wave height coefficients would be around 0.05 or less (Figure 3-6 and Figure 3-7), indicating benign wave conditions.

3.4 North-Westerly Wave Conditions

There are no field measurements that allow for the development of a NW wave climate for the Port of Townsville. Wave climates have been derived from wind data using hindcasting modelling methods (CLT, 2009; Appendix A). The results of these are summarised in Figure 3-8 which show extreme wave conditions (100y ARI) have significant wave heights of around 2 m with peak wave periods around 4.0s to 4.5s. Such periods produce waves of length 30m and less. Given that the beam of the design ship is greater than 30m, these waves should not limit shipping operations, even for these infrequent events. Therefore there is no need for a western breakwater to provide protection for berths for operational conditions.



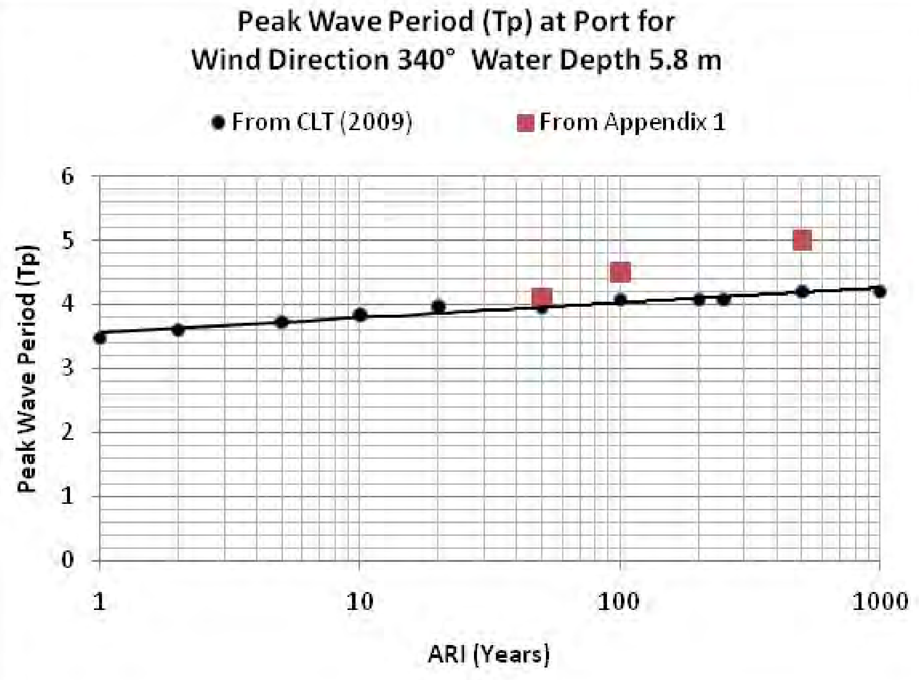


Figure 3-8 Derived NW wave climate for port operations

3.5 Long Wave Conditions and Harbour Seiching

Seiching is the formation of standing waves in a basin water body due to wave reflections from the ends of the basin. These waves may be incited by earthquake motions, impulsive winds over the surface, gravity (swell) wave motions entering the basin or free long infragravity waves existing in the Bay and entering the basin. The various modes of seiching correspond to the natural frequency response of the water body in the harbour basin.

A rectangular basin with given length and depth will seiche with a period (*T)* determined by finding the correct length of wave that will fit in the basin for the given water depth. For shallow water theory, the seiching period (*T)* is given by twice the basin length (l) divided by the modal number (n) and the speed of a shallow water wave, which depends on the water depth (h), thus:

$$T = 2l/(n(gh)^{0.5})$$

The dimensions of the proposed outer harbour development are approximately 1000m × 1000m × 13m - 16m deep. With such dimensions, possible seiching periods, as computed by simple linear wave theory, are 80-89s (mode 2) and 160-177s (fundamental mode). Of the few measurements of long waves generated during storms in Cleveland Bay, their energy has been found to peak at frequencies of around 0.006 Hz (170s), 0.009Hz (110s) and 0.013Hz (80s) (see Section 2.6.4). Long wave heights were in the order of 10cm. That the measured long waves have periods matching the natural resonance frequency of the proposed harbour basin, there is a possibility that such a regular harbour basin may seiche at these frequencies during storms.

An enquiry was made with POTL to ascertain whether there was information of any historical disruptions to port operations. There was no knowledge of disruptions; however it is noted that seiching during extreme events may not be observed because shipping was not present during these events.

4.0 Design Water Level & Wave Conditions

The design conditions refer to the extreme water level and wave conditions that are used in the design of structures including revetments, breakwaters, wharf structures and navigation aids. The combined water level and wave conditions are important as they directly impact on the wave climate that reaches the structure (depth limiting conditions), overtopping rates and design features such structure heights or fill levels.

4.1 Design Water Levels

Design water levels during extreme events are called storm tides, and are a combination of normal astronomical tides and storm surge.

Storm surge, associated with extreme weather systems (cyclones) includes the influence of winds, currents and barometric pressure. A storm surge of several metres is not uncommon when powerful a cyclonic system crosses the coast. Design storm tide levels consider the combined occurrence of the storm surge with the tide. This combined probability is then used to define the overall water level occurrence.

A recent example of significant storm surge was captured during Tropical Cyclone Yasi. This cyclone was an intense category 5 system and crossed the coast approximately 30km north of Cardwell. During Cyclone Yasi, storm tide data was captured by the Department of Environment and Heritage Protection (EHP) array of storm tide monitoring gauges. As indicated in the Figure 4-1 (using data presented on the EHP web site) a large storm surge of 5.2m was recorded at Cardwell during the Cyclone. Fortunately this occurred at low tide and resulted in a storm tide only 2m above the Highest Astronomical Tide (HAT).

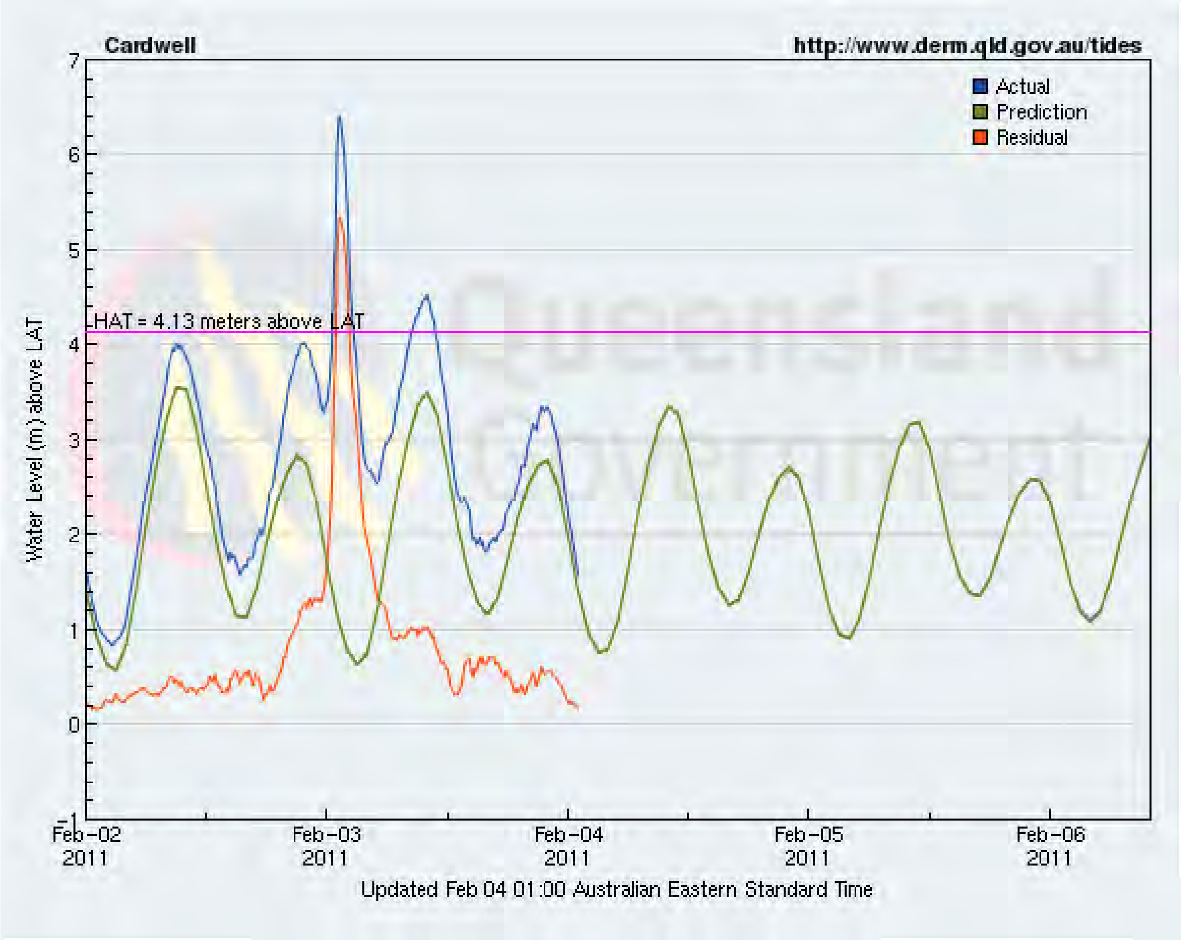


Figure 4-1 Cardwell - cyclone Yasi storm tide extracted from EHP (Qld Government) storm tide monitoring website

Because Cyclone Yasi crossed the coast approximately 160km north of Townville, the storm surge and thus storm tide was less at the port. As indicated in Figure 4-2 a storm surge of 2.4m was recorded at Townville with a peak storm tide level 4.5m LAT (0.4m above HAT).

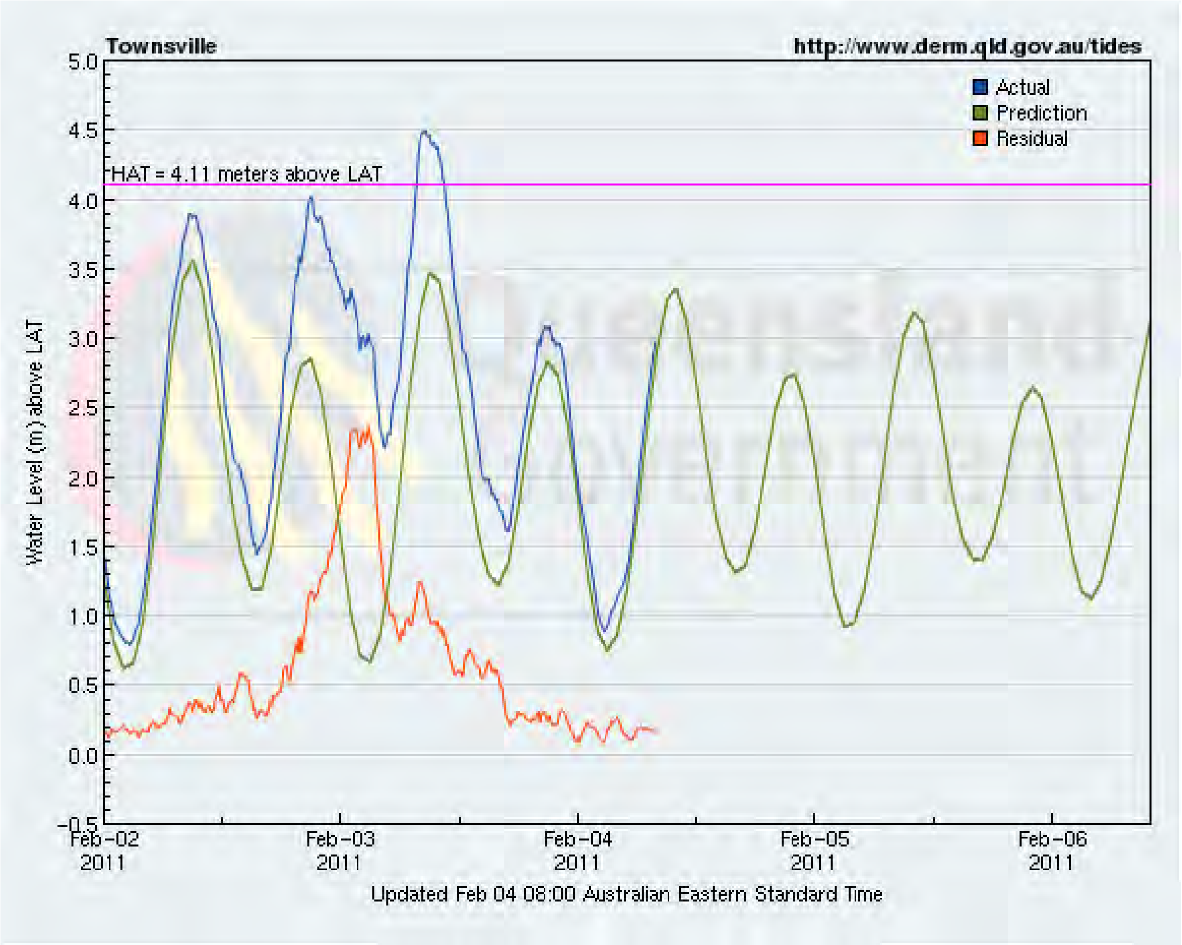


Figure 4-2 Townsville - cyclone Yasi storm tide extracted from EHP (Qld Government) storm tide monitoring website

Design storm tide levels vary significant along the coast due to the impact of bathymetry, coastal topography, cyclone frequency and tidal levels. This means that the storm tide adopted is quite site specific. To define design storm tide levels at Townsville a number of previous studies have been referenced, including the Queensland Coastal 2004 JCU study, a Queensland Government study (reference Harper 1998) and a study for Townsville outer harbour (reference Lawson and Treloar 1996). The older studies contained similar values, approximately 0.5m higher than those from the 2004 study. When historical storm surge levels were compared with the forecast levels it was assessed that the 2004 study had forecast unrealistically low storm tide levels. The 1996 and 1998 studies both forecast similar values and these were adopted, as presented in Table 4-1. Note that Cyclone Yasi storm tide level was less than 50 year ARI with today's sea level condition.

In accordance with the Queensland State Government draft guidelines a sea level rise of 0.5m by 2070 is proposed for design event forecasting.

Table 4-1 Design storm tide levels for Port of Townville

ARI	Present Day Storm Tide Levels		2070 Storm tide levels incl. 0.5m sea level rise	
(years)	(m LAT)	(m AHD)	(m LAT)	(m AHD)
10	4.1	2.2	4.6	2.7
20	4.2	2.3	4.7	2.8
25	4.3	2.4	4.8	2.9
50	4.6	2.7	5.1	3.2
100	4.9	3.0	5.4	3.5
200	5.2	3.3	5.7	3.8
250	5.3	3.4	5.8	3.9
500	5.6	3.7	6.1	4.2
1,000	5.9	4.0	6.4	4.5
2,000	6.2	4.3	6.7	4.8

Note that the levels are presented to both the maritime Lowest Astronomical Tide (LAT) datum and Australia Height Datum (AHD). Also note that Highest Astronomical Tide (HAT) including 0.5m sea level rise is 4.61m approximately equivalent to the 10yr ARI WL.

4.2 Design Waves

Overwhelmingly waves approach the port from the NE quadrant, through the main entrance to Cleveland Bay. Alternatively waves can approach the port from the NW through a passage between Magnetic Island and the mainland. Finally local waves generated within Cleveland Bay impact on the eastern revetment of the port. To assess the design wave heights it has been necessary to use slightly different methodologies in assessing the waves from the alternate approaches.

4.2.1 East through to North-East Wave Climate

Offshore Waves (Cape Cleveland)

Offshore of Cleveland Bay ambient waves predominately approach the area from the east. This is reflective of the dominant seasonal winds and longer fetches to the east. During cyclonic events the bias in ambient wind direction is no longer important. Rather consideration of wind fields in cyclonic systems plus the available fetch lengths define the critical directions for the design wave climate. Winds and storm surges on the leading and southern sides of the cyclones are the most server and will drive wave generation from the quadrant north through to east when a cyclone crosses the coast over or to the north of Townsville.

A Waverider buoy, maintained by the Department of Environment and Heritage Protection (EHP) has been collecting wave climate information in 15m of water off Cape Cleveland since 1975 (35+ years). This instrument has captured a number of significant events over this period. Using extreme event data presented on the EHP web site a statistical analysis was undertaken to determine design wave heights.

Cyclone Yasi, despite crossing the coast approximately 150km north of Townville resulted in a very significant wave event that was largely captured by the EHP Waverider buoy. The recorded significant wave height (H_S) exceeded 5m for 10 hours from 1900 on 2nd February to 0400 on 3rd February 2011. During this period of high waves the wave direction varied within the range 30° to 90° TN.

The peak significant wave height recorded during Cyclone Yasi was approximately 5.5m with a maximum wave height of 9.9m. This event is 1/3 larger than the next largest event in the data set and statistically appears to be an outlier, making the estimation of its occurrence probability unreliable. Based on data captured before Cyclone Yasi the recorded waves were equivalent to a 6500 year ARI event. It is our opinion that this is excessive and that the event is not significant in a geological time scale. A closer examination of the data indicates that the larger, cyclonic, wave events have a different statistical relationship than the more common, non-cyclonic, waves. Considering the four most significant pre-Yasi events a revised relationship was developed. Based on this analysis Cyclone Yasi waves off Townsville had a recurrence interval of approximately 300 years, a value that appears more realistic.

To validate the lower end of the extreme event analysis the results of an analyis for all data was considered. Cardno Lawson and Treloar (ref 2009) undertook an analysis of all data. This analysis considered 1975 to 2008 data set and the 2001 to 2008 sub set. Due to changing technology, data capture rates for ambient wave conditions were lower before 2001. This makes comparison of ambient data sets from the earlier period with the more recent data unreliable in the format considered. As such only the 2001 to 2008 analysis was used for the comparison. The extreme event data and the all data analysis are ploted together in Figure 4-3. This figure demonstrates that the extreme event analysis is consistent with the analysis of all data.

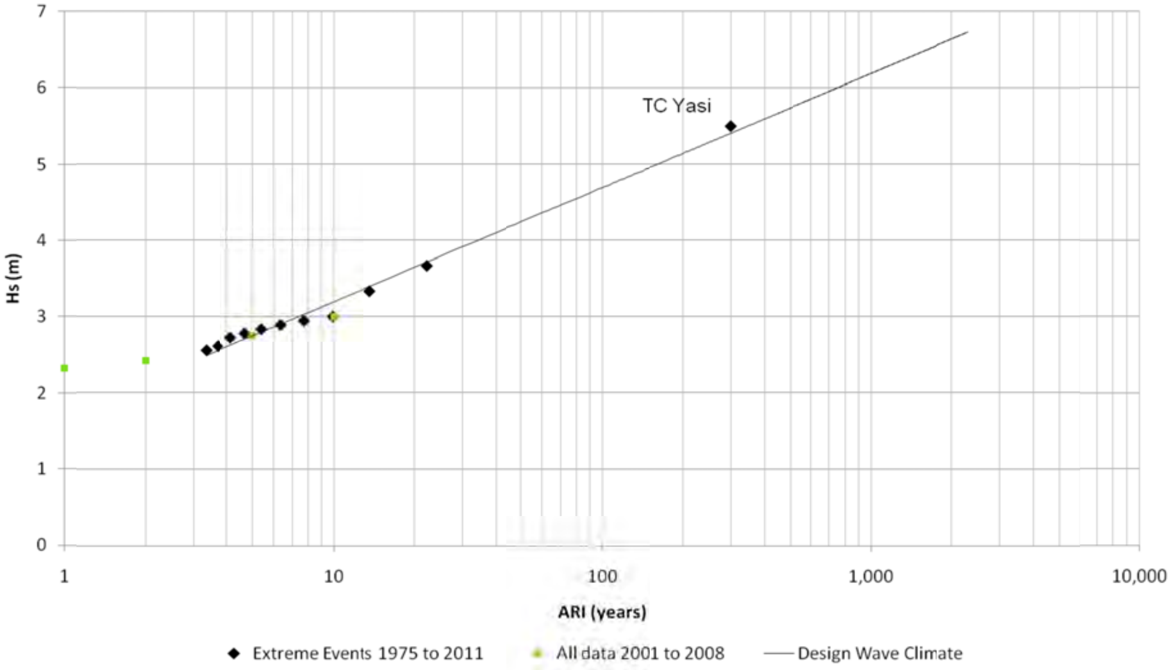


Figure 4-3 Cape Cleveland Waverider buoy offshore wave climate analysis

Table 4-2 Design offshore wave climates (Cape Cleveland Waverider buoy)

ARI	Wave Climate Pre – Yasi		Adopted Offshore Wave Climate (Yasi included)		
(years)	H_S (m)	H_{MAX} (m)	H_S (m)	H_{MAX} (m)	T_P (s)
5	2.7	4.9	2.7	4.9	6.0
10	3.0	5.3	3.2	5.8	6.3
20	3.2	5.8	3.7	6.6	6.8
25	3.3	6.0	3.8	6.8	7.0
50	3.6	6.5	4.3	7.7	7.3
100	3.9	6.9	4.7	8.5	7.6
200	4.1	7.4	5.2	9.3	8.0
250	4.2	7.6	5.3	9.6	8.2
500	4.5	8.1	5.8	10.4	8.5
1,000	4.8	8.6	6.2	11.2	9.0
2,000	5.0	9.0	6.6	12.0	9.3

Nearshore

Waves at the port are not the same as those offshore. Waves are transformed by diffraction around Cape Cleveland, shoaling and refraction on the shallow bathymetry of Cleveland Bay and interactions with the dredge channel. The relationship between offshore waves and those near shore is complicated, with waves approaching from the east heavily modified before reaching the port, while those from the north have a near clear passage into the port.

To examine the wave transformation a spectral wave model (SWAN) was utilised to bring waves from offshore into a near shore site known as channel ADCP located south of Platypus Channel where the sea bed is at -5.5m CD. Based on the SWAN modelling a representative transformation coefficient of 0.84 was adopted. When this coefficient was applied to the offshore pre-Yasi wave climate it resulted in a good match with the Cardno Lawson and Treloar study (ref 2009). The design wave climate near shore is presented in Table 4-3.

Table 4-3 Design nearshore NE wave climates (channel ADCP site)

ARI	Adopted nearshore NE wave climate (-5.5m CD)		
(years)	H_S (m)	H_{MAX} (m)	T_P (s)
5	2.3	4.1	6.0
10	2.7	4.9	6.3
20	3.1	5.5	6.8
25	3.2	5.7	7.0
50	3.6	6.4	7.3
100	3.9	7.1	7.6
200	4.3	7.8	8.0
250	4.5	8.0	8.2
500	4.8	8.7	8.5
1,000	5.2	9.4	9.0
2,000	5.6	10.0	9.3

It is noted that during Cyclone Yasi a bottom mounted ADCP in Spoil Grounds captured the wave climate in Cleveland Bay. The wave climate at spoil grounds reflected conditions offshore with a significant wave height of 5.1m measured. Because of the varied wave direction offshore the duration of the high waves was less than those observed offshore.

Around the port

A Boussinesq wave model (BOUSS2D) was used to transform the wave climate presented in Table 4-3 into the various parts of the port. This modelling includes the impacts of diffraction and reflections off steep bathymetry (dredged channel), that are not included in spectral wave modelling. This modelling indicated that waves within the harbour were very small with wave height coefficients of less than 0.1, while due to wave energy reflecting off the dredge channel the waves on the NE breakwater and revetment are typically larger than those at the near shore site. For high water levels the waves are 20% larger, while for low water levels the waves are 40% larger. It is noted that depth limiting conditions are anticipated for a number of the exposed revetments and this will be considered in the armour design and overtopping considerations.

4.2.2 North-West Seas

The NW wave climate is vital in consideration of the potential need for a western breakwater. For the determination of the design NW wave conditions the offshore Waverider buoy data is of little relevance. The design wave climate from this direction is defined by local seas penetrating through the gap between Magnetic Island and the main land. This wave climate was analysed using the SWAN modelling and indicated the following wave climate at the near shore channel ADCP site.

Table 4-4 Design NW wave climates (port expansion site)

ARI	Adopted near port NW wave climate (-3m CD)		
(years)	H_S (m)	H_{MAX} (m)	T_P (s)
5	1.3	2.3	3.8
10	1.5	2.7	3.9
20	1.7	3.1	4.0
25	1.8	3.2	4.0
50	1.9	3.4	4.1
100	2.1	3.8	4.5
200	2.3	4.1	4.7
250	2.4	4.3	4.8
500	2.5	4.5	5.0
1,000	2.7	4.9	5.4
2,000	2.9	5.2	5.7

4.2.3 Easterly Seas

Along the eastern revetment swell waves penetrating into Cleveland Bay run along the wall, rather than breaking into it, while wave energy reflecting off the dredge channel does not impact this revetment. Similar to the NW Wave Climate the SWAN modelling has been used to determine a design wave climate for this part of the reclamation.

Table 4-5 Design east wave climates (port expansion site)

ARI	Adopted near port easterly wave climate (-2m CD)		
(years)	H_S (m)	H_{MAX} (m)	T_P (s)
5	1.6	2.9	4.5
10	1.8	3.2	4.6
20	1.9	3.4	4.7
25	2.0	3.6	4.8
50	2.2	3.9	4.9
100	2.3	4.2	5.0
200	2.4	4.3	5.0
250	2.4	4.3	5.1
500	2.5	4.4	5.5
1,000	2.5	4.5	5.8
2,000	2.7	4.8	6.0

5.0 Summary, Conclusions and Recommendations

Wave conditions for the Townsville PEP have been assessed using gravity wave modelling, validated with field data, to provide nearshore wave climate data for the assessment of:

- Operational wave and extreme conditions for the proposed harbour expansion and to enable the structural design of breakwater and revetment armouring.
- Wharf, breakwater and revetment crest levels for acceptable wave overtopping.

Infragravity wave characteristics were gleaned from existing field data and an assessment was made of the possibility of harbour seiching. The proposed port development has regular dimensions, which would have natural seiching periods of around 160 to 180s (fundamental mode) and 80 to 90s (1st harmonic). Long waves with these periods have been measured in Cleveland Bay during storms. The possibility and occurrence of harbour seiching should be investigated as part of the detailed design process.

The field data, photography and modelling has shown that the Platypus Channel and the dredging configuration for Berth 11 have an influence on nearshore wave transformation at the port. The existing dredged configuration provides some wave sheltering for Berth 11 as incident swell waves are deflected away from Berth 11 by the bathymetric discontinuity and are directed towards the reclamation revetment causing considerable wave focussing there.

For the PEP, the wave study has shown that the port would be protected from seas emanating from the NE quarter. The Platypus Channel causes wave deflection onto the northern breakwater and reclamation revetment, increasing significantly the incident wave conditions there, which would need to be taken into consideration for the design of armouring and assessment of wave overtopping. Modelling has indicated that up to 100% of the incident wave energy could be reflected onto the port structures, increasing the incident wave heights by a factor of 1.4 from this process alone. The channel has resulted also in reducing wave stirring on the bottom to the west of the channel, which may have had implications for the marine benthic ecology.

The wave study has indicated that the wavelengths of seas emanating from the NW quarter are less than the beam dimensions of the design vessels, indicating that a western breakwater may not required for operations. However, during extreme events, a cost comparison of constructing a western breakwater versus designing the outer harbour marine structures to withstand the wave attack would determine whether there is a requirement. The layout adopted for the EIS includes the option of a western breakwater as part of the design. The need would be assessed during the detailed design undertaken for each stage of development and would consider construction cost as well as the type and size of vessels that will use the outer harbour.

6.0 References

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Appendix A

SWAN Wave Modelling

Appendix A: SWAN Wave Modelling

Table of Contents

1.0 Introduction

SWAN wave transformation modelling was undertaken to generate a wave climate within the Cleveland Bay and to determine nearshore wave boundary conditions for a Boussinesq wave model (BOUSS2D).

The SWAN model is a third-generation stand-alone (phase-averaged) wave model for the simulation of waves in waters of deep, intermediate and finite depth (Booij, 1999). It is also suitable for use as a wave hindcast model. The model is based on the wave action balance equation with sources and sinks.

SWAN simulates the following physical phenomena:

- Wave propagation in time and space, shoaling, refraction due to current and depth, frequency shifting due to currents and non stationary depth.
- Wave generation by wind.
- Nonlinear wave-wave interactions (both quadruplets and triads).
- Whitecapping, bottom friction, and depth-induced breaking.
- Blocking of waves by currents.

2.0 Model Setup

The model set-up consisted of a coarse 50 m grid with the extent shown in Figure 2-1. A finer model of grid size 25 m was nested within the 50 m grid in order to resolve the Platypus Channel, which has a width of 90 m. The sea and the swell components were modelled using different model set-ups.

The sea component of the model was driven by applying time-varying wind parameters distributed uniformly over the entire model domain. The offshore winds (Figure 2-2) from the BoM global model were used to compute the local sea within the model domain.

The inputs for the sea (wind wave) model were:

- Wind and wave directions in deg true north.
- Wind speeds in the range of 5-20m/s.
- Wind direction in the range of 0 to 330 deg.

The swell model was forced by the application of offshore waves at the model boundaries. The inputs for the swell model were:

- Wave periods in the range of 5-11s
- Wave directions in the range of 30-100 deg

The time-series of wave heights, periods and directions measured at the WRB was then transformed to the ADCP site by record-by-record interpolation using the wave period-wave direction matrix obtained by the SWAN swell model results.

2.1 Bathymetry and Computational Domain

The digital elevation model developed by BMT WBM (2009) was used to create bathymetry for the SWAN model. The data were available on a rectangular grid with a grid size of 50 m (Figure 2-1).

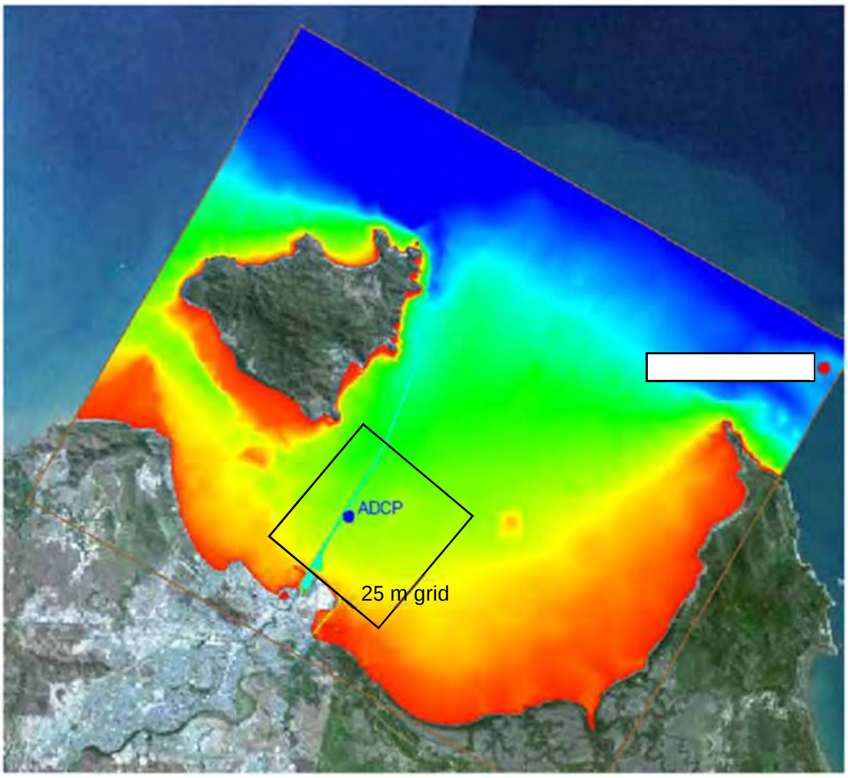

Figure 2-1 Model bathymetry from BMT WBM (2009) and model grids extent

The maximum offshore water depth is approximately 23m below AHD.

The computational domain consists of:

- Main model domain grid size = 50 m
- Sub-model domain grid size = 25 m
- Main model dimensions: 24,750 m x 29,000 m
- Sub-model dimensions: 6,875 m x 6,250 m

2.2 Measured Wave Data

Wave measurements were available at the following two sites (Figure 2-1) from:

- Waverider Buoy (WRB) deployed by Queensland Department of Environment and Heritage Protection (EHP) near the Cape of Cleveland from 1975-2008.
- ADCP located at a depth of 5.5 m CD (484,300 E 7874878N) from September 2008-February 2009.

2.3 Wind Data

Measured wind data were available for the Townsville Airport (Figure 2-3). However, the sea-swell separation processing by Cardno Lawson Treloar (2009) indicated that the Townsville Airport data were affected by land and sea breezes. The Airport wind data would also be influenced by buildings and other land features. Therefore, it was not used for wave modelling exercise.

For wave modelling, hindcast wind parameters for locations offshore of Cape Cleveland and the Great Barrier Reef were obtained from the global wave model, AUSWAM, developed by the Australian Bureau of Meteorology (BoM). AUSWAM, a version of WAM, is maintained and operated at BoM and provides up to 96-hour forecasts of sea-state. Forcing is obtained from surface wind fields calculated from the operational atmospheric systems. Model spectra are adjusted using various assimilation strategies. Results are validated against a number of Waverider buoys situated around the Australian coast.

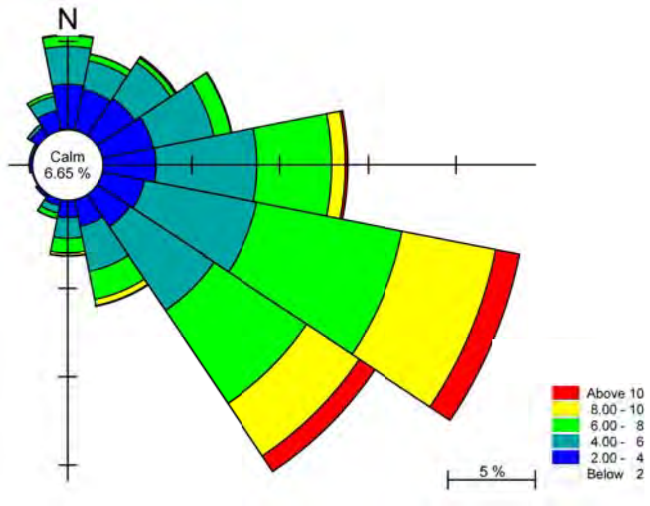

Figure 2-2 **Wind Rose for location offshore of Cape Cleveland (148° E, 17.4° S)**

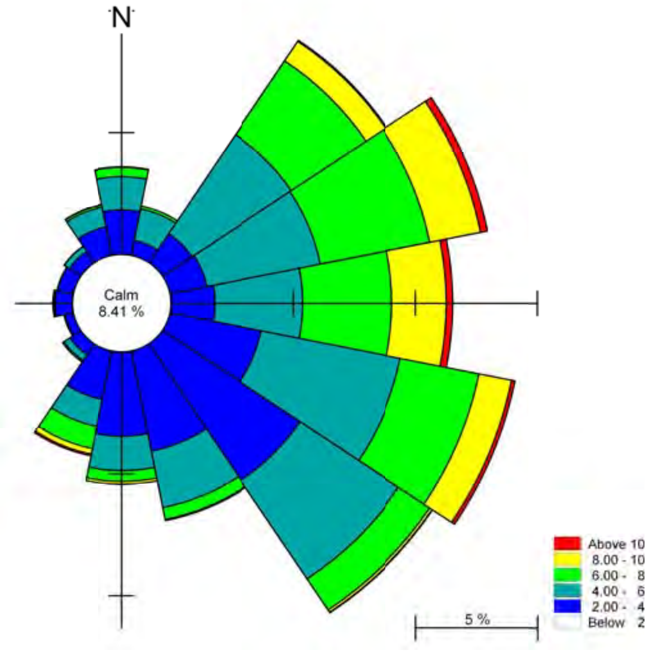

Figure 2-3 **Wind Rose for the Townsville Airport**

The model data for the Australian Regional grid are on a 0.125° latitude and longitude grid (approximately 14 km x 11 km) and include wave parameters for sea and swell including height, period and direction as well as wind speed and direction. These data provide time series at offshore locations in Australia. Data from AUSWAM were available from January 2003 to the December 2008 at 12-hour intervals. Wind rose for a location offshore of Cape Cleveland (148° E, 17.4° S) is shown in Figure 2-2. For comparison, the wind rose from the Townsville Airport is also shown (Figure 2-3).

3.0 Verification

The SWAN model results were extracted at the ADCP site (Figure 2-1) and verified by comparison against the measured ADCP data. The sea-swell separation of the ADCP wave data consisted of separating the sea from the swell at a cut-off peak wave period of 6 s and 7s. Comparison of the modelled sea (wind waves) with the sea component from ADCP is shown in Figure 3-1. The agreement between the model and the ADCP was within ±0.1 m, indicating that the winds used to drive the model are realistic and result in producing inshore wind waves with acceptable accuracy.

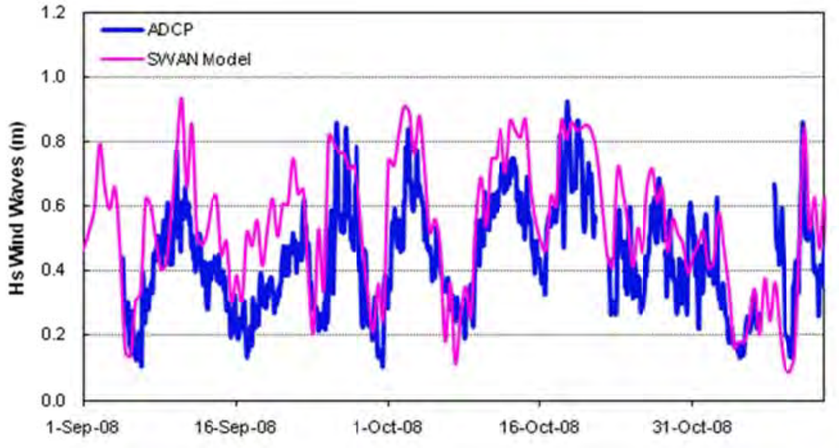

Figure 3-1 Comparison of measured and modelled H_s (Local Sea at ADCP site)

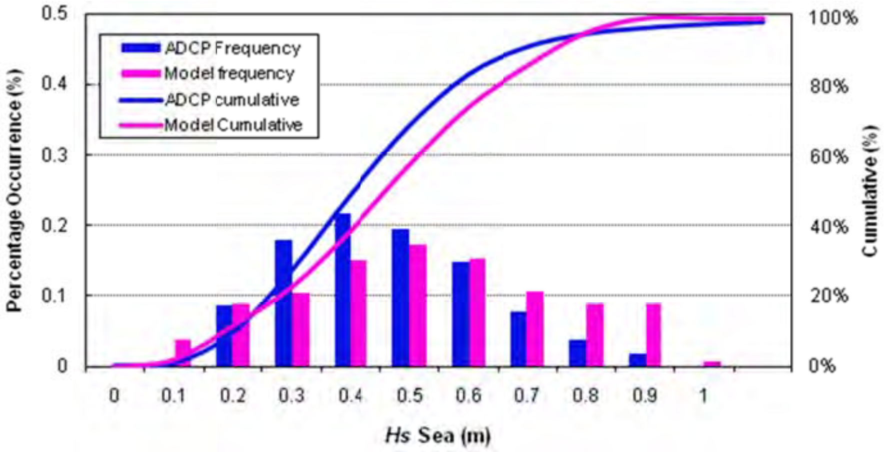

Figure 3-2 Percentage occurrences and cumulative distributions of measured and modelled H_s (Local Sea at the ADCP site)

As a further check of the accuracy of the model, histogram and cumulative distributions of the modelled and measured wave heights (local sea) at the ADCP site were computed. Figure 3-2 shows that the model slightly underestimated wave heights between 0.3 and 0.5 m while it generally overestimated the wave heights greater than 0.6 m. Overall, the modelled distribution was very similar to the measured distribution. The wave directions generated from the wind-driven model followed the wind directions.

Sea and swell separation of the wave data from the Cleveland WRB has not been undertaken for the time period between September and October 2008. Therefore swell heights were not available to drive the swell model. Instead, the inshore swell wave heights were generated using the total significant wave heights (H_s) from the WRB. To separate the sea from swell, the WRB data from 2000-2004 was split into peak wave periods of (T_p) greater than 7s (Figure 3-3) and T_p greater than 6s (Figure 3-4). When Tp is greater than 7s, the majority of the waves arrive at the WRB from the north-east (45 degrees) with a smaller but significant percentage arriving from just north of east (85 degrees). When *Tp* is greater than 6s, the dominant wave direction is from the east with smaller percentage from the north-east.

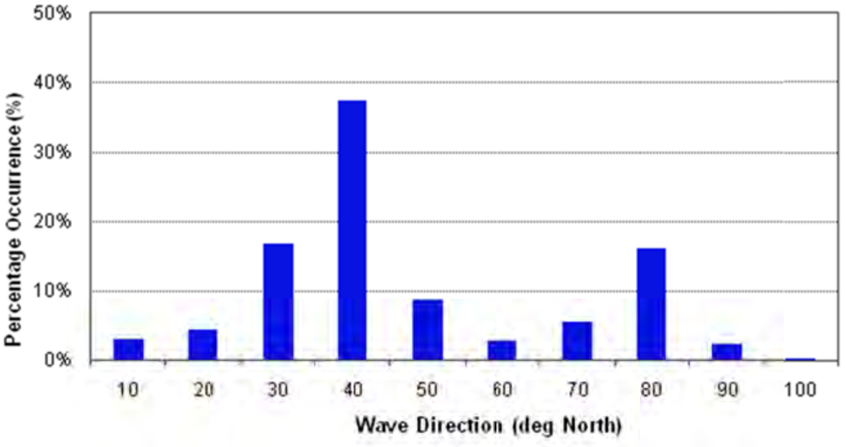

Figure 3-3 Histogram of Wave Direction at WRB, from 2000 to 2004 (T_p > 7s)

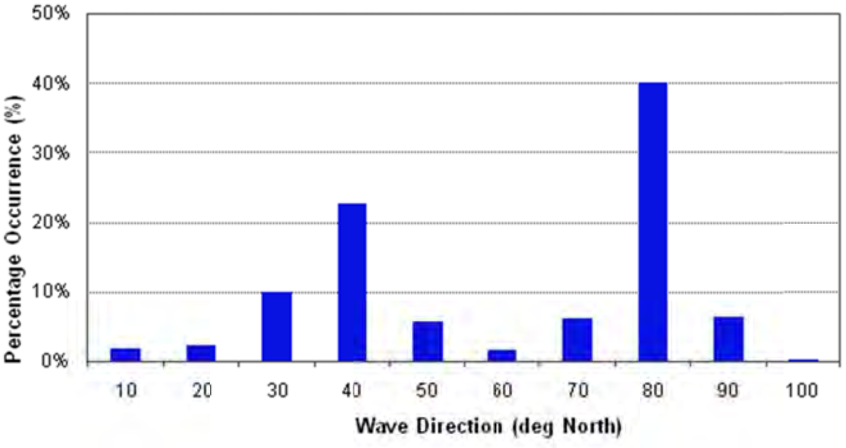

Figure 3-4 Histogram of Wave Direction at WRB, from 2000 to 2004 (T_p > 6s)

The WRB data in 2008 did not record wave directions except for the last 3 days in October 2008. Based on the 2000-2004 observations from the WRB, the offshore waves were split separately into peak wave period of greater than 6s and 7s and transformed to the inshore ADCP location. For the time period with missing offshore directions, an easterly offshore wave direction was assumed when *Tp* was less than 7s and a north-east offshore direction was adopted when *Tp* was greater than 7s. Figure 3-5 presents histogram of swell wave periods, heights, and directions at the ADCP site, from 2000-2004.

Figure 3-6 and Figure 3-7 show the comparison of the transformed modelled swell waves at the ADCP site with the swell wave height from the ADCP data. The model performs well in reproducing the swell height from the ADCP data.

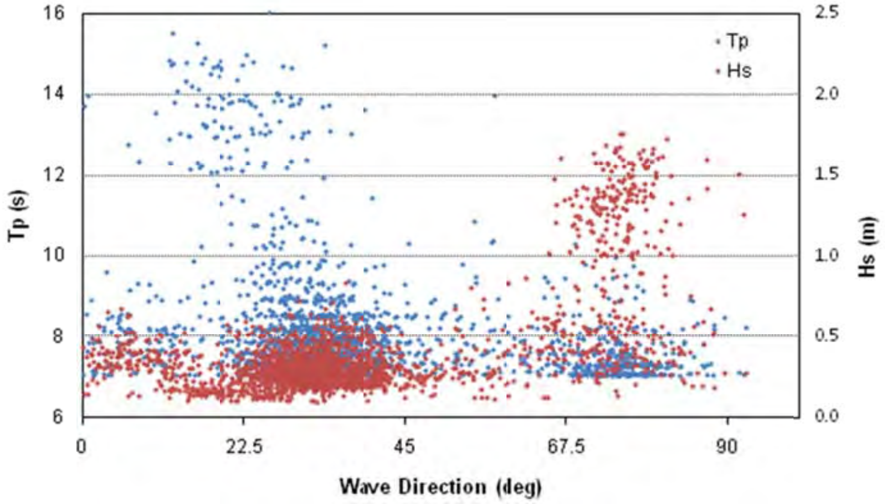

Figure 3-5 **Histogram of Swell wave periods, heights and directions at WRB, from 2000 to 2004 (T_p > 7s)**

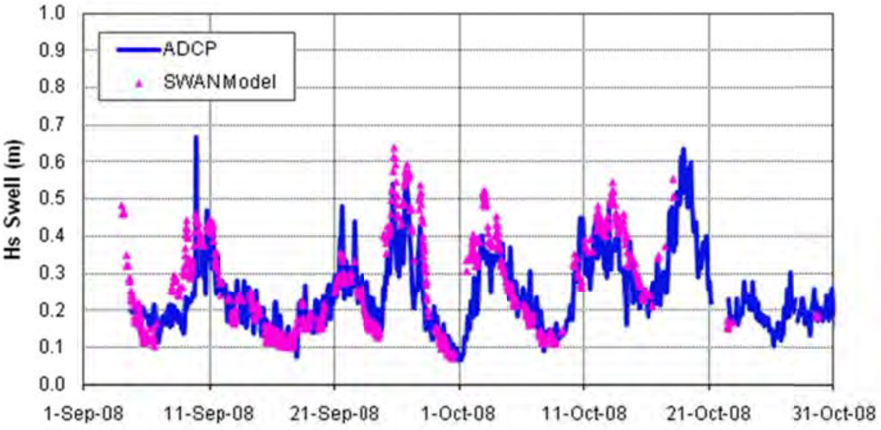

Figure 3-6 **Comparison of measured and modelled H_s at ADCP site (T_p > 6s)**

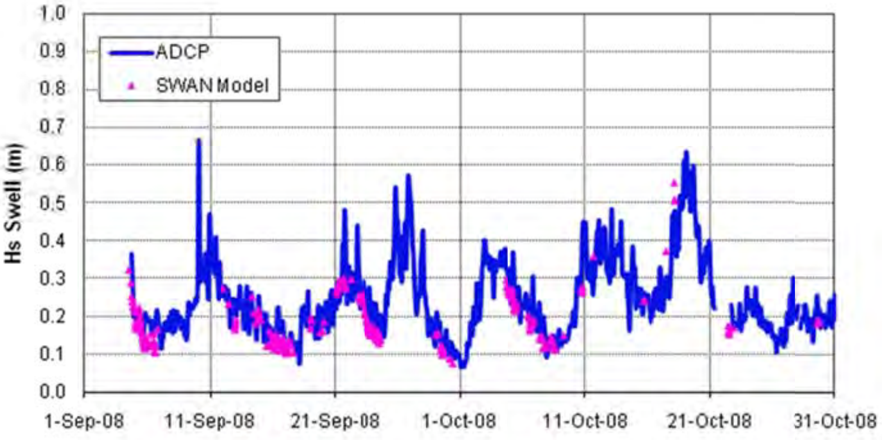

Figure 3-7 **Comparison of measured and modelled H_s at ADCP site (T_p > 7s)**

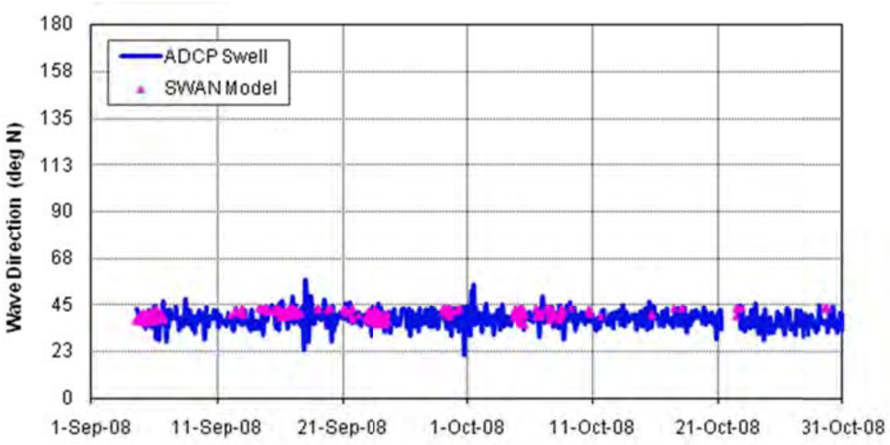

Figure 3-8 Comparison of measured and modelled wave direction at ADCP site

The offshore waves at the model boundary from the north-east and east are refracted to about 33 to 45 degrees at the ADCP location (Figure 3-8). The wave directions from the ADCP occur mainly between 30 and 45 degrees for the swell component. The ADCP directions were given relative to magnetic north and, therefore, have been adjusted by 7.5 deg for conversion to True North. Due to the uncertainties in the measurement and estimation of wave and swell directions from the ADCP, it is considered that the agreement between the model and measured wave directions is reasonable.

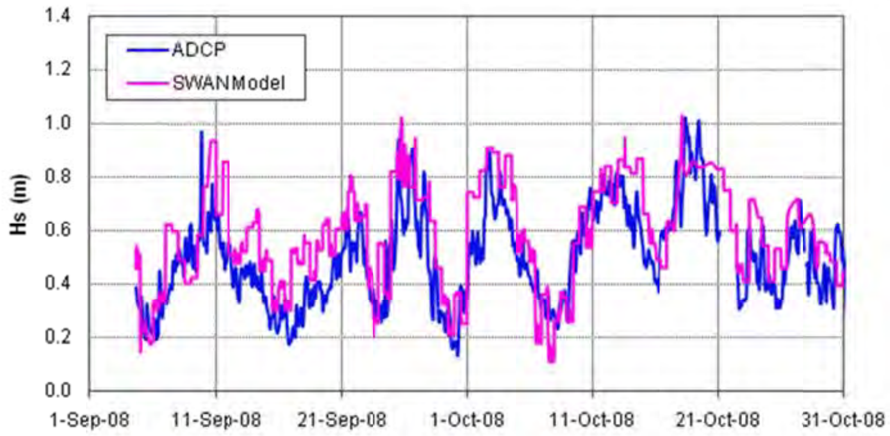

Figure 3-9 Modelled and measured H_s (combined local sea and swell waves) at the ADCP site.

The combined sea and swell wave height for the modelled sea and swell waves was computed using Equation 1 below. Comparison of modelled and measured total significant wave heights at the ADCP location is presented in Figure 3-9.

$$\text{Total}\,H_S = \sqrt{(\text{Wind wave}\,H_S)^2 + (\text{Swell wave}\,H_S)^2} \qquad (1)$$

The model wave heights are in good agreement with the measured wave heights by the ADCP. The calibration exercise indicated that the significant wave heights were reproduced by the model with acceptable accuracy

4.0 Results

4.1 Normal Wave Conditions at the ADCP site

The joint distribution of significant wave heights (H_S) and wave directions for the waves recorded by the ADCP during the time period between 4 September 2008 and 11 February 2009 is shown in Table 4.1. Table 4.2 presents the joint occurrences of H_s with the peak wave period. The waves at the ADCP location arrive predominantly from the north-east to east-north-east sector. The average H_s is 0.47m while the maximum occurring H_s over a period of approximately 4 months is 2.3m. Table 4.1 shows that the percentage exceedance of H_s greater than 0.8 m is 7.3%. The peak wave periods are generally between 3s and 6s (Table 4.2) indicating the dominance of local sea waves.

Table 4.1 Joint distribution of measured significant wave heights and wave directions at the ADCP site

Direction	Significant wave height, H_s (m)												
	0.0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-0.9	1.0-1.2	1.2-1.4	1.4-1.6	1.6-1.8	1.8-2.0	2.0-2.2	2.2-2.4	>2.4
N-NNE	0.32	0.11	0.11										0.54
NNE-NE	2.36	3.33	1.56	0.32	0.32	0.21	0.05	0.05	0.05				8.27
NE-ENE	3.22	28.4	21.69	8.05	1.99	0.64	0.43	0.27	0.21	0.21	0.16	0.05	65.32
ENE-E	0.32	4.62	10.04	5.9	2.2	0.38							23.46
E-ESE	0.05	0.48	0.97	0.27	0.11								1.88
ESE-SE	0.05	0.11	0.11										0.27
SE-SSE													
SSE-S													
S-SSW													
SSW-SW	0.05												0.05
SW-WSW													
WSW-W													
W-WNW			0.05										0.05
WNW-NW													
NW-NNW	0.05	0.11											0.16
Total	**6.44**	**37.14**	**34.51**	**14.55**	**4.62**	**1.23**	**0.48**	**0.32**	**0.27**	**0.21**	**0.16**	**0.05**	
Exceedance	**99.98**	**93.54**	**56.4**	**21.89**	**7.34**	**2.72**	**1.49**	**1.01**	**0.69**	**0.42**	**0.21**	**0.05**	

Table 4.2 Joint distribution of measured significant wave heights and peak wave periods at the ADCP site

Peak wave period (T_p)	Significant wave height, H_s (m)												
	0.0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-0.9	1.0-1.2	1.2-1.4	1.4-1.6	1.6-1.8	1.8-2.0	2.0-2.2	2.2-2.4	>2.4
0.0-1.0													
1.0-2.0													
2.0-3.0	1.45	7.57	5.42	0.7									15.14
3.0-4.0	1.5	9.55	8.32	2.95	0.75	0.05							23.13
4.0-5.0	0.75	4.35	5.37	2.2	0.38	0.11	0.11						13.26
5.0-6.0	1.23	5.85	6.82	3.81	1.88	0.86	0.21			0.05			20.72
6.0-7.0	1.02	5.64	5.37	2.74	0.86	0.21	0.11	0.27		0.05			16.26
7.0-8.0	0.21	3.11	2.84	1.88	0.43	0	0.05	0.05	0.16	0.05			8.8
8.0-9.0	0.21	1.07	0.32	0.27	0.32				0.11	0.05	0.16	0.05	2.58
9.0-10.0	0.05		0.05										0.11
Total	**6.44**	**37.14**	**34.51**	**14.55**	**4.62**	**1.23**	**0.48**	**0.32**	**0.27**	**0.21**	**0.16**	**0.05**	
Exceedance	**99.98**	**93.54**	**56.4**	**21.89**	**7.34**	**2.72**	**1.49**	**1.01**	**0.69**	**0.42**	**0.21**	**0.05**	

The model results for selected wave conditions are shown in Figure 4-1 to Figure 4-6. Figure 4-1 and Figure 4-2 show the entire modelled area while Figure 4-3 to Figure 4-6 shows the model results from the finer grid model (grid size is 25m). Note that in these figures, the wave vectors have been plotted at a distance greater than the actual grid size.

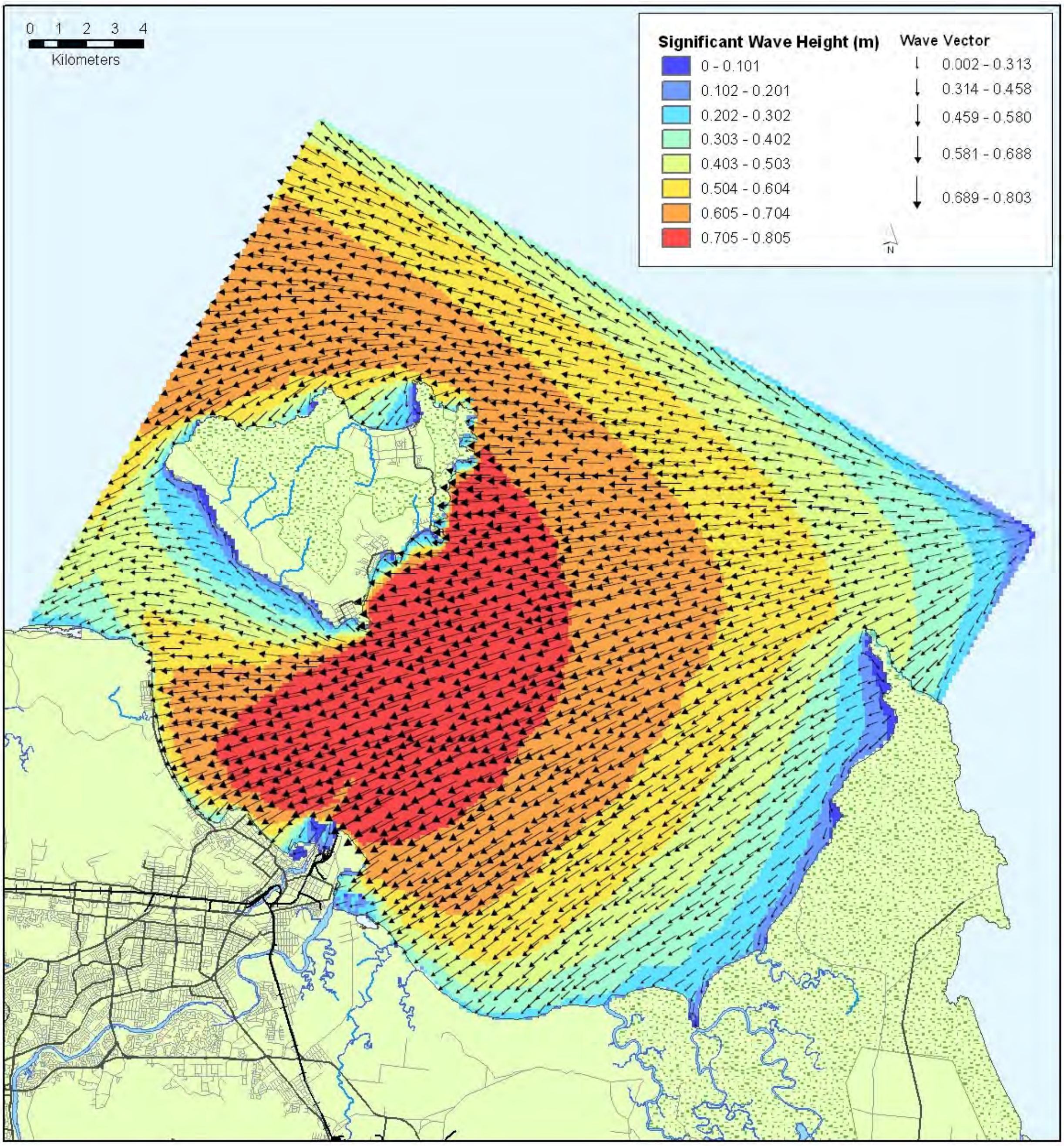

Figure 4-1 **Modelled local sea waves generated from wind (speed=10m/s, direction=75 deg)**

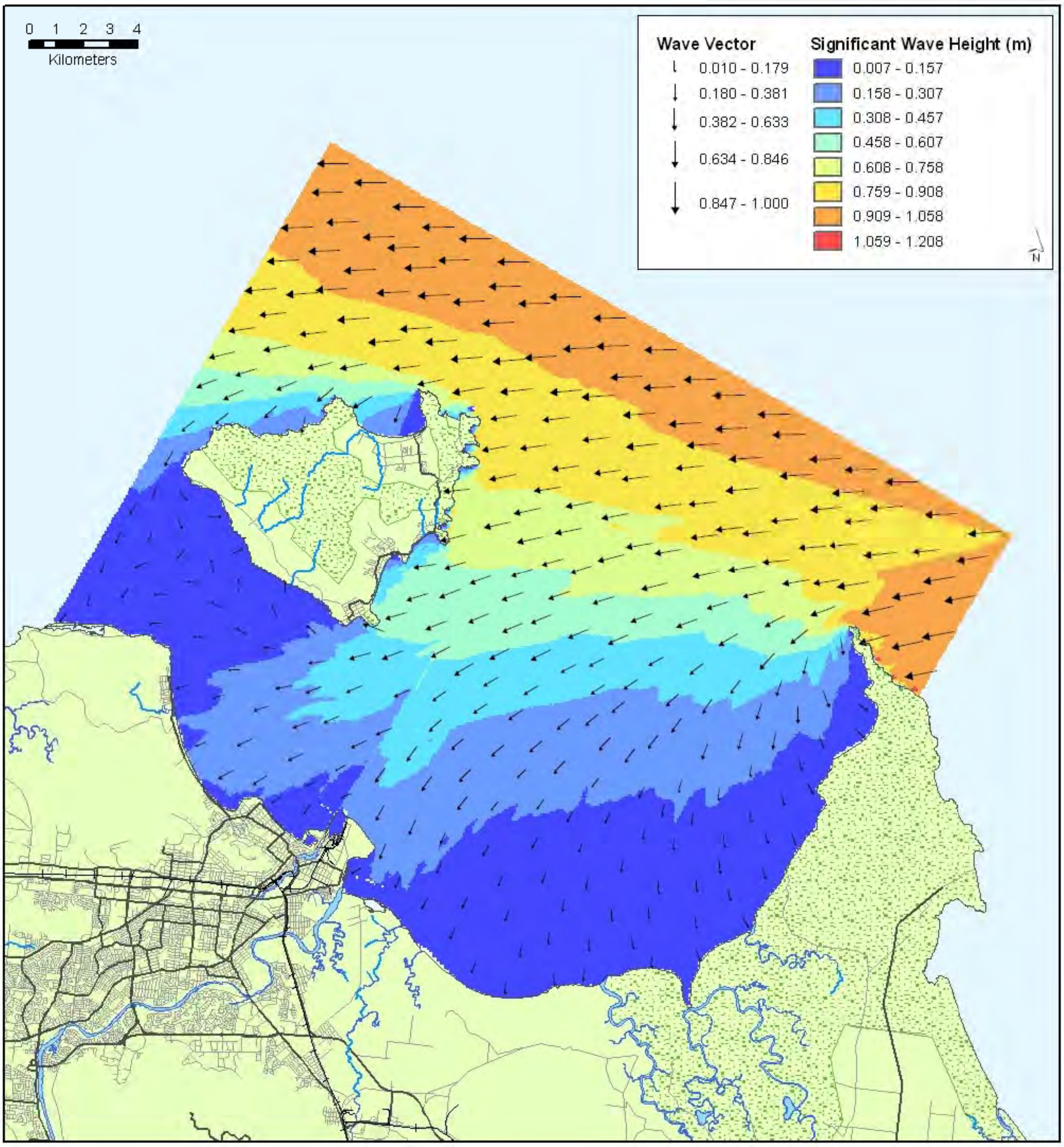

Figure 4-2 **Modelled swell waves transformed from offshore waves (T_{peak} = 7s, wave direction 90°)**

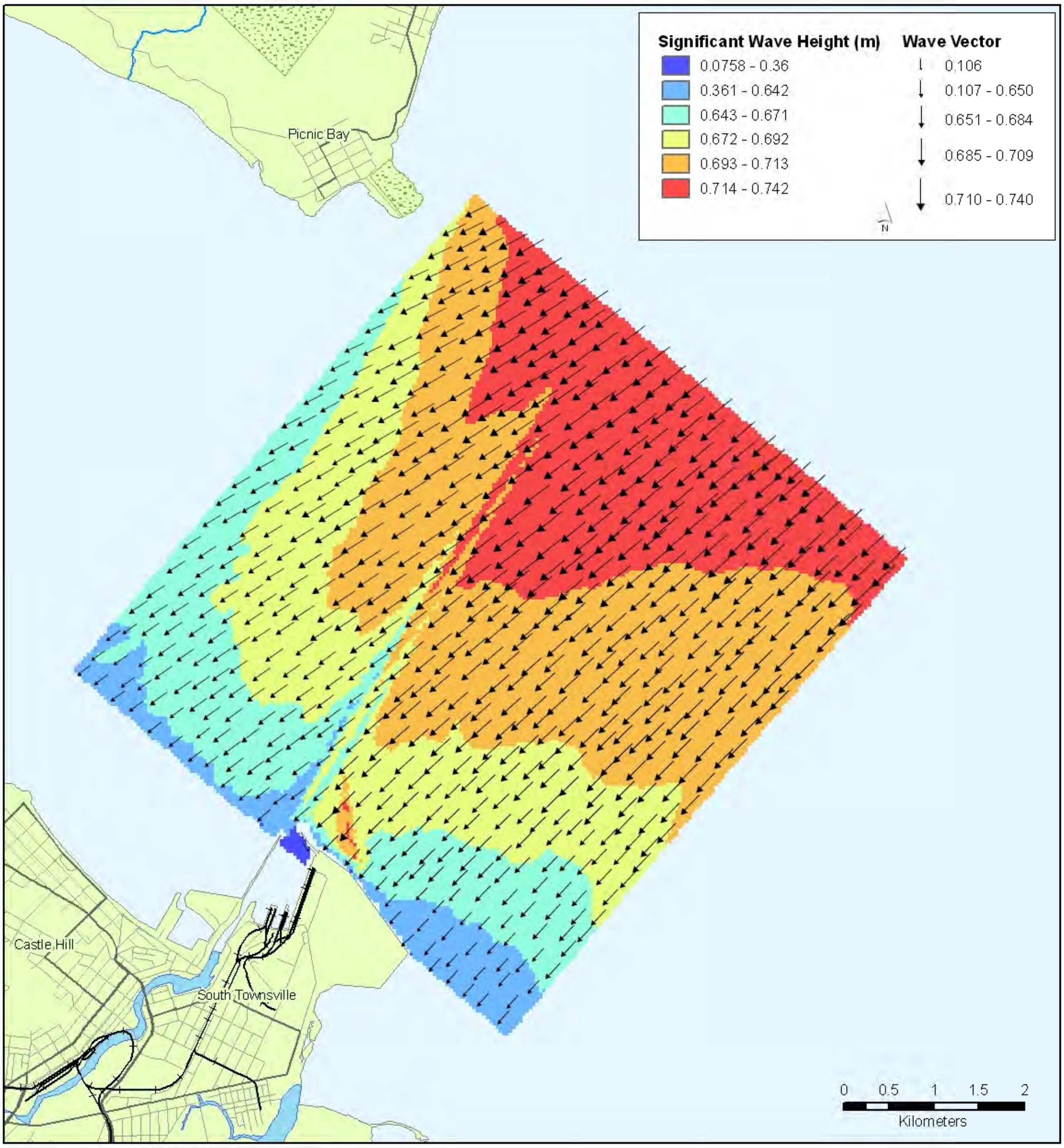

Figure 4-3 Computed significant wave height for wind wave (speed = 10m/s, direction=45deg)

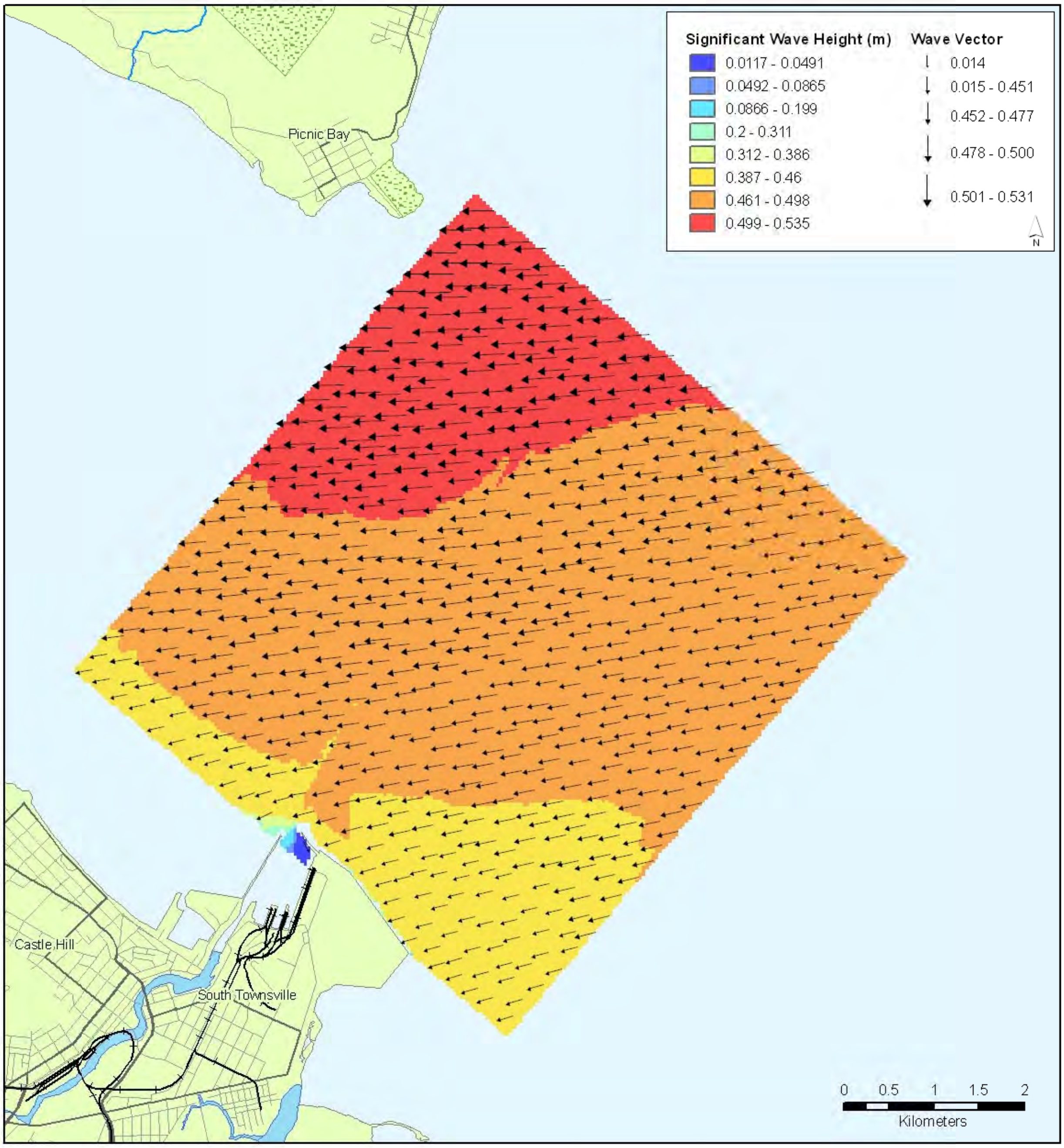

Figure 4-4 Computed significant wave height for wind wave (speed = 10m/s, direction=90deg)

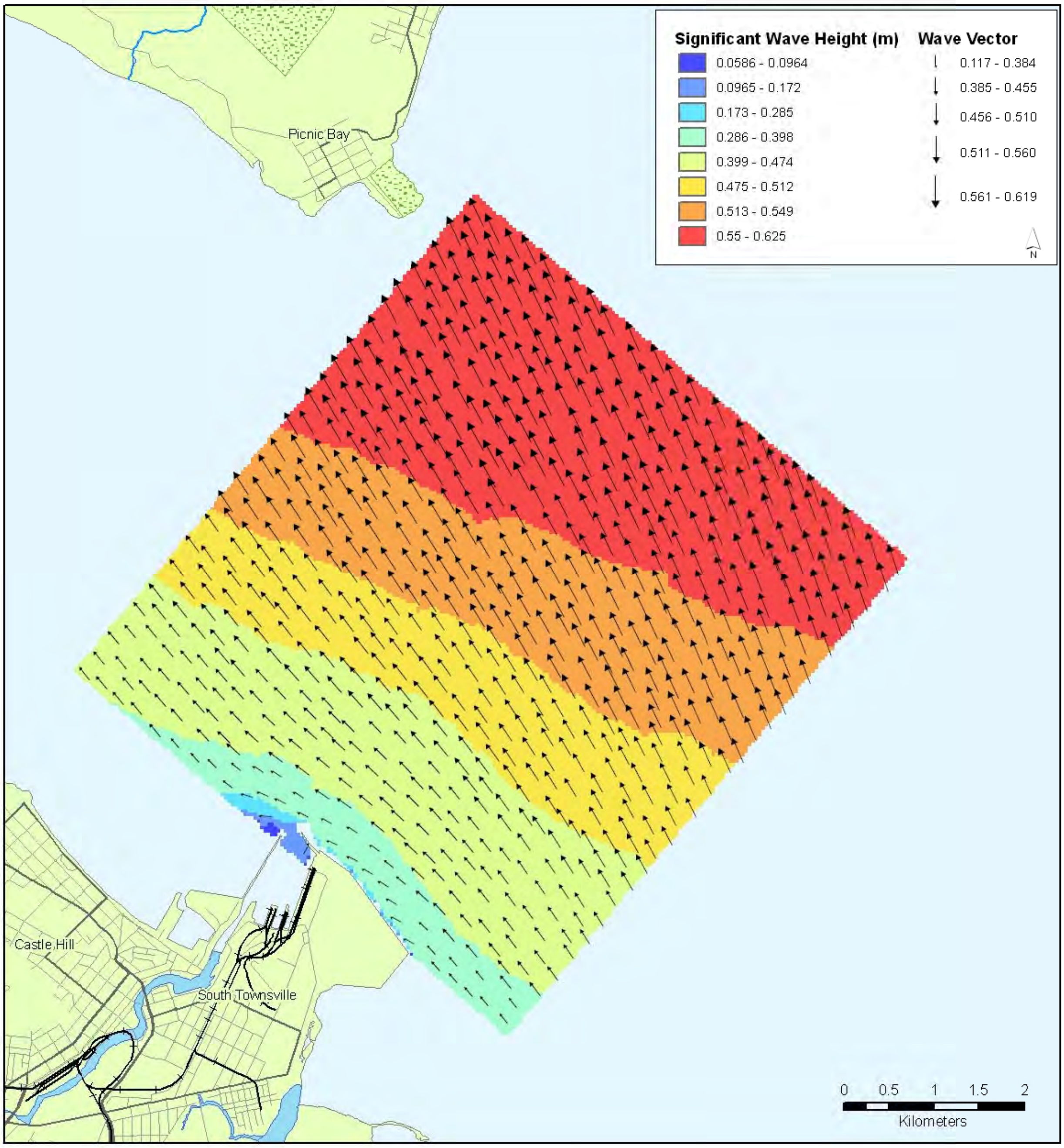

Figure 4-5 **Computed significant wave height for wind wave (speed = 10m/s, direction=165deg)**

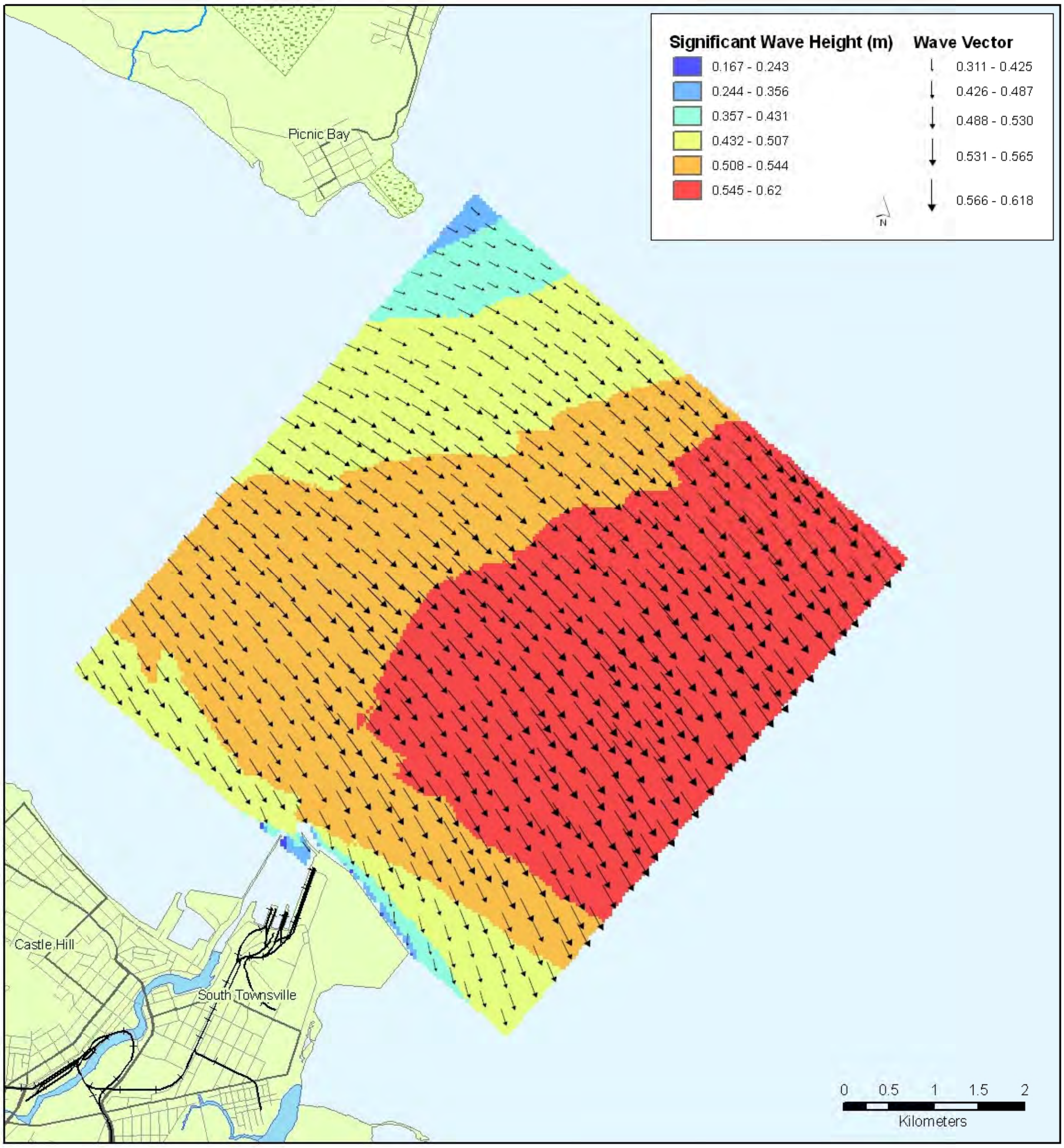

Figure 4-6 Computed significant wave height for wind wave (speed = 10m/s, direction=315deg)

4.2 Storm Waves from the North-East Sector

Simulations for the storm wind waves were undertaken by forcing the SWAN model with extreme storm winds. An extreme water level of MSL + 2m AHD was adopted to include the influence of storm surge. The extreme wind conditions defined by the Standards Australia AS/NZS1170.2 for the Townsville region were used to drive the SWAN models (Table 4.3).

The 3s gust was converted to hourly mean speeds by multiplying by a factor of 0.6 as recommended by AS 3962 (Guidelines for Design of Marinas). The longest available fetches from ENE and NE relative to the ADCP location were selected as the wind directions for each of the extreme wind speeds. The model results are presented in Table 4.4 and Table 4.5.

Table 4.3 Extreme wind speeds for various storm return periods

Average return interval (ARI) (years)	3s Wind Gust (m/s)	Hourly mean wind speed (m/s)
50	52	31
100	56	34
500	66	40

Table 4.4 Extreme wind wave conditions from ENE at the ADCP location

Average return interval (ARI) (years)	Significant wave height H_s sea (m)	Peak wave period T_p (s)	Wave direction (deg N)
50	2.6	6.0	65
100	2.8	6.0	64
500	3.3	7.3	62

Table 4.5 Extreme wind wave conditions from NE at the ADCP location

Average return interval (ARI) (years)	Significant wave height H_s sea (m)	Peak wave period T_p (s)	Wave direction (deg N)
50	2.4	6.6	50
100	2.6	6.6	49
500	3.1	7.3	46

The storm waves in Table 4.4 are approximately 0.5 m lower than those reported by Cardno Lawson Treloar (CLT) (2009). The extreme waves determined by CLT were based on extrapolating the modelled waves generated by 11 cyclones using extreme value analysis. The CLT model has been calibrated against cyclonic conditions only using the EHP Waverider Buoy off Cape Cleveland. The model has not been calibrated inside the Cleveland Bay. The present model set-up uses the extreme winds as per AS1170.2, where cyclonic wind conditions are taken into account. The model has been calibrated successfully inside the Cleveland Bay against the ADCP wave measurements. Therefore, the results presented in Table 4.4 are considered to be reliable and suitable for wave conditions inside Cleveland Bay.

Wave height coefficients for transformation from the Waverider site to nearshore locations, shown in Figure 4-7, were derived from the CLT SWAN modelling (CLT, 2009) and are presented in Table 4.7.

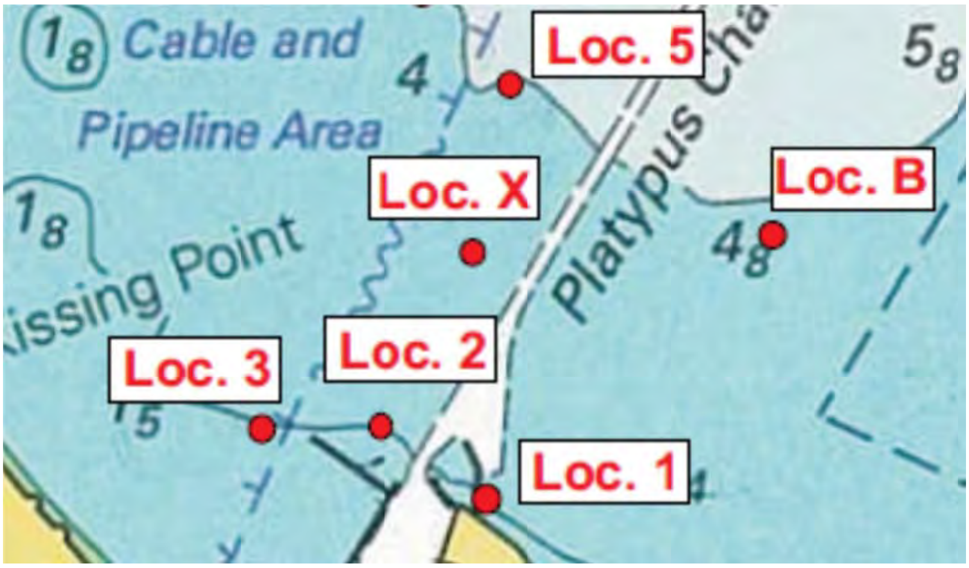

Figure 4-7 Locations of sites for nearshore wave coefficients from the Waverider site derived from SWAN modelling (CLT, 2009)

Table 4.6 Wave height transformation coefficients for Location B and Location 5 in Figure 4-7 (from CLT, 2009)

Waverider		Location B				Location 5			
Dir °TN	Tp(s)	Dir °TN	Tm01(s)	Tp(s)	Kt	Dir °TN	Tm01(s)	Tp(s)	Kt
22.50	6.0	22.4	4.69	5.97	0.46	39.3	4.25	5.42	0.32
22.50	7.0	22.1	5.03	6.40	0.43	39.6	4.30	5.48	0.27
22.50	8.0	21.8	5.50	7.01	0.40	39.9	4.41	5.62	0.23
22.50	9.0	21.6	6.09	7.76	0.37	40.3	4.58	5.83	0.20
45.00	6.0	29.6	5.08	6.47	0.69	48.0	4.41	5.62	0.45
45.00	7.0	27.7	5.65	7.20	0.69	48.8	4.54	5.78	0.40
45.00	8.0	26.3	6.34	8.08	0.68	49.5	4.75	6.05	0.35
45.00	9.0	25.2	7.09	9.04	0.67	50.2	5.04	6.42	0.30
56.25	7.0	29.9	6.06	7.72	0.73	53.2	5.19	6.62	0.44
67.50	7.0	31.3	5.83	7.42	0.58	54	4.97	6.33	0.37
90.00	6.0	44.2	5.44	6.93	0.36	59.8	5.07	6.45	0.32
90.00	7.0	38.2	6.31	8.04	0.40	59.1	5.71	7.27	0.32
90.00	8.0	34.0	7.22	9.19	0.44	58.8	6.43	8.20	0.31
90.00	9.0	31.2	8.11	10.33	0.46	58.8	7.19	9.17	0.31

As depicted in Table 4.7, the wave height transformation coefficients at location B, which is on the Waverider side of the Platypus Channel, generally were, on average, some 60% higher than those in the equivalent water depth at Location 5 on the “lee” side of the channel. This is attributed to wave reflection off the Platypus Channel.

4.3 Storm Waves from the North-West Sector

The impact of strong north-westerly winds was investigated to determine the magnitude of the storm waves generated by these winds inside Cleveland Bay. The SWAN model was run for the various ARI wind speeds presented in Table 4.3. The storm tide of MSL + 2m AHD was included in the model runs. The modelled waves at the ADCP location are presented in Table 4.7. These results gave wave heights some 10-30% higher than those derived in CLT (2009) with commensurate wave periods.

Table 4.7 Extreme wind wave conditions from NW at the ADCP location

Average return interval (ARI) (years)	Significant wave height H_s sea (m)	Peak wave period T_p (s)	Wave direction (deg N)
50	2.0	4.1	318
100	2.2	4.5	318
500	2.6	5.0	317

5.0 Summary and Conclusions

SWAN Model for Cleveland Bay has been successfully set-up and verified using the ADCP data from September – October 2008. The main purpose has been to define the wave boundary conditions for a Boussinesq model of nearshore wave transformation to the port.

The model accurately reproduced the wave heights measured near the port. The model wind wave directions follow the offshore wind directions used to drive the wind wave model. The transformed swell wave directions using the offshore WRB waves are in good agreement with the measured ADCP swell wave directions. The model can now be used to define and extract waves anywhere within the model domain.

The frequency distribution of wave heights, periods and directions for operational waves has been computed from the ADCP data. The average H_s at the ADCP location was 0.47m and the maximum H_s was 2.3m. The instrument showed that the dominant wave direction was from the north-east to east-north-east with smaller occurrences from the east. The easterly waves at the WRB are refracted to north-east as they arrive at the ADCP location.

Extreme wind conditions from AS/NZS1170.2 have been used to simulate the extreme storm waves for 50, 100, and 500 year ARI periods.

Storm waves from the NE-ENE sector are estimated to be 3.1m with a peak wave period of 7.3s for the 500 year ARI storm while the storm waves from the NW sector have a significant wave height of 2.6 m with a peak wave period of 5s.

6.0 References

1) BMT WBM Pty Ltd, “Townsville Port Expansion Preliminary Engineering and Environment Study Hydrodynamic Modelling (1.11)”, prepared for Maunsell Australia by BMT WBM Pty Ltd, Report No. R.B16930.005.02._1.11_Final.doc, July 2009.

2) Booij N, Ris, R C and Holthuijsen LH , “ A third-generation wave model for coastal regions, Part I, Model description and validation”, Journal of Geophysical Research, 104, C4, 7469-7666, 1999.

3) Cardno Lawson Treloar Pty Ltd, “Townsville Port Expansion offshore wave climate study”, report prepared for AECOM Australia by Cardno Lawson Treloar, Report No. LJ2752/R2508v3, July 2009.

Appendix B

BOUSS2D Wave Modelling

Appendix B: BOUSS2D Wave Modelling

Table of Contents

1.0 Introduction

Numerical modelling of shallow water waves adjacent to the proposed site of the Townsville Port Expansion Project (PEP), refer Figure 1-1, was undertaken to determine wave height parameters for the design of the reclamation revetments and breakwaters and to assess harbour calmness for storm and normal operational conditions. A Boussinesq formulation was preferred so that severe refraction and diffraction effects would be represented.

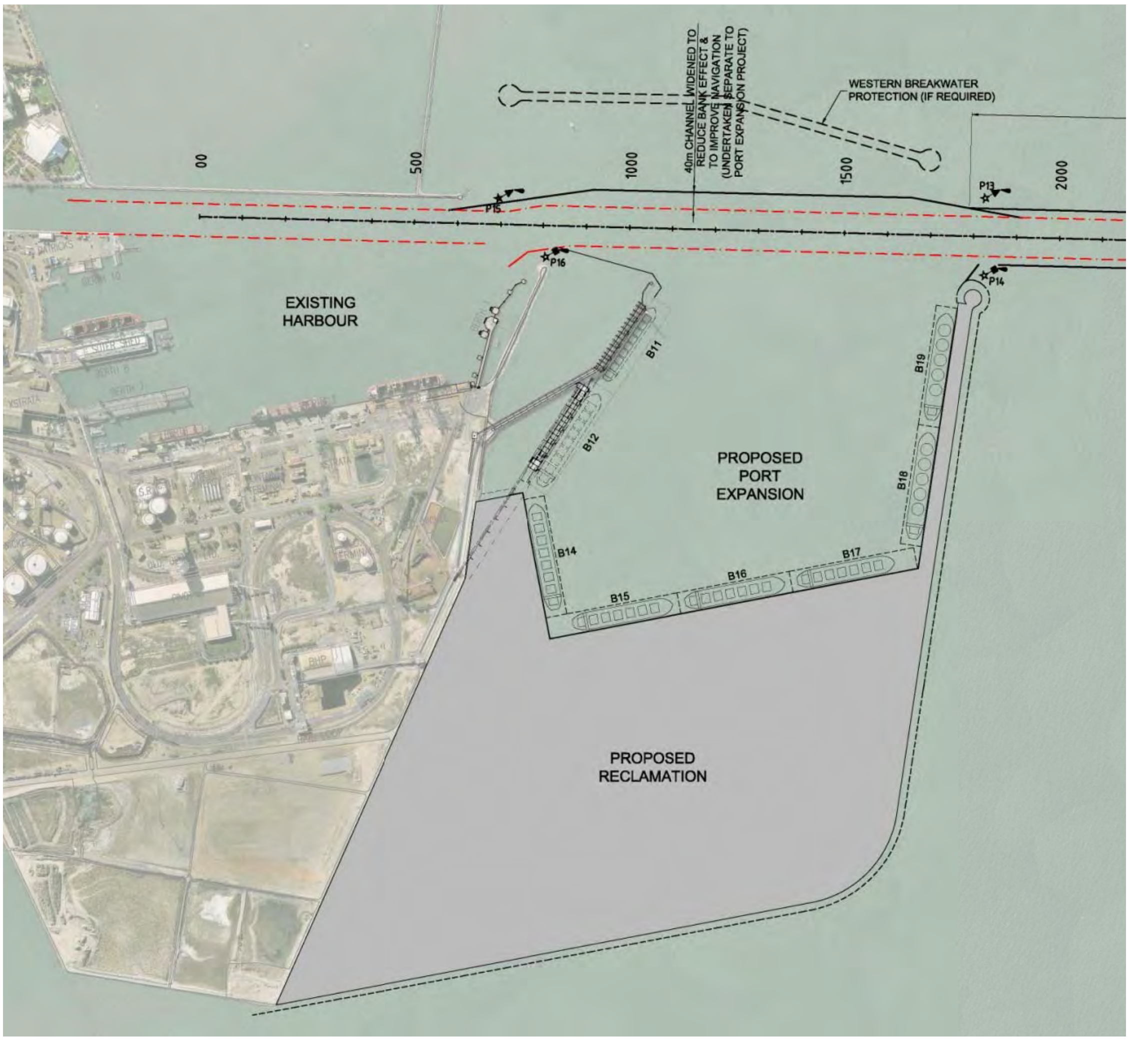

Figure 1-1 Proposed Port Expansion Project layout

2.0 Model Setup

2.1 Model Description

The modelling used BOUSSS-2D, a numerical Boussinesq-type wave modelling program developed by the U.S. Army Corps of Engineers (Nwogu and Demirbilek, 2001) and operated through the Surface Water Modeling System (SMS) interface (Aquaveo, 2008). BOUSS-2D employs a time-domain solution of fully nonlinear Boussinesq-type equations, valid from deep to shallow water, representing the depth-integrated equations of conservation of mass and momentum for waves propagating in water of variable depth. BOUSS-2D models various wave phenomena including shoaling, refraction, diffraction, full/partial reflection and transmission, bottom friction, nonlinear wave-wave interactions, wave breaking and dissipation, wave runup and overtopping of structures, wave-current interaction, and wave-induced currents. Details of the BOUSS-2D model are presented in Nwogu and Demirbilek (2001).

The governing equations in BOUSS-2D are solved in the time domain with a finite-difference method, from which water-surface elevation and horizontal velocities are calculated at the grid nodes in a staggered manner. Waves propagating out of the computational domain are absorbed in damping layers placed around the perimeter of the domain. Damping and porosity layers can be used also to simulate the reflection and transmission characteristics of jetties, breakwaters, and other structures existing in the modelling domain (Demirbilek *et al.*, 2005).

2.2 Bathymetry

The bathymetric data applied for BOUSS-2D modelling was based on Charts AUS 256 and adjusted to AHD from lowest astronomical tide (LAT) datum using a difference of 1.8m. In the present study, still water levels of above MSL and CD were applied for all simulations. The bathymetry of the modelling domain was obtained by linear interpolation of the bathymetric data sources.

2.3 Computational Domain

The modelling domain is presented in Figure 2-1. The domain dimensions were 5,550 m in x-direction (onshore) by 5,590 m in y-direction (alongshore). The grid resolution was 10 m, yielding a total of 311,360 mesh points.

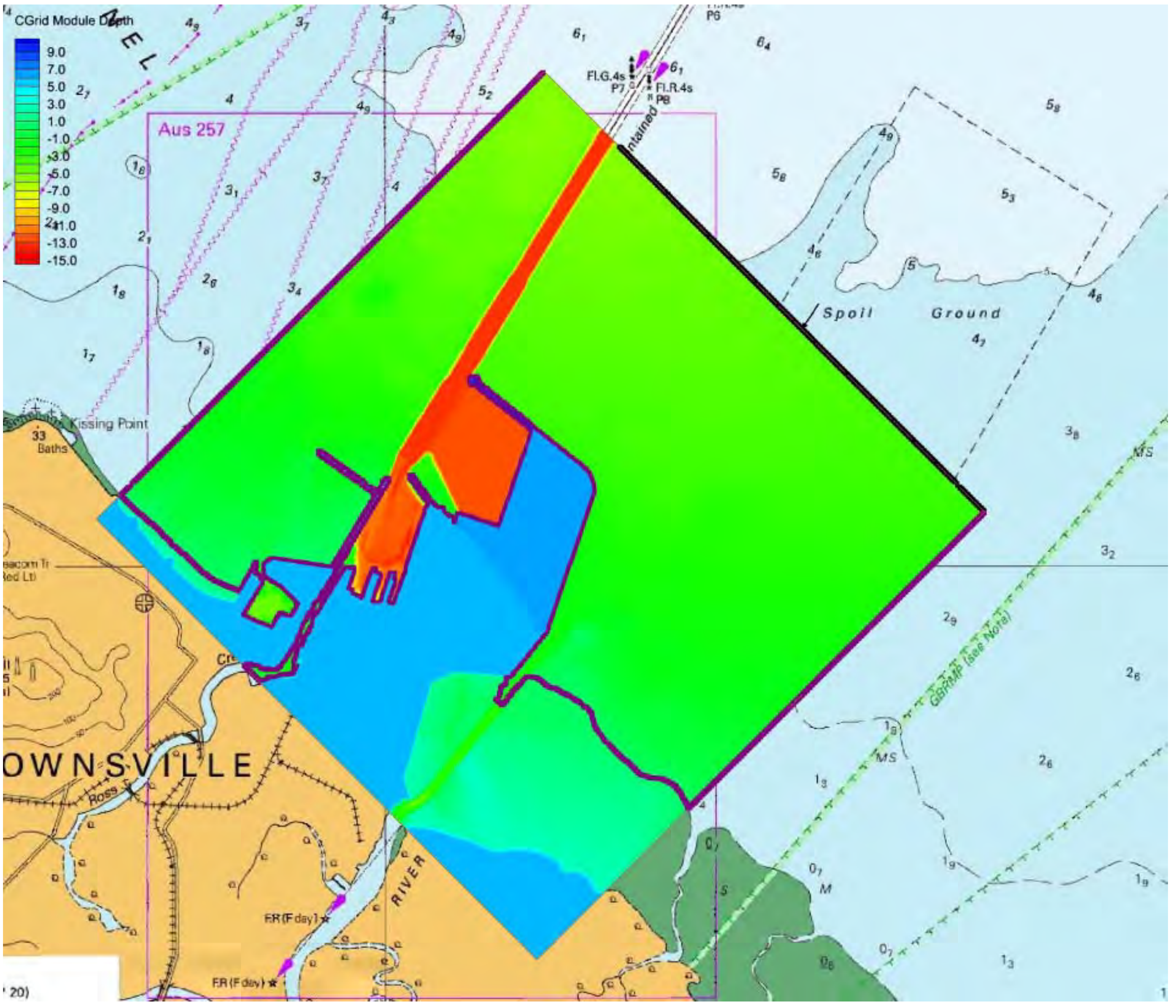

Figure 2-1 **Computational domain and bathymetry**

2.4 Boundary Conditions

Spectral wave parameters of H_s = 1.0 m, T_p = 7.5s with mean wave directions of 34°TN and 56°TN and 67°TN were discretised as an irregular, multidirectional JONSWAP similarity fitting spectrum, with the gamma frequency spreading factor equal to 3.3, and directional spread of ±25°.

Each simulation was conducted for 1500 seconds (25 minutes), which represented approximately 200 waves with a typical wave period of 7.5s. The simulation period was defined as 1500 seconds to assure that the waves were fully developed in the entire computational domain with a time step of 0.35 seconds. The bottom friction factor was set at the minimum value with a Chezy friction coefficient of 65 (Manning's number n = 0.02).

The coastline and lateral boundaries were set up as damping or 'sponge' layers. The thickness of the damping layer was varied as a function of offshore wavelength (Nwogu and Demirbilek, 2001). The characteristic parameters of sponge layer configuration were defined based on the characteristic of each type of boundary. Table 2-1 presents the sponge layer details for each boundary.

Table 2-1 Sponge layer configurations for boundaries

Boundary	Sponge Layer	
	Width (m)	Damping coefficient
Beach	25	0.9
Harbour Structures & Breakwater	40	0.5
NW and SE (Lateral Boundaries)	50	1.0

3.0 Results

3.1 Site Validation

Model validation at the Port of Townsville was achieved for the existing harbour configuration by comparing modelled wave cases with measured conditions. The available data comprised a directional Waverider Buoy located offshore in 19 m of water and, intermittently for short periods, an Acoustic Doppler Current Profiler that was deployed at the northern mooring dolphin of Berth 11, located outside the eastern breakwater (Figure 3-1).

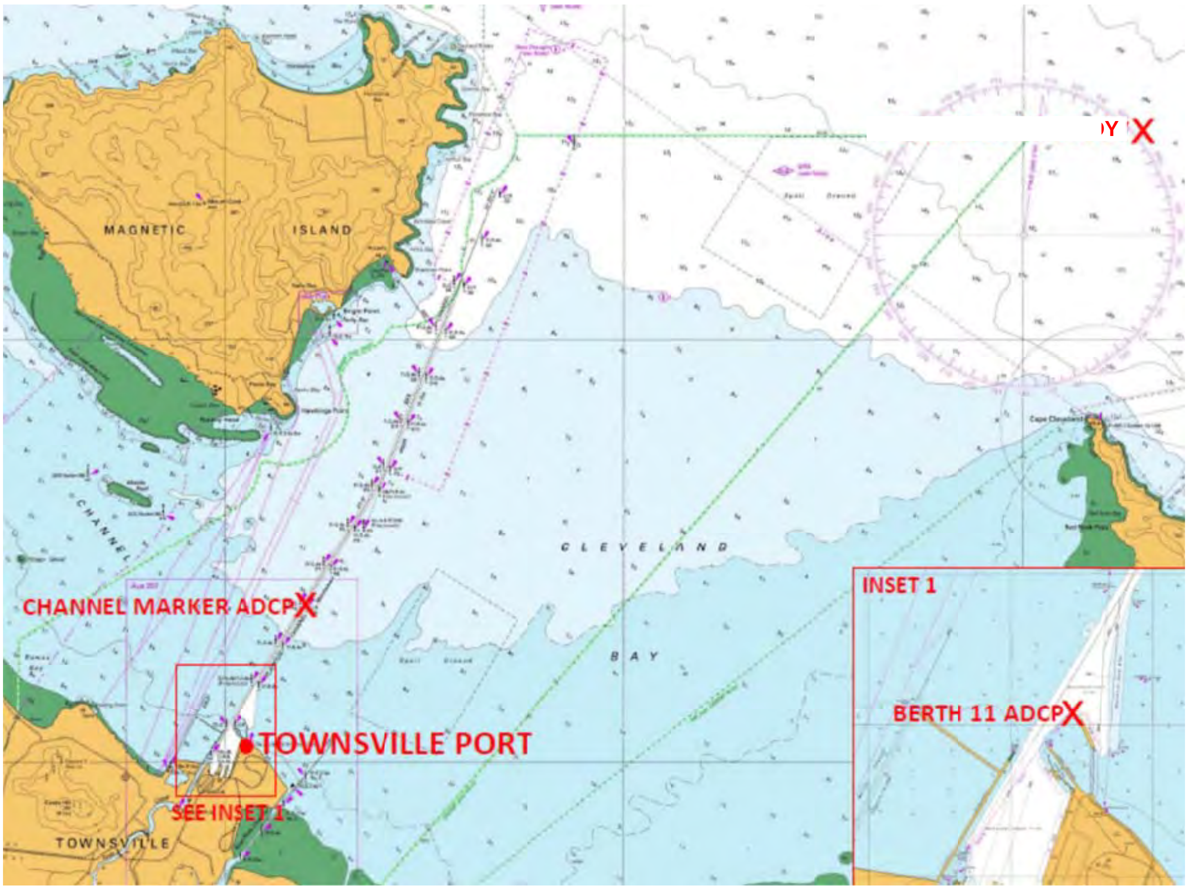

Figure 3-1 Field wave data instrument locations

Waves approach Cleveland Bay from a narrow range of easterly offshore directions (Figure 3-2) and the Platypus Channel is of such an orientation and of such dimensions that it causes wave reflection, which is portrayed by the limited available wave data.

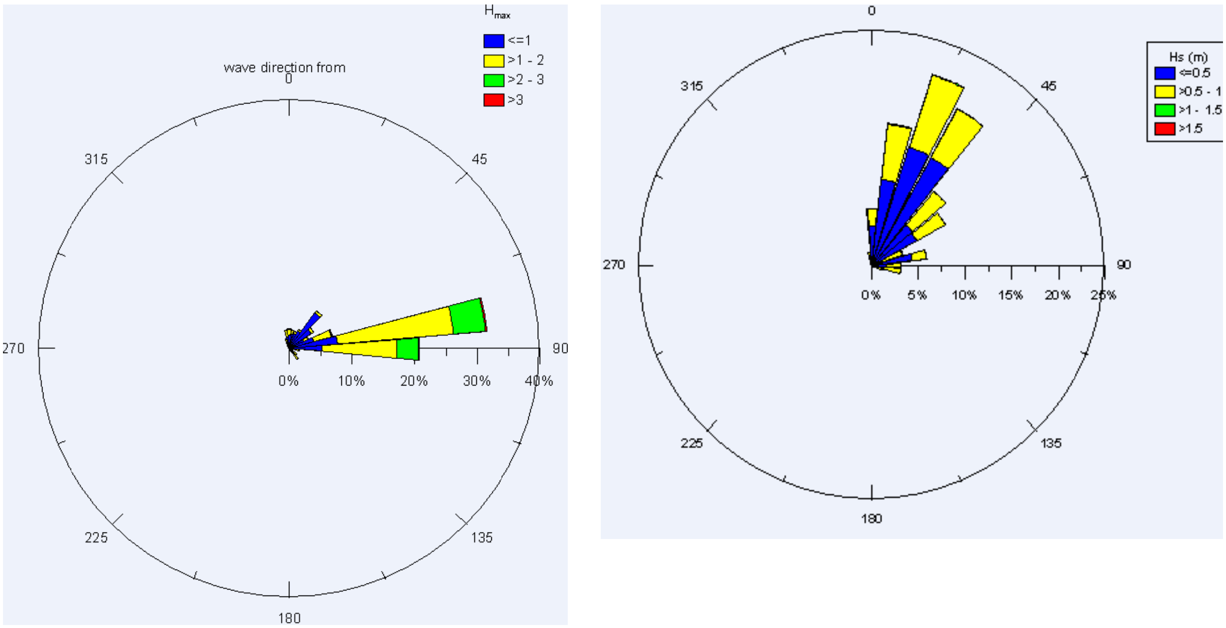

Figure 3-2 Wave heights and directions at Cleveland Bay Waverider Buoy (left) and at Berth 11 (right)

The time series of significant wave heights from these instruments are depicted in Figure 3-3. From these data, nine storms were selected when the offshore significant wave height peaked at over 1.5 m to derive inshore significant wave height coefficients at Berth 11. Those data are presented in Table 3-1, which indicated an average wave height coefficient of around 0.4 for 6s to 7s swell.

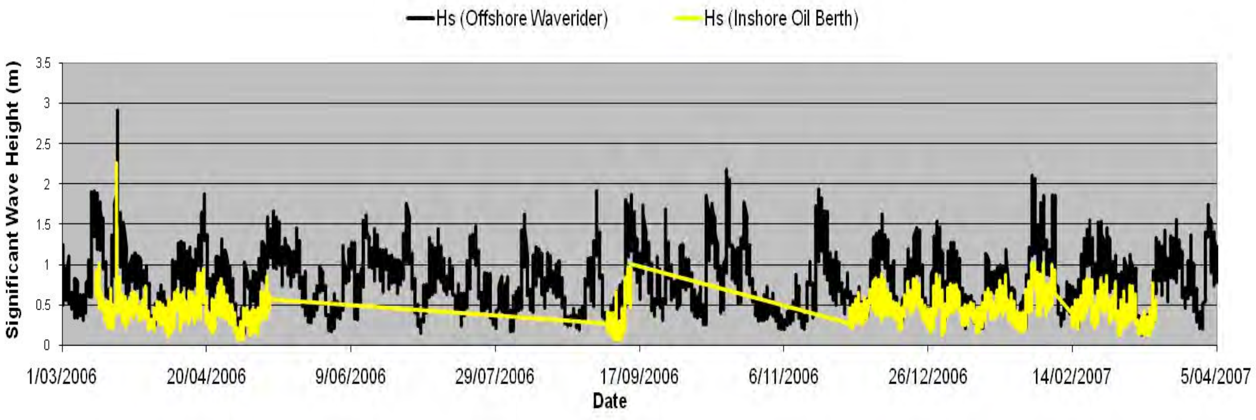

Figure 3-3 Townsville wave height data 1/3/2006 to 5/4/2007

Table 3-1 Wave coefficients for selected storms

Date time (from - to)	Average offshore H_s (m) ; T_p (s)	Average inshore H_s (m) ; T_p (s)	H_s ratio
13/03/06 20:00 - 14/03/06 00:00	1.66; 6.6	0.75; 5.6	0.45
19/03/06 22:30 - 21/03/06 04:30	2.00; 6.7	0.88; 4.4	0.44
18/04/06 19:00 - 19/04/06 11:00	1.65; 6.3	0.78; 5.0	0.47
12/09/06 21:00 - 13/09/06 02:00	1.71; 6.8	0.67; 5.3	0.39
29/12/06 20:00 - 30/12/06 06:30	1.39; 5.8	0.60; 4.3	0.43
31/01/07 06:30 - 01/02/07 08:00	1.78; 6.4	0.85; 5.0	0.48
03/02/07 17:00 - 04/02/07 03:00	1.64; 6.1	0.74; 4.7	0.45
07/02/07 11:30 - 08/02/07 04:30	1.71; 7.3	0.78; 4.9	0.46
20/02/07 03:00 - 20/02/07 04:00	1.53; 6.8	0.53; 5.2	0.35

The modelling approach comprised offshore wave transformation using SWAN from the Waverider Buoy location to the boundary of the BOUSS2D model (~5m CD isobath – Appendix A) then the BOUSS2D model was used to propagate the transferred wave conditions to Berth 11 area. The BOUSS2D model domain is portrayed in Figure 3-4.

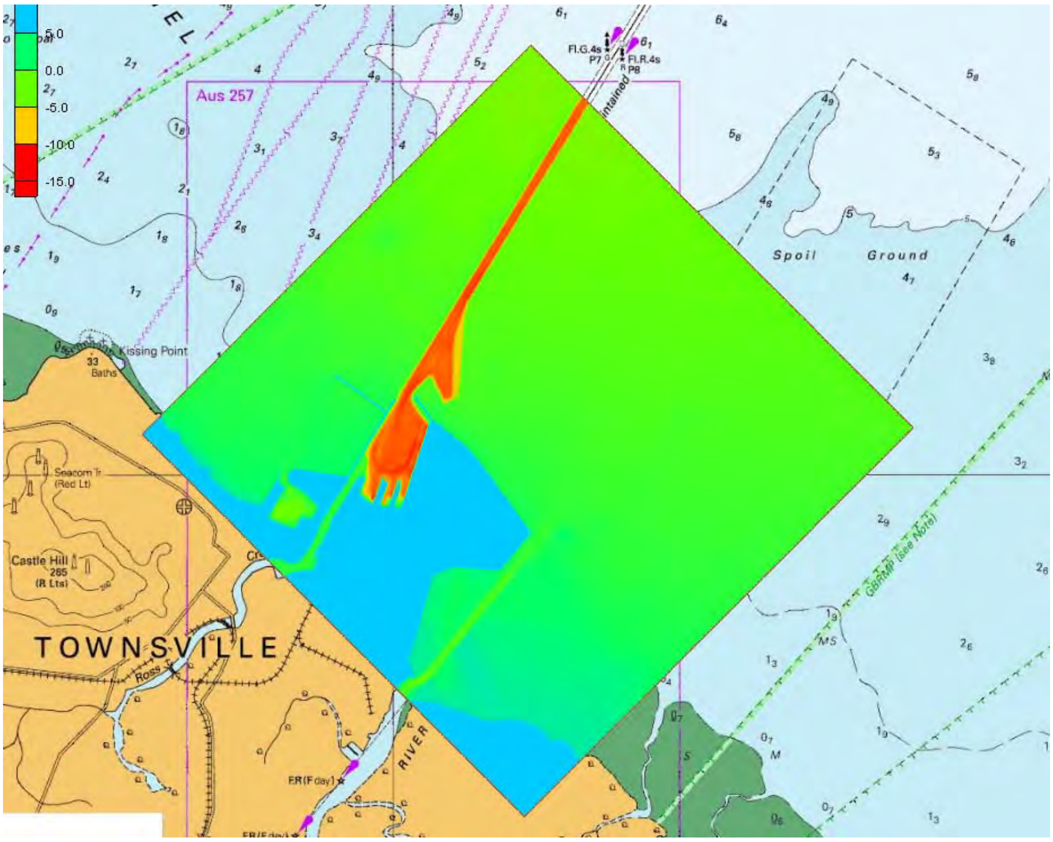

Figure 3-4 BOUSS2D model domain existing conditions

The calibration comprised the following SWAN model parameters: Jonswap spectrum with H_s = 1.5 m; T_p = 7 s; wave direction 56.25°TN; directional spread of ±25° with a friction coefficient of 0.001. The wave height coefficient obtained at the boundary of the BOUSS2D model was 0.73 with a nearshore wave direction of 30°TN and period 7.7 s. The BOUSS2D model had a grid resolution of 10 m. The following model parameters were used: Jonswap spectrum with H_s of 1.0 m; T_p of 7.5 s; wave direction 34°TN; directional spread of ±25° with a Chezy friction coefficient of 65 (Mannings n = 0.02). The model was run for the existing bathymetry including the Platypus Channel and with the channel filled in to the level of the surrounding sea bed.

The combined results from the models and observed data are presented in Figure 3-5. It is shown clearly that the amount of wave energy reaching Berth 11 was reduced significantly from that which would otherwise occur without the channel. The modelled nearshore wave height coefficient for the existing channel was 0.38 whereas that for the model with the channel filled in was 0.63, indicating that some 60% of the incident wave energy had been reflected off the dredged channel and away from Berth 11. The observed data had an average coefficient of 0.44, confirming the modelling results.

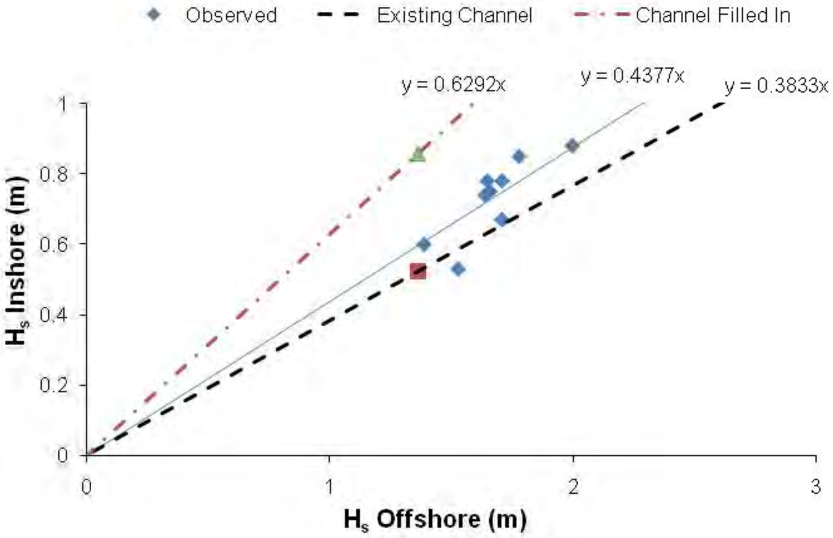

Figure 3-5 Observed wave height coefficients at Berth 11 and those modelled with and without the Platypus Channel

The results indicated that the BOUSS2D model was suitable for assessing nearshore wave transformation for the developed layout plan. It showed also that Berth 11 was well protected from easterly swell waves due to the wave energy reflection characteristics of the dredged channel configuration.

3.2 Easterly Conditions

3.2.1 Wave Fields

Wave fields for three easterly offshore swell wave directions, which encompass the range determined from SWAN modelling (Appendix 1), are presented in Figure 3-6, Figure 3-7 and Figure 3-8. These wave fields represent wave height coefficients for a peak swell wave period of 7.5 s as the incident wave height used was 1.0 m.

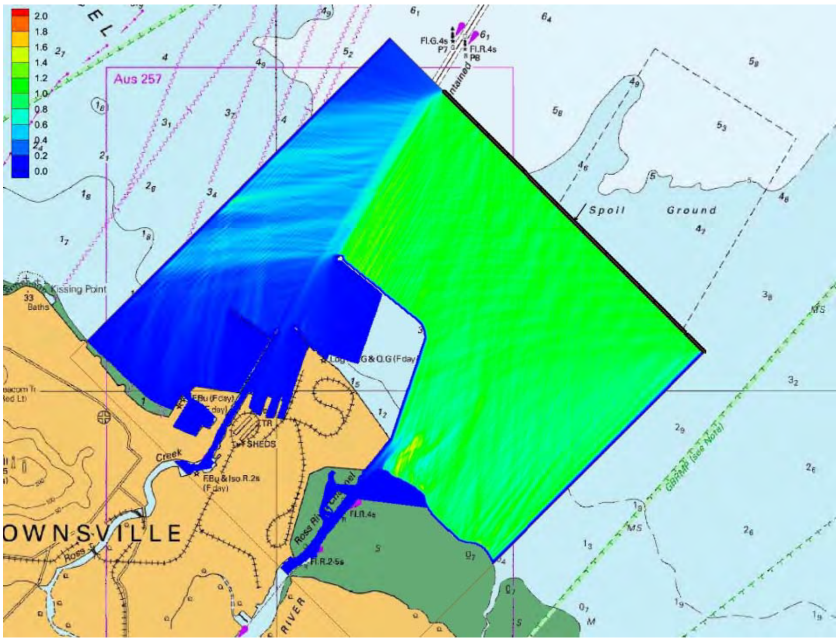

Figure 3-6 Computed Wave Field for offshore wave direction 34° (water level 2m CD)

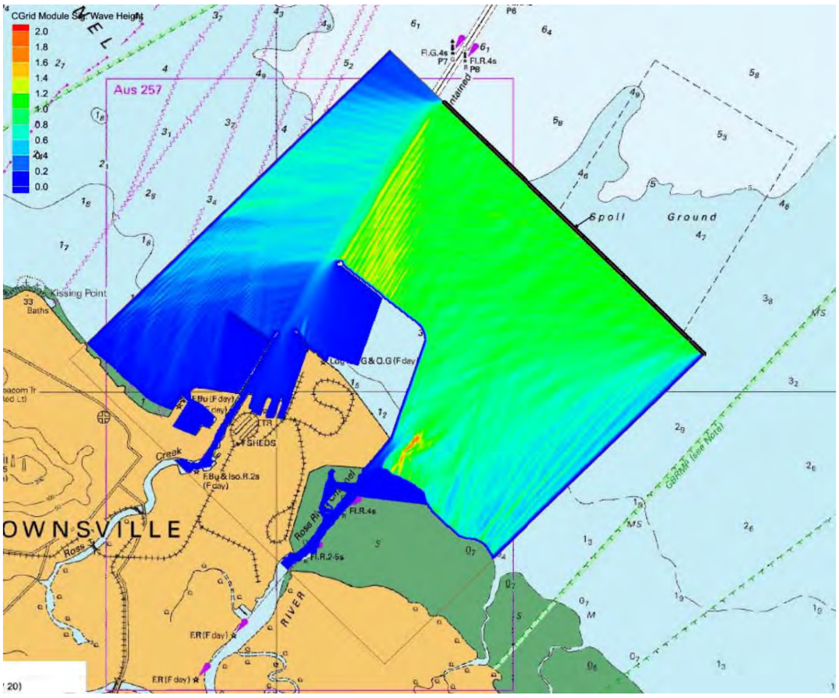

Figure 3-7 Computed Wave Field for offshore wave direction 56° (water level 2m CD)

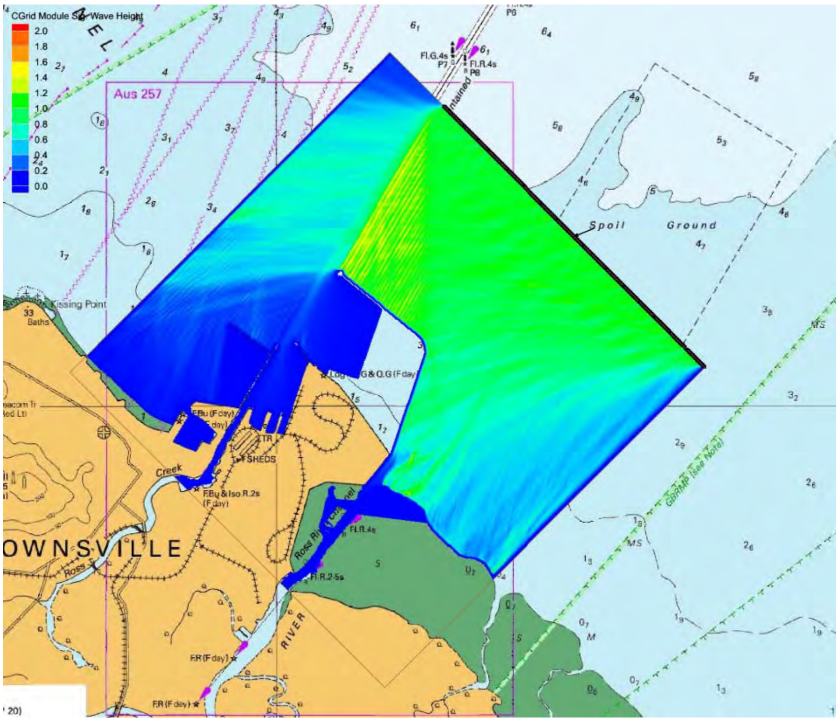

Figure 3-8 Computed Wave Field for offshore wave direction 67.5° (water level 2m CD)

It is noted that Figure 3-7 represents the most prevalent wave direction.

All figures showed that the proposed berths would be well protected from waves from the NE quarter. More interestingly, however, the figures showed that wave reflection off the Platypus Channel resulted in wave focussing onto the eastern breakwater. Wave energy reflection increased at lower water levels.

3.2.2 Wave Conditions on the Northern Breakwater

Details of the wave height coefficients computed for the northern breakwater and reclamation revetment are presented in Figure 3-9 and Figure 3-10. These range from around 1.4 for the breakwater and 1.3 for the revetment.

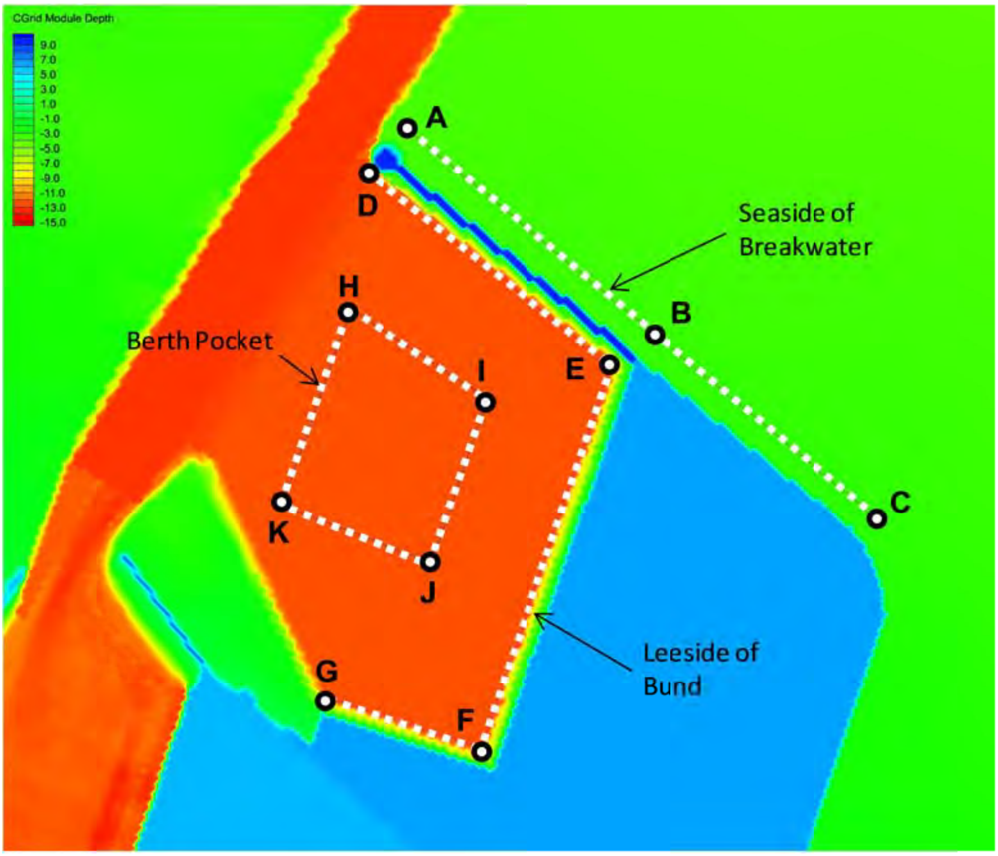

Figure 3-9 Location of wave height coefficients presented in Figure 3-12, Figure 3-11 and Figure 3-12

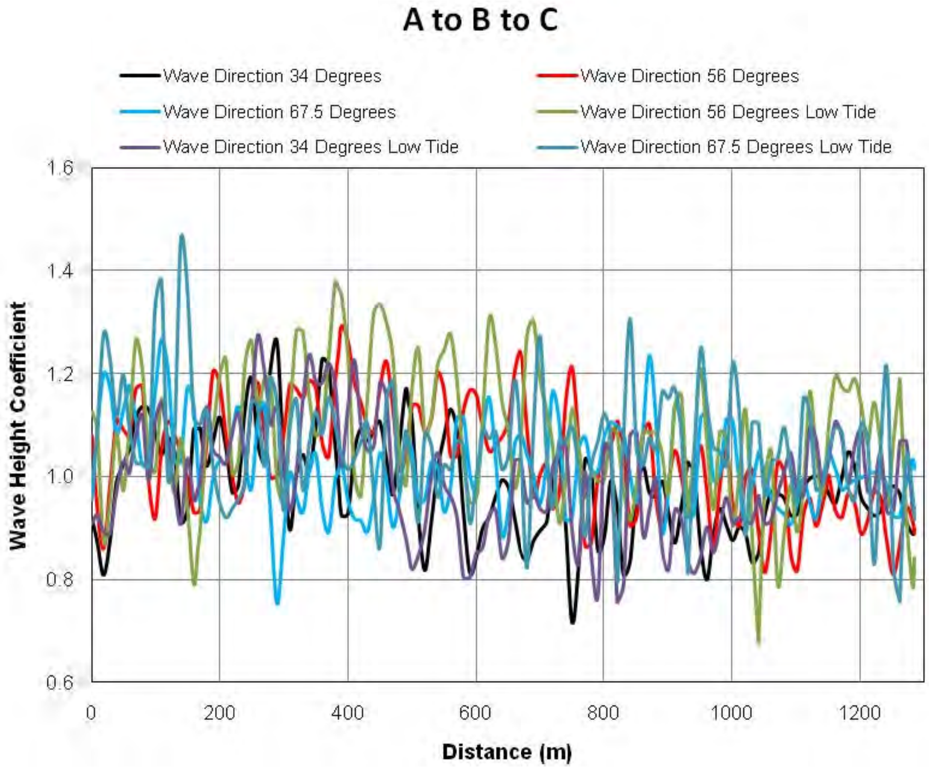

Figure 3-10 Wave height coefficients from the ADCP channel marker site to a line along the proposed northern breakwater and reclamation revetment shown in Figure 3-9

3.2.3 Wave Conditions within the Port

Wave height coefficients computed for the berths and within the harbour are presented in Figure 3-11 and Figure 3-12. These show that the northern breakwater provide complete wave protection from the north-easterly quadrant.

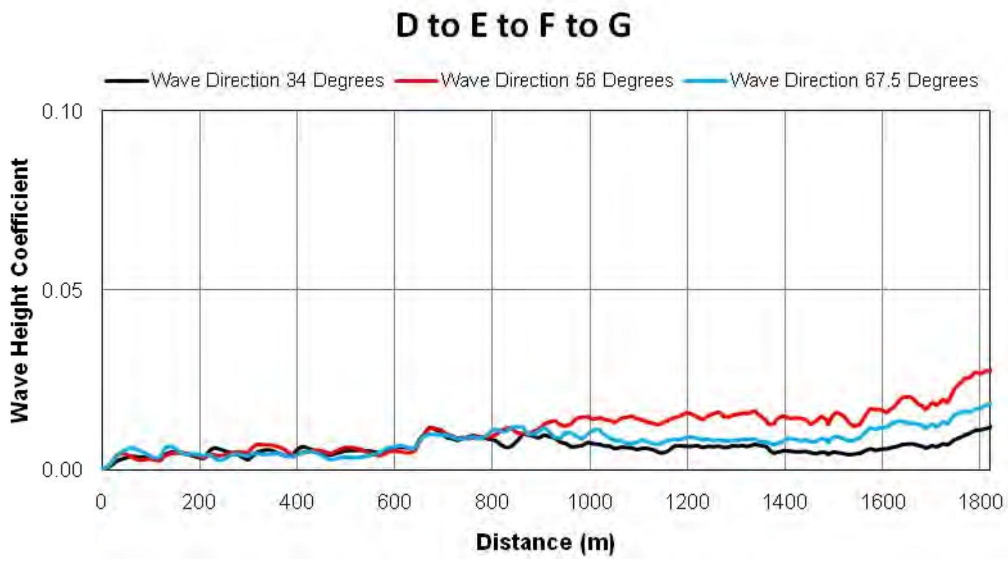

Figure 3-11 Wave height coefficients from the ADCP channel marker site to a line along the proposed berths shown in Figure 3-9

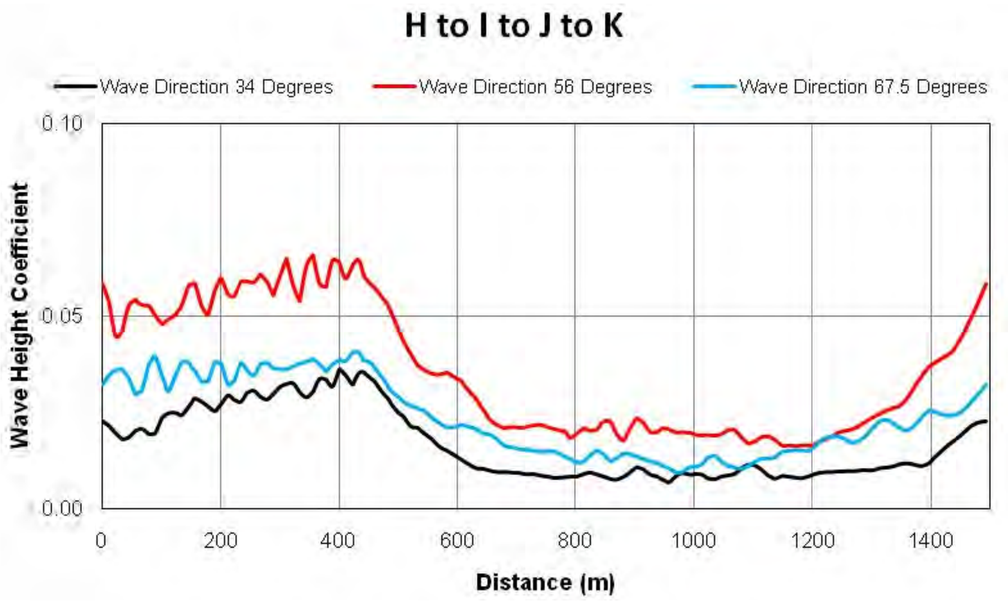

Figure 3-12 Wave height coefficients from the ADCP channel marker site to a line defining the port precinct shown in Figure 3-9

4.0 Summary and Conclusions

A Boussinesq wave transformation model has been developed and validated with field data for nearshore wave transformation at the Port of Townsville. The modelling results have been verified also with photographic observations during storms and with images from aerial photography. The modelling of existing conditions has indicated that acceptable wave conditions at the proposed berths could be achieved without constructing the northern breakwater.

Construction of the northern breakwater would provide very calm wave conditions at the berths for waves emanating from the north-eastern quadrant. The modelling has shown that wave energy from the north-eastern quadrant would be reflected by the bathymetric discontinuity presented by the Platypus Channel and this would cause wave focussing on the breakwater and reclamation revetment. The modelling indicates that up to 100% of the incident wave energy would be reflected off the Channel to become incident on the breakwater and revetment.

5.0 References

1) AECOM Australia Pty Ltd, “Townsville Port Expansion Preliminary Engineering and Environment Study”, prepared for Port of Townsville Limited, April 2009.

2) Nwogu O & Z Demirbilek, “*BOUSS-2D: A Boussinesq wave model for coastal regions and harbors*” ERDC/CHL TR-01-25, U.S. Army Engineer Research and Development Center, Vicksburg, MS, 2001.

3) Zeki Demirbilek Z, Zundel A & Nwogu O, “BOUSS-2D Wave Model in SMS: Tutorial with Examples”, ERDC/CHL CHETN-I-70. U.S. Army Engineer Research and Development Center, Vicksburg, MS, 2005.

Port Expansion Project EIS

Appendix E4

Dredge Material Disposal Options Assessment

AECOM BMT WBM

A part of BMT in Energy and Environment

BMT WBM

Dredged Material Disposal Options

R.B17733.009.05.DMPA Options Assessment.doc
March 2013

Dredged Material Disposal Options

Prepared For:	AECOM
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Title :	Dredged Material Disposal Options
Author :	Greg Fisk, Brad Grant
Synopsis :	This report provides the findings from an assessment into a number of dredged material disposal options for the PEP.

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1 INTRODUCTION

As outlined in Part A of the EIS, a large proportion of the overall volume of material to be dredged as part of the Port Expansion Project (PEP) consists of firm to stiff subsurface material which would be suitable (although not ideal) for beneficial re-use as reclamation fill and could be placed in a confined reclamation area adjacent to the current port. This area has been sized to meet future port operational needs as well as to accommodate the vast majority of the dredged material from the dredging of the basin for the Outer Harbour. It is anticipated that the dredged material (excluding soft marine sediments) from the creation of the proposed harbour basin area would be dredged using a cutter-suction dredge (CSD) with direct placement of the dredged material to reclamation by pipeline.

The original concept design for PEP (as part of the Port of Townsville Master Plan 2007) was further developed as part of the Preliminary Engineering and Environment Study (PEES) (AECOM 2009). As a result of PEES investigations, the volume of dredged material potentially requiring at-sea disposal was minimised by optimising the reclamation area. The reclamation area maximises the re-use of dredged material, balanced against the need to minimise environmental impacts and to size the overall footprint to be consistent with the operational requirements of the facility.

Above what is required for reclamation filling, there is expected to be approximately 5.6 million m^3 of surplus material that will be dredged as part of the development of the Outer Harbour and Platypus and Sea Channels. The quantity of material to be dredged as part of the channel development could not be placed within a reasonable reclamation footprint and an alternative end-use of the material is therefore required.

The most cost effective way of relocating this surplus material will be to place it in an approved offshore location. Accordingly, unconfined at-sea placement is proposed for dredged material associated with the following stages of the port expansion:

1) Initial site preparation – involving the removal of 1.5 million m^3 of soft marine sediments from the surface layers of the Outer Harbour and future reclamation area.

2) Platypus and Sea Channel dredging – involving the removal of 4.1 million m^3 of dredged material associated with the deepening of the Platypus Channel and deepening and extension of the Sea Channel.

The preferred option for at-sea disposal is placement in the existing approved dredged material placement area (DMPA) which is located outside of the Great Barrier Reef Marine Park and has been used for dredged material placement for many years.

Nevertheless, as per Section 5.10.9 of the EIS Guidelines (DSEWPC 2011), alternatives to the existing DMPA have also been assessed. Therefore, this section outlines alternatives and options to placement of this excess material at sea including the viability of on-shore re-use of the dredged material that is proposed to be placed offshore.

2 VIABILITY OF ONSHORE RE-USE OF DREDGED MATERIAL

Reclamation is the most cost effective beneficial use of dredged material on land as it minimises material handling costs, and is able to absorb the considerable quantity of material involved. The alternative is to bring the material onshore and use it either for land based filling or to reprocess it for use a raw material for manufacturing purposes, such as brick making.

Onshore re-use was examined as a method of disposal of dredged material with a potentially lower marine environmental impact than sea disposal. Potential environmental benefits from onshore disposal include:

- Reduced risk of smothering of benthic habitat from placement at disposal sites.
- Reduced risk of alteration of endemic substratum types.
- Reduced risk of additional turbid plumes in the vicinity of placement areas and subsequent effects on benthic primary producer habitat during placement.
- Reduced risk of resuspension of placed materials and subsequent settlement on benthic habitats beyond the boundaries of the DMPA.

Given the apparent benefits of onshore re-use, the potential for onshore disposal is discussed below in the following areas:

- Method of dredging.
- Potential pumping distances.
- Quantities and quality of material.

2.1 Method of Dredging

Three methods of dredging are viable on the Port Expansion Project:

- Cutter suction dredging (CSD): this method uses a suction tube which has a cutter head at the suction inlet to loosen the earth and transport it to the suction mouth. The cutter can also be used for hard surface materials such as gravel or rock.
- Backhoe dredging (BHD): this method uses barge mounted excavators to remove material which is typically then placed onto self-propelled hopper barges. Grab dredging is similar except uses clam shell buckets to remove the material.
- Trailer suction hopper dredging (TSHD): this method trails a suction pipe which removes material from the bed and loads the dredge spoil into hoppers on the vessel.

For the main body of dredging it is likely that work will be a combination of a medium TSHD (for deepening of the Platypus and Sea Channels), a CSD (for Outer Harbour basin), and a large BHD (for minimal widening of the Outer Harbour end of the Platypus Channel between P11/P12 and P13/14). A combination of small TSHD and large BHD is expected to be used to remove the soft marine sediments of the Outer Harbour basin and reclamation area during the initial site preparation.

For the channel areas, the quickest and most efficient dredging method is for TSHD and BHD (with self-propelled hopper barges) as they are able to remove material, place material at the DMPA and head back to the channel dredge area. A TSHD or a BHD would be able to work continuously over 24 hour period ensuring the project is completed in the shortest timeframe possible which would reduce the overall impact of dredging on the environment and on shipping.

If dredged material from the channel areas were to be re-used onshore, the timeframe for dredging these channel areas would be significantly extended due to the need for material rehandling from a TSHD / BHD. Furthermore, the use of a CSD in the channel areas is not a viable option due to the unacceptable disruption to shipping in the channels throughout the dredging operation.

2.2 Potential Pumping Distances

For CSD dredging of the Outer Harbour area, the dredged material is proposed to be pumped into the future reclamation area adjacent to the current port using 700 mm diameter pipelines.

For the channel dredging, if the material is to be re-used onshore, it would not be practical to pump the dredged material via pipelines due to the distances involved. This would require pipelines extending a distance of up to 16 km from the furthest dredging location. Aside from the practicalities of installing and operating these pipelines, the costs involved would be significant. Pumping would effectively increase the per unit volume cost of removal and disposal of material resulting in pumping ashore becoming uneconomical. Furthermore, a pipeline would create additional risk to navigational safety for commercial and recreational traffic.

The operational reliability (including risk of damage) of a 16 km length of pipeline is significant particularly given the length of the pipeline and the exposure of the pipeline to some of the extreme weather events in the area. Damage to a pipeline carrying the dredged material could result in unchecked discharges of the dredge slurry to the marine environment and the associated issues with nearshore turbid plumes and sedimentation.

2.3 Material Quantities and Qualities

The material to be dredged in this project will be mainly of two types: soft marine mud or silt, and stiff clay. The dredging process will turn the marine silt into a slurry, and will turn the stiff clay into either a slurry, resulting from the trailer suction hopper dredge operation, or a matrix of clay balls and slurry resulting from a cutter suction dredge operation.

There may be a small quantity of rock dredged from the channel at the north-eastern end, but the dredging process will render this material into a similar form as the stiff clay. There may also be a small quantity of sand.

Marine Silt

It would not be practical to re-use the soft marine silt on land. The material would need to be dried out and treated in some fashion to enable it to be handled for re-use onshore. Even after drying and treating, which would take several years, the silt would form a soft, weak material unsuitable for re-use as fill or similar engineering use without cement stabilisation. Initially it would need to be contained in a pond onshore to allow it to drain and dry out and be treated. Such a pond would need to be within pumping distance from the dredge site, as this would be the only practical way to bring the slurry material onshore. It is anticipated that there will be approximately 2 million m^3 of marine silt to be removed from the project area, which would result in about 4 - 6 million m^3 of liquid slurry created by the dredging process. The pond would need to be approximately 600,000 m^2 to 2,000,000 m^2 or 60 to 200 hectares in plan area to contain this volume, assuming a pond 3m deep. There is no practical site of this area within pumping distance from the works.

Stiff Clay

While the stiff clay from dredging of the Outer Harbour basin will be used as reclamation fill, the stiff clay from channel dredging could be used for fill once brought onshore. However, this stiff clay would still require some drying out and consolidation. It would initially have to be stockpiled close to the works and then transported overland by truck to its final destination. There will be approximately 3.6 million m^3 of stiff clay to be dredged from the channel areas, and at a stockpile height of 3m would occupy an area of approximately 1.2 million m^2 or 120 hectares. Around half a million truck loads would be required to transport this material to a long term storage site or beneficial re-use site. Furthermore, it is highly unlikely that the Townsville area could absorb 3.6 million m^3 of fill, and thus re-use as fill would not be practical.

Reprocessing the clay, such as for brick making, would also not be practical given the volumes of material involved. 3.6 million m^3 of clay would make over 1.5 billion house bricks, again a number unsustainable in the Townsville region. Furthermore, transport would also still pose an issue for brick making (i.e. half a million truck loads required to transport the clay).

Sand

The only material from the dredging process likely to have practical beneficial re-use (other than for reclamation fill) would be sand, if any was found in useful quantities. The principle beneficial re-use would be for surfacing the reclamation and for creating the surcharge needed for consolidation of the reclamation fill. This would also reduce the quantity of sand required to be imported from other areas.

2.4 Other possible beneficial re-uses

Other possible beneficial re-uses of dredge material include beach nourishment, habitat development, levee maintenance and rehabilitation, construction fill, and cover at existing sanitary landfills. A common form of habitat development using dredged material is the creation or restoration of tidal wetlands (SFBRWQCB, 2000). However, no local construction project could be identified in which the dredged material could be beneficially reused.

The high fines content of material from the dredge areas renders the proposed dredge material unsuitable for beach nourishment as the majority of material would not be stable under the moderate wave climate typical of the shallow waters of Cleveland Bay.

The characteristics of the sediments (i.e. high fines content) also make the material unsuitable for use as fill or other purposes. Most topsoils comprise at least 70 to 80% sand by weight due to drainage requirements and sediment from the dredge areas would require blending with additional large quantities of sand, for use as a soil product, e.g. a topsoil. Consequently for every one tonne of dredged sediment, around 3 tonnes of clean sand would need to be blended with the material. Another issue is that the high salt content of the dredged material would likely necessitate extensive irrigation (salt leaching) of the sediments before use.

2.5 Response to NAGD Key Elements

In developing an assessment framework for disposal of dredged material, the *National Assessment Guidelines for Dredging* (NAGD) (DEWHA 2009) identifies key elements for assessing disposal options for dredged material in section 4.1. Responses to each of these key elements are presented in Table 2-1 below.

Table 2-1 NAGD (DEWHA, 2009) Key Elements of Assessing Disposal Options

Element	Response
Are there opportunities to beneficially use or recycle such materials?	**Marine silts** While opportunities may exist for the re-use of dredged marine silts as engineering fill, the material is unusable without treatment including dewatering, reduction of fines content and cement stabilisation. The material in its present form is not considered of beneficial use. **Stiff clay** Notwithstanding the proposed use of stiff clay as reclamation fill, the large volume of stiff clay for other uses (such as brick making) poses issues with stockpiling, transport and demand for the end product. **Sand** If found in useful quantities, sand could be re-used for surfacing the reclamation and for creating the surcharge needed for consolidation of the reclamation fill. **Other uses** Other possible beneficial re-uses, such as beach nourishment, are considered unsuitable due to the nature of the dredged material (i.e. high fines content).
If they have no beneficial use, can they be treated to destroy, reduce or remove the hazardous constituents?	While there are no ‘hazardous’ constituents in the dredged material, the material does have a high fines content. As described above, there is a potential for drying back the material and blending with other material and cement stabilisation of the dredged material to create a fill adequate for use onsite.
If hazardous constituents are destroyed, reduced or removed, do the materials have beneficial uses?	If fines and seawater were removed from the material and the material was blended and treated with cement, there is the potential for reuse of the dredge material as fill. However, the high costs and other practicalities involved may be prohibitive to any beneficial re-uses.

Element	Response
What are the comparative risks to the environment and human health of the alternatives?	There are no known risks to human health from offshore placement of the material. Risks to the marine environment from offshore placement include: • Smothering benthic habitat from placement at disposal sites. • Alteration of endemic substrates. • Risk of additional turbid plumes in the vicinity of placement areas and subsequent effects on benthic primary producer habitat during placement. • Risk of resuspension of placed materials and subsequent settlement on benthic habitats beyond the boundaries of the DMPA. Human health risks from onshore disposal potentially include respiratory risks from dust generation as material dewaters, and from application of lime to neutralise any potential acid sulphate soils. Further safety risks result from the potential formation of surficial crusts over the top of sediment layers which retain high moisture content and therefore little load bearing strength. Environmental risks from onshore placement potentially include: • Potentially enlarged reclamation footprint due to the need to construct bunded settlement and dewatering pond, resulting in impacts to coastal processes and benthic habitat loss. • Modification of landform and associated issues with drainage, erosion and stability. • Potential for uncontrolled discharge of dredge slurry into nearshore environment from damage to pipeline dredge slurry pipeline or failure of pumping station. • Potential for breach of bunded wall and slurry discharge to terrestrial, aquatic and marine environment. • Visual impact from construction of the settlement and dewatering pond. • Potential for exposure of marine acid sulphate soils and leachate from the dewatering basin. • Potential for dust settlement on nearby sensitive receptors during construction and drying of the dredged material.

2.6 Conclusion

Notwithstanding the approximately 4.3 million m^3 of dredged material (stiff clays) from the Outer Harbour basin to be re-used in the reclamation, onshore re-use of the remainder of dredged material is considered not to be a viable option for the disposal of the material dredged for the Port Expansion Project. The high fines content in the dredged material and the dredging process renders the material unusable as untreated competent structural fill in a practical development timeframe. Substantial ground improvement works would be required to improve their engineering fill characteristics for typical port uses.

Handling and stockpiling onshore would also result in significant management issues and potential environmental effects. In addition, use of a substantial pipeline to transport the slurry material onshore from the channel areas may create an unacceptable risk to navigational safety and the nearshore environments especially in a tropical setting prone to extreme weather. While onshore re-use of selective volumes of competent fill may be technically possible, the cost to dredge and pump those materials alone is not economically viable, nor is the material likely to be utilised effectively.

Dredging in the channels using a CSD would also result in unacceptable disruption to shipping in the channels throughout the dredging campaign.

3 THE CURRENT AND ALTERNATIVE DMPAS

3.1 Suitability of the Dredged Material for Marine Disposal

3.1.1 Physical Characteristics

The sediment profile within the Platypus and Sea Channels is broadly similar to that of the proposed harbour and reclamation area.

The soft surface sediments vary in thickness but are relatively thin and are thought to arise from tidal and seasonal movement of the seabed sediments. The underlying in-situ material is generally comprised of very stiff to hard grey and brown sandy clay and medium to coarse grained clayey sand.

Previous dredging campaigns and borehole investigations indicated that there are some areas of low strength rock or cemented material in the channel, which were not successfully dredged by a smaller TSHD as part of previous development of Platypus and Sea Channels. A grab dredge was employed for excavation of small quantities of cemented materials. Anecdotal evidence suggests that this material was more prevalent on the western side of the channel.

3.1.2 Sediment Chemistry

Sediment quality data from POTL's Long Term Sediment Monitoring Programme has been reviewed and analysed (refer to Chapter B5 - Marine Sediment Quality). The purpose of this preliminary assessment was to review the analysis of surface sediments within the proposed Outer Harbour and Platypus and Sea Channels.

The National Assessment Guidelines for Dredging (NADG) provide an approach for assessing the quality of sediments and the suitability for ocean disposal. The first step of this process is to compare contaminant concentrations in sediments proposed for dredging to defined screening levels. If contaminant concentrations exceed screening levels, then further testing is required to assess their suitability for ocean disposal. However, should contaminant concentrations fall below screening levels, then dredged material is considered suitable for ocean disposal.

Statistical methods outlined in the NADG were used to compare contaminant concentrations to screening levels. This involved the calculation of the upper 95% confidence limit (95% UCL) of test data, and comparison of this value to the screening level.

For the purpose of calculating the 95% UCL, sediment quality data from monitoring sites in the proposed dredge footprint and reclamation area were lumped into five investigation areas, as follows:

1. *Outer Harbour*.
2. *Berth 11* - comprises a section of the proposed Outer Harbour dredge area adjacent to Berth 11 operations. This area was specifically delineated due to the proposed removal of surficial sediment from this area as part of Berth 11 maintenance dredging prior to the Port Expansion Project.
3. *Platypus Channel*.

4. *Sea Channel.*
5. *Rock Wall* - comprises an area along the existing north-eastern rock wall within the proposed reclamation area.

At all investigation areas except the Berth 11 area, the 95% UCL for trace metals/metalloids were below NAGD screening levels. At the Berth 11 area, nickel and lead had a 95% UCL above the respective screening level. However, it should be noted that concentrations above NAGD screening levels only triggers further testing to determine suitability for ocean disposal (i.e. Phase III assessments), and does not necessarily mean that sediment is contaminated and unsuitable for ocean disposal.

Nevertheless, the Berth 11 surficial sediment will likely be removed as part of maintenance dredging prior to the Port Expansion Project commencing, and is therefore subject to separate approvals. As such, further Phase III testing has recently been undertaken in the Berth 11 area as part of the maintenance dredging approvals process, and at the time of writing the results were being reviewed by DSEWPAC and DEHP.

As the Berth 11 area (along with other areas) will be deepened as part of capital dredging for the Port Expansion Project, the *in situ* consolidated sediment below the surficial sediment to be maintenance dredged is still required to be characterised. This will be undertaken as part of the sediment Sampling and Analysis Plan (SAP), however as these sediments are below the ‘zone of contemporary contamination’ (as per NAGD terminology) (typically >1 m), it is expected that they are not likely to be contaminated.

Further testing will be undertaken as part of the sediment Sampling and Analysis Plan to refine the preliminary assessment above. Depending on the results from implementation of the Sampling and Analysis Plan, further assessment as per Phase III of the NAGD assessment framework may be required.

These results provide a preliminary indication that surface sediments throughout the proposed Outer Harbour area, and Platypus and Sea Channels should be suitable for ocean placement. In the event that further assessments indicate that any localised areas of sediment are not suitable for ocean placement, appropriate land-based disposal will be utilised. Land based disposal typically involves placement of material unsuitable for sea disposal in POTL’s drying ponds, with disposal at an appropriate location after material has dried sufficiently.

3.2 History of Dredged Material Placement in Cleveland Bay

3.2.1 Dredged Material Placement Locations

Sea disposal of dredged material has occurred at a number of locations within Cleveland Bay for over a century. The material has typically been associated with the development and maintenance of the Port of Townsville harbour and channel. In recent times, three sites within Cleveland Bay have been used for dredged material placement. These sites all lie within Port Limits and within the port exclusion area that is excised from the boundaries of the Great Barrier Reef Marine Park.

The inshore site, shown on , is located immediately seaward of the Ross River and the existing harbour and to the east of Platypus Channel. Regular use of this inshore site ceased in the early 1990s.

To replace the inshore site, an offshore site was developed in two iterations. The ‘first’ offshore site was situated in the intermediate depths of the Bay (between 8m and 14m depth contours), roughly midway between Cape Cleveland and Magnetic Island and was rectangular in shape (). The ‘second’ offshore site (refer Figure 3-2) was developed as part of the 1992/93 capital works to develop Platypus and Sea Channels and was based on the location of the ‘first’ offshore site. As part of the capital works program, the environmental impacts of placement of dredge material at the ‘first’ site was extensively reviewed and assessed. Consequently the site was reshaped to its current trapezoidal shape and repositioned seaward to its current location (beyond the 11 m depth contour) at the northern edge of the port exclusion area. The requirement for safe and efficient navigation through existing shipping lanes was also considered in the location and shape of the site.

This ‘second’ site is currently used regularly for disposal of material dredged from the harbour and channel as part of ongoing maintenance dredging.

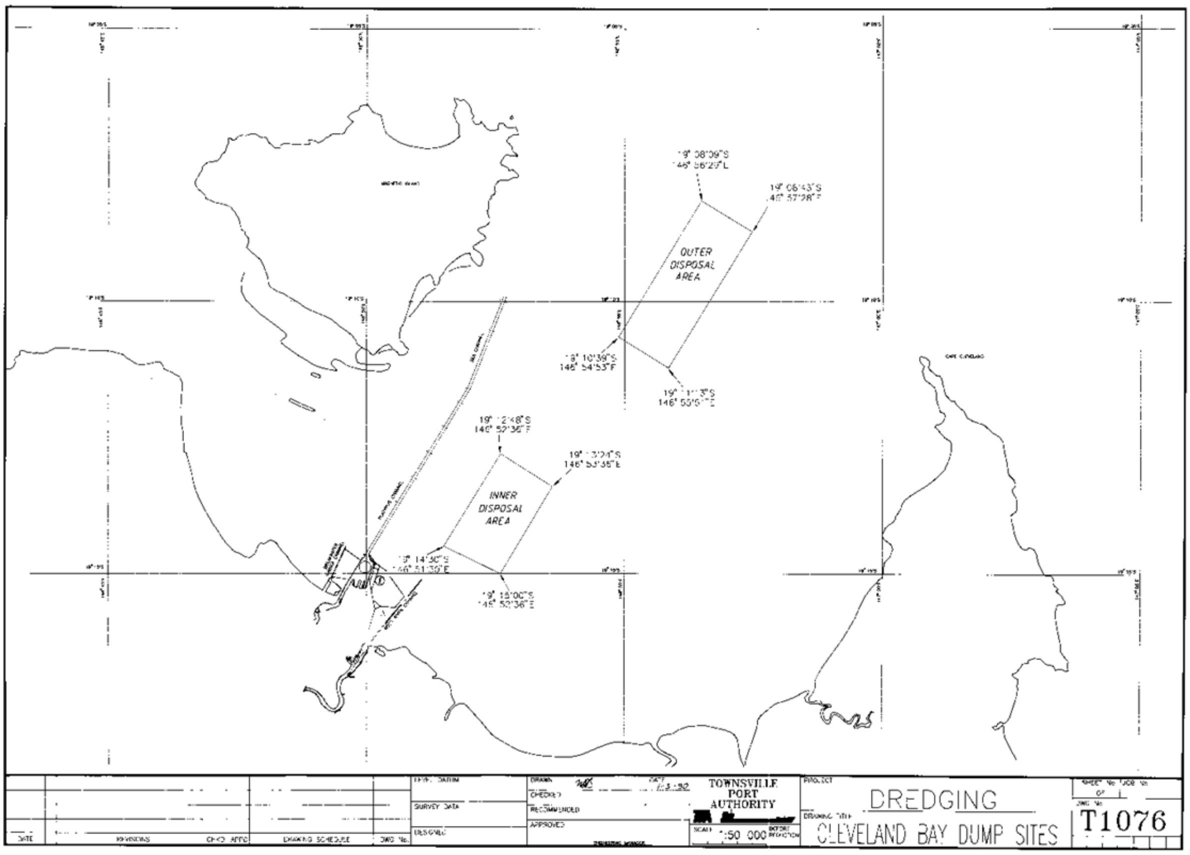


Figure 3-1 Locations of Inshore Disposal Ground and 'First' Offshore Disposal Ground

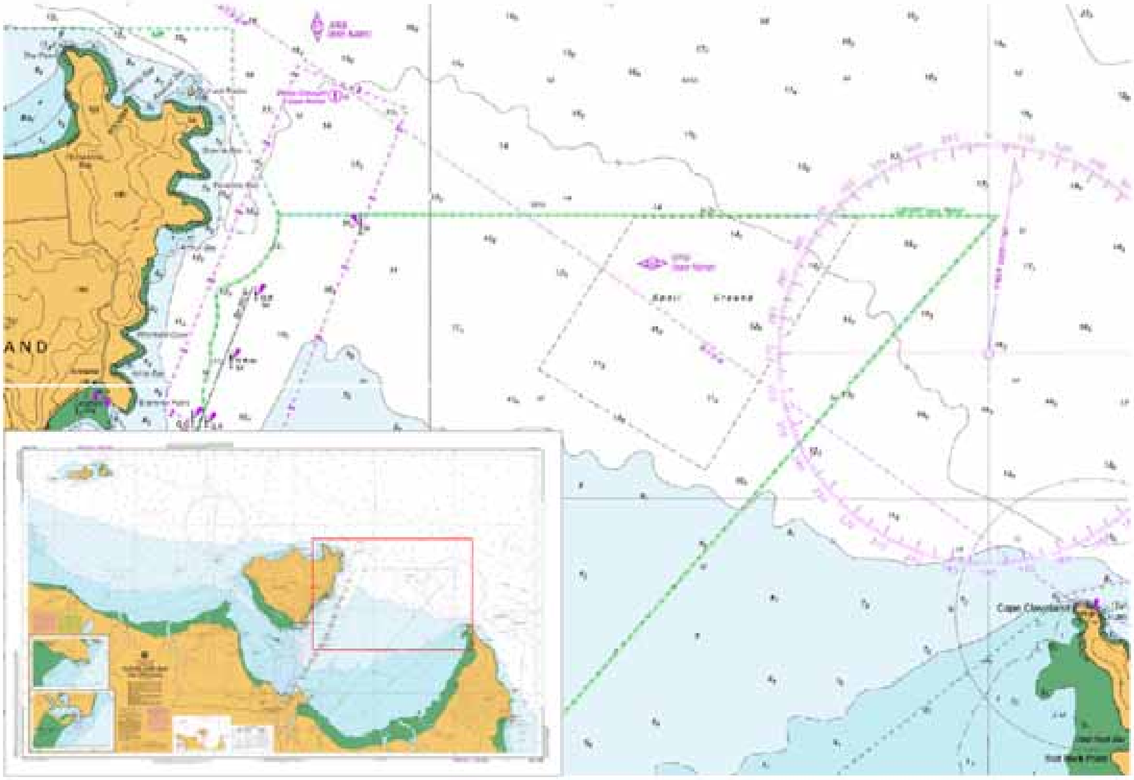


Figure 3-2 Location of Current Marine Disposal Ground (Extract from AUS256, Australian Hydrographic Service, 2003)

The disposal ground was relocated further offshore in deeper water (>11m depth contour) to minimise bed resuspension and potential impacts on adjacent areas (such as Magnetic Island). The key factors identified in the literature that influenced the decision to relocate the disposal site included:

- Modelling as discussed in Bode *et al* (1993) which showed dumping of material in the outer and deeper half of the disposal area reduced turbidity effects and movement of particles into sensitive environments of Magnetic Island situated to the west of the sea disposal ground.
- Modelling and analysis in Wolanski *et al* (1991) which showed the shallower area of the disposal ground was more prone to long term bed resuspension and shoaling as a result of wind and wave-induced near bottom currents.
- Avoidance of impacts on benthic habitats from mobile fluid mud layers that can be generated from the near bottom currents described above (Wolanski *et al* 1991).

The relocation strategy would appear to have been effective with previous reports reviewed (in particular Benson *et al* 1994) indicating that consolidated capital dredged material (predominantly sandy clay) has tended to remain in place at the disposal site while the unconsolidated maintenance dredged material is predominantly dispersed. Consequently, this DMPA alternative analysis is not considering the idea of a nearshore disposal option.

3.2.2 History of Dredging Campaigns

The first wharf at the Port of Townsville was erected in Ross Creek in 1863 and dredging first commenced in 1883. Early dredging records are sparse and generally describe capital dredging, but from 1893 dredging was undertaken to maintain previously dredged areas. The fate of the dredged material was not always recorded, but it is likely that much of the dredged material was disposed at sea.

Ongoing sedimentation in dredged areas has meant that regular maintenance dredging is vitally important to sustain vessel access to berths. Annual maintenance dredging requirements are largely dependent upon the area and location (e.g. ambient energy conditions) of dredged areas and have increased over time, but detailed analysis prior to 2008 is hampered by inconsistent measurement systems and reporting (Kettle *et al.,* 2002).

Capital dredging of previously undisturbed sediments is also periodically undertaken at the Port of Townsville. The purpose of capital dredging is to provide access to new Port facilities and to increase navigable depths in existing channels and navigation areas to accommodate larger ships and changing shipping patterns.

Table 3-1 includes a summary of dredging history at the Port of Townsville from 1978 to 2012. This table indicates the quantities of material dredged from various areas at the Port and disposed either at sea or on land. The majority of dredged material placement that has occurred at the current offshore site is as a result of maintenance dredging of the harbour and channel. It is estimated that over 12 million m^3 of dredged material has been placed at sea since 1978 (Table 3-1).

Table 3-1 Port of Townsville Dredging History (1978 - 2012)

Year	Sea Channel	Platypus Channel	Dogleg & Platypus Channel entrance	Outer Harbour	Outer Harbour Berths	Inner Harbour (General)	Inner Harbour (Berths)	Inner Harbour (Swing Basin)	Inner Harbour	Ross River (Channel)	Ross River (Moorings)	Ross Creek	Marine Precinct	TOTAL DREDGE MATERIAL	Total Sea Disposal	Total Land Disposal
1978		265,450					91,400	290,150		200000				847000	647000	200000
1979		484,400					93,550	124,100		28830				730880	702050	28830
1980		494,280					23,920	186,150		53070				757420	704350	53070
1981		184,020					40,700	179,350		63600				467670	404070	63600
1982		293,120					32,000	159,170		99460				583750	484290	99460
1983		100,000								120,000				220,000	100,000	120,000
1984		232,000									24,000			256,000	232,000	24,000
1985		53,500												53,500	53,500	0
1986		265,000												265,000	265,000	0
1987		100,000		88,000										188,000	188,000	0
1988		199,250		124,400										323,650	323,650	0
1989		122,500		122,500						13,121				258,121	245,000	13,121
1990										30,510				30,510	0	30,510
1991									70,500	98,000	47,000			215,500	70,500	145,000
1992									324,800					324,800	324,800	0
1993		130,000		122,000		160,000	124,000	220,000						756,000	472,000	284,000
1994		175,100							95,200	52,000				322,300	270,300	52,000
1995		253,200							143,400					396,600	396,600	0
1996		173,000							17,300	78,000				268,300	190,300	78,000
1997	1,511	108,299		71,466	26,529	2,661		21,529	16,471					248,466	181,276	67,190
1997		119,000		66,820	8,718	6,966		16,534						218,038	185,820	32,218
1998	25,800	104,750		124,400		11,460								266,410	266,410	0
1999		220,000		234,000					10,000	58,700				522,700	464,000	58,700
2000	25,000	229,000		199,800					33,000					486,800	486,800	0
2001		110,000		232,800							80,000			422,800	342,800	80,000
2002		210,500		117,000						103,200				430,700	327,500	103,200
2003	25,000	118,000		85,500					78,500					307,000	228,500	78,500
2004		132,640		195,737			1,500		160,863	2,000				492,740	489,240	3,500
2005	7,700	172,200		121,000								12,000		312,900	300,900	12,000
2006	6,000	175,000		106,000					10,000	5,560				302,560	297,000	5,560
2007	118,000					2,691								120,691	120,691	0
2008	37,910	112,960		95,675	13,010	26,375	1,256	13,360	62,340					362,886	361,630	1,256
2009	236,201	141,500		140,950	9,350	2,000	13,683	71,200		63,180				678,064	614,884	63,180
2010		100,000		200,580	9,600		6,375			45,000			200,000	561,555	316,555	245,000
2011		275,800		195,620	13,260		25,050	76,940		23,850			291,000	901,520	586,670	314,850
2012	46,500	123,210	131,530	10,500	150		9,700	29,050		77,990				428,630	350,640	77,990
2012							24,795							24,795	24,795	0
2012	34,300	74,690	85,700	54,480	6,970		12,500	22,900						291,540	291,540	0
Total														**14,645,796**	**12,311,061**	**2,334,735**

🟦	Sea Disposal
🟨	Land Disposal
⬜	Capital dredge material

Note:

All values are in cubic metres

Dredge volumes in table prior to 2008 are likely to be maintenance only volumes.

Records after 2010 include capital amounts as indicated by cross-hatching.

3.2.3 History of Dredging Approvals

In 1997, the Port of Townsville became the first Australian port to receive a long-term sea dumping permit which addressed annual maintenance dredging over three years. In February 2001, this three year permit was renewed with a five year permit under the Commonwealth *Environment Protection (Sea Dumping) Act 1981*. Two short term extensions of this permit were granted to allow maintenance dredging to be undertaken in 2006 when the dredge was available and these expired in November 2006. In October 2007, a new maintenance dredging sea dumping permit was issued under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* for a period of five years. This permit provided certainty over the sea disposal of maintenance dredging requirements for existing and proposed Port facilities up to October 2012. Two further short term extensions have since been granted to this permit. Table 3-2 includes a summary of the current and historical government approvals.

Table 3-2 Current and Historical Commonwealth Government Approvals

Permit Number	Effective Date	Expiry Date	Duration	Type of Dredging	Approved Disposal Volume (m^3)	Actual Volume Removed (m^3)	Disposal Location
Extension of Sea Dumping Permit SD2007-0602	19/12/12	01/04/13	3 months	Maintenance	2,750,000	Work still ongoing	Current offshore site
Extension of Sea Dumping Permit SD2007-0602	28/09/12	31/10/12	3 months	Maintenance	2,750,000	Work still ongoing	Current offshore site
Sea Dumping Permit No SD2007-0602	09/10/07	08/10/12	5 years	Maintenance	2,750,000	Work still ongoing	Current offshore site
Extension of Sea Dumping Permit	23/10/06	30/11/06	One month	Maintenance	3,500,000	270,490	Current offshore site
Extension of Sea Dumping Permit	23/02/06	23/10/06	8 months	Maintenance	3,500,000	0 (no dredging undertaken)	Current offshore site
Sea Dumping Permit	23/02/01	23/02/06	5 years	Maintenance	3,500,000	2,171,164*	Current offshore site
Sea Dumping Permit (Inner Harbour)	12/12/02	12/12/03	1 year	Maintenance	236,380	No material was deposited under this permit	Current offshore site
Sea Dumping Permit (Inner Harbour)	01/06/97	01/06/00	3 years	Maintenance	500,000	–	–
Sea Dumping Permit (Inner Harbour)	31/05/96	31/05/97	1 year	Maintenance	500,000	–	–
Sea Dumping Permit (Inner Harbour)	24/02/95	24/02/96	1 year	Maintenance	500,000	–	–

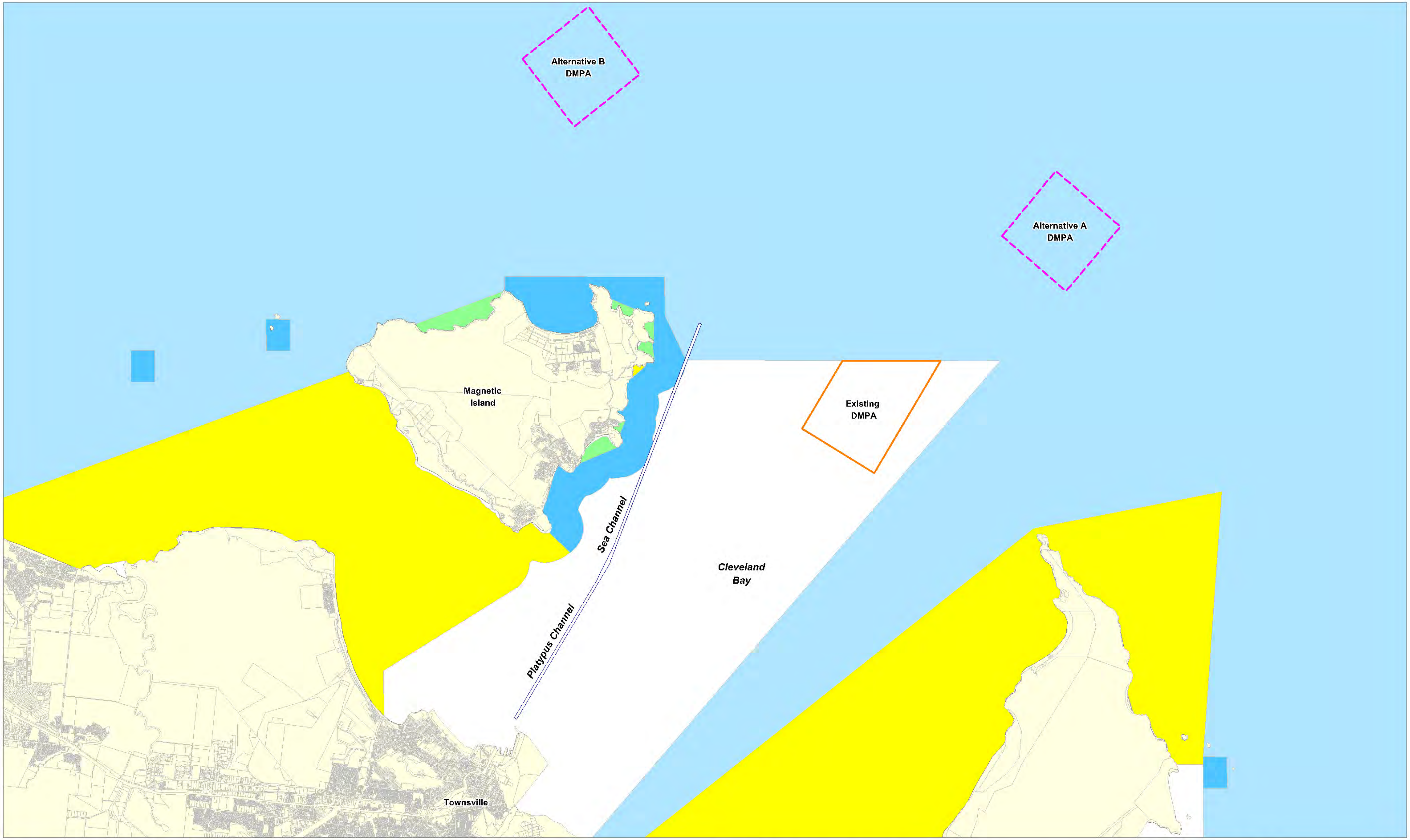
* Note: this figure does not include the 'Brisbane' dredging campaign in 2006 as this was done under the permit extension.

3.3 Alternative DMPAs

In addition to the existing DMPA, alternative DMPAs were identified for further assessment. Three alternative DMPAs were originally identified as a result of a preliminary constraints analysis undertaken for the offshore disposal study as part of the Preliminary Engineering and Environment Study (PEES) (AECOM 2009). Of the three DMPAs identified in that study, two have been shortlisted for further assessment. The third DMPA was not shortlisted due to its location further out to sea than the other two DMPAs, which would result in considerable additional cost to the proposed capital dredging campaign. The locations of the two shortlisted DMPAs were amended slightly after consideration of shipping transit routes (refer to Section 3.3.1). The two alternative DMPAs include the following:

- Alternative A (eastern offshore north of the current DMPA).
- Alternative B (western offshore north of Magnetic Island).

The locations of the existing and alternative DMPAs are shown in Figure 3-3.



LEGEND

▱	Existing DMPA
◇	Alternative DMPA
▨	Cadastre

Great Barrier Reef Marine Park Zones

🟨	Conservation Park
■	General Use
🟦	Habitat Protection
🟩	Marine National Park

Title:

Location of Existing DMPA and Alternative DMPAs

Figure:

3-3

Rev:

A

N

0 2.5 5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

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Alternative A

A potential offshore DMPA (Alternative A) was identified seaward of the existing offshore DMPA.

This site was selected on the basis that:

- It is located in close proximity to the dredging area (Platypus and Sea Channels).
- It has adequate water depth for the probable dredge equipment (sufficient depth to accommodate a medium TSHD).
- The sea bed materials are likely to be similar in nature to those materials to be dredged as part of the channel development.
- The site supports low commercial fishing activity.
- It is situated between the ‘preferred’ shipping fairway and the 22m depth contour, which is considered to be the approximate extent of the inshore, terrigenous system.

The greater water depth at Site A, compared to the existing offshore DMPA, may be advantageous to reducing mobilisation of dredged material by coastal processes. However, material that is mobilised may deposit within Platypus and Sea Channels. While this is not undesirable in the context of maintaining the material within the active system, the frequency and extent to which this would occur is not currently known (noting that Larcombe and Ridd 1993 reported a net movement of material from the offshore to the inshore areas of Cleveland Bay under some conditions). Further assessment would be required to determine the potential influences on maintenance dredging of the access channels.

While the existing offshore DMPA is located within the port exclusion area, Site A is located outside of this exclusion area and within the Great Barrier Reef Marine Park (GBRMP). Therefore, placement of dredged material at this site would involve disturbance of a new site within the GBRMP.

Alternative B

Alternative B is a potential offshore disposal site that has been identified to the west of Sea Channel. This site has similar characteristics to Alternative A in terms of water depth and placement of dredged material in a ‘like for like’ environment and the site offers the potential for reduced mobilisation and deposition of dredged materials to Platypus and Sea Channels.

Potential constraints against the use of Site B include:

- The relatively high commercial fisheries activity.
- The proximity of the site to Magnetic Island and the potential for impacts to amenity.
- The distance of the disposal site from the location of dredging.
- Similar to Site A, Site B is located within the GBRMP and would therefore involve disturbance of a new site within the GBRMP.

3.3.1 Operational Considerations Related to Shipping and Navigation

Commercial shipping into and out of the Port of Townsville uses dedicated shipping lanes within the offshore area. As such, the locations of the two alternative DMPAs were chosen to ensure they would be located out of shipping lanes as far as practicable, but still in close proximity to the end of the Sea Channel.

To achieve this, shipping tracks were obtained from Marine Safety Queensland (MSQ) in Townsville for a three month period (December 2011 – February 2012) and overlain over the project area to identify areas with the least amount of shipping traffic. The shipping tracks (different colours represent different months) along with the locations of the two alternative DMPAs are shown in Figure 3-4.

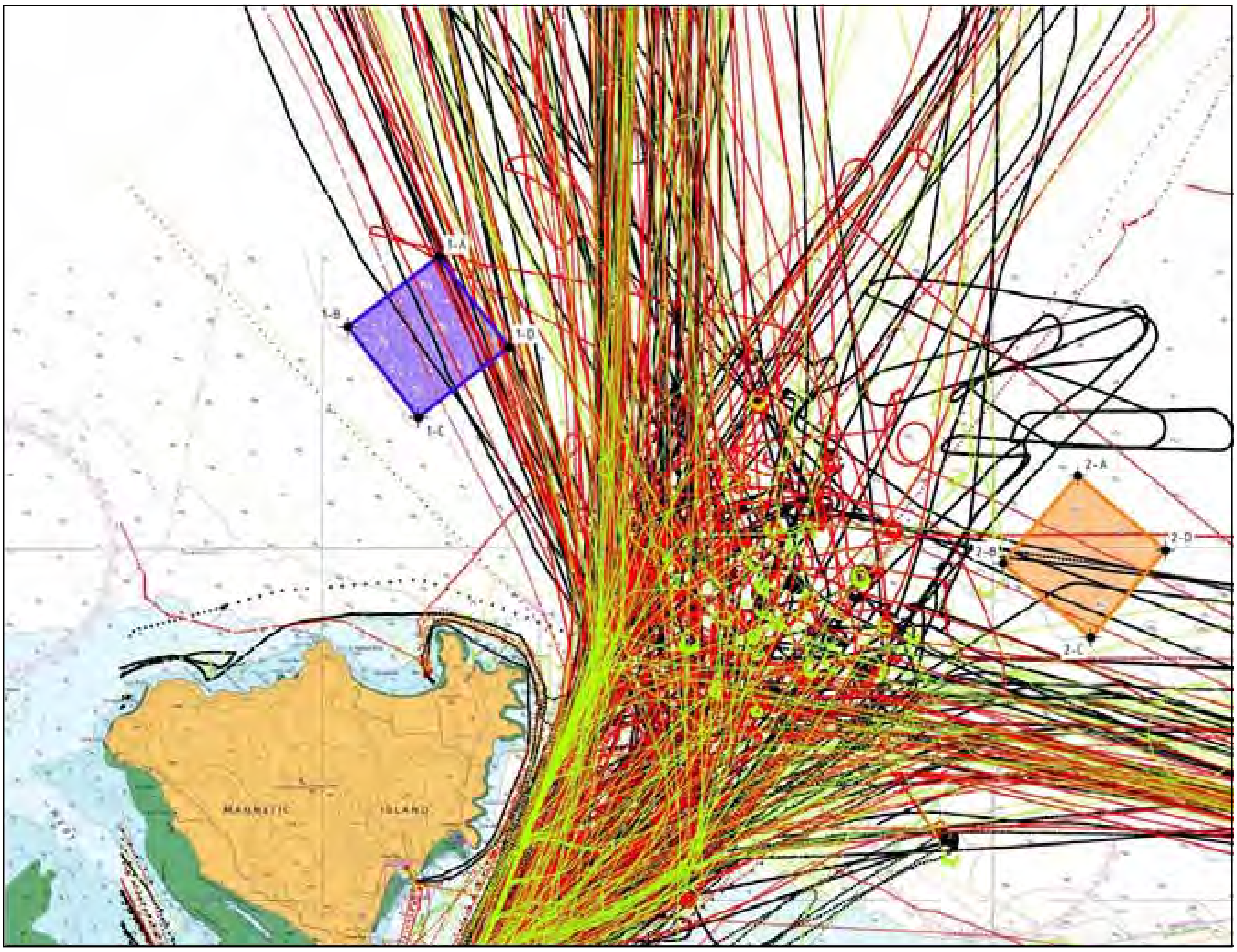


Figure 3-4 Shipping tracks and locations of Alternative DMPAs. Different colours represent three different months (Dec 2011 - Feb 2012)

3.4 Key Selection Criteria

This section examines the process of identifying the preferred DMPA. Three sites have been evaluated as part of the EIS. These are described as follows:

- Existing DMPA – as discussed in Section 3.2.
- Alternative A (eastern offshore north of the current DMPA) – as discussed in Section 3.3.
- Alternative B (western offshore north of Magnetic Island) – as discussed in Section 3.3.

Key selection criteria should generally be based on natural conditions and seabed features as well as economical and operational considerations of dredging. Based on the information currently available, this section outlines the selection criteria and applies them to the three potential DMPAs. Key site selection criteria relate to:

- Economic cost – handling and disposal effort to transport material to a suitable DMPA.
- Ecological value – placement of the dredged material on seabed lacking high value benthos such as corals and seagrass.
- Bed stability – retention of placed material on the DMPA.

In reviewing the suitability of the current site and assessment of alternative sites, the criteria in the following sections are being assessed.

3.4.1 Bathymetry, Seafloor Topography and Capacity

There is a significant amount of material that will be dredged as part of the Outer Harbour and channel development. These volumes and dredge vessels are included in Table 3-3.

Table 3-3 Estimate of Dredged Material to be placed in DMPA

Dredge Campaign	Vessel Delivering Dredge Material	*In-situ* Volume to be placed in DMPA (m^3)
Outer Harbour basin and reclamation	Small TSHD / self-propelled hopper barges	1,500,000
Channel upgrade Stage 1 - deepening	Medium TSHD	1,600,000
Channel upgrade Stage 1 – widening P11/12 to P13/14	Self-propelled hopper barges	700,000
Channel upgrade Stage 2 - deepening	Medium TSHD	1,800,000

The preferred method of dredging for the channel deepening works involves the use of a medium sized TSHD. The preference for this dredge type and capacity is based on a number of practical considerations, including:

- The dredging power required for excavation of the firm, stiff and very stiff clay materials that are characteristic of the channel, whereby a medium to large size dredge is required to provide sufficient power.
- The operational constraints for dredging within an active navigation channel, whereby the dredge type must be mobile so that it can vacate the channel to allow for passage of vessels arriving and departing the Port of Townsville.

- The efficiency and economy of dredging operations, whereby a medium to large size dredge is required to provide efficient and economical dredging of the volume of material to be removed during each stage of channel development.

Based on these considerations, a medium sized TSHD (approximately 6000 to 10,000 m^3 capacity) is proposed for the dredging works associated with deepening of the channel. For channel widening a large BHD with self-propelled hopper barges (approximately 2,500 m^3 capacity) is proposed. For removal of soft marine sediments in the Outer Harbour and reclamation area, a small TSHD (approximately 5,000 m^3 capacity) is proposed along with a BHD.

The dredge vessel capacities and water depth requirements are included in Table 3-4. This indicates that a medium TSHD would typically have a laden draft of approximately 8.8 m and require a minimum water depth of approximately 13 m for effective disposal from the underside of the vessel. A small TSHD and self-propelled hopper barges would have laden drafts of 6.5 m and 5 m respectively, and require water depths of approximately 9.5 m and 8 m respectively for effective disposal.

Table 3-4 Dredge Vessel Capacities and DMPA Depth Requirements

Vessel	Capacity (m^3)	Max. Draft (m)	Minimum Water Depth at DMPA (m)
Small TSHD	5,000	6.5	9.5
Medium TSHD	6,000 - 10,000	8.8	13.0
Self-propelled hopper barge	2,500	5.0	8.0

Accordingly, as the medium TSHD requires the greatest depth for disposal, any offshore disposal location is required to provide sufficient water depth for effective and efficient operation of a medium sized TSHD. A minimum depth of 13 m is required, but the ideal depth is likely to be greater than 13 m, to allow for spoil stockpiling within the disposal area.

These characteristics establish a physical constraint to the use of the existing offshore disposal area, which has a depth of between 11 m and 15 m across its extent, with only a small pocket with a depth greater than 15 m. As such, the existing DMPA has been divided into three zones (A, B, C) based on water depth (refer to Figure 3-5). Dredged material from the Port Expansion Project could be placed in the shallow zone (i.e. Zone A) using the shallow draft self-propelled hopper barges only, while material from the TSHD could be placed in the deepest zone (i.e. Zone C) only.

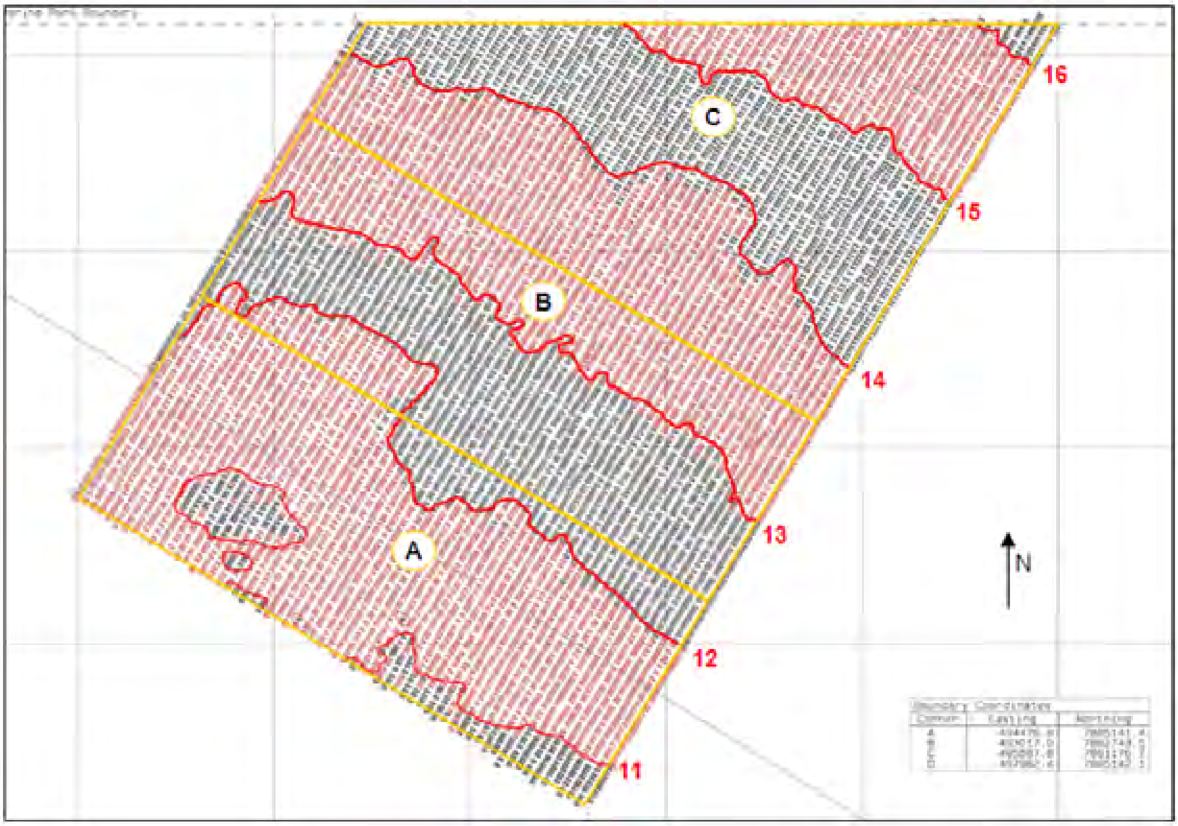


Figure 3-5 Zones within the existing DMPA

A preliminary capacity assessment was undertaken (AECOM 2012) and indicates that the existing offshore DMPA is expected to have sufficient capacity for the placement of dredged material from the Port Expansion Project in addition to other planned port development projects and maintenance dredging works. This is subject to allocation of material from campaigns to zones appropriate for the equipment (as discussed above) and placement that supports even distribution within each zone.

In regard to the two alternative DMPAs, due to their location further out to sea they are in deeper water at approximately -20 m LAT. Based on the anticipated volume of material from the widening and deepening of Platypus and Sea Channels, an overall capacity of approximately 6 million m^3 would be required for any new offshore disposal site (excluding any contingent capacity for potential long-term use of the site). The capacity of each of the alternative DMPAs has been estimated at greater than 63 million m^3 if a medium TSHD places the material, indicating that there is more than enough capacity at these sites.

Therefore, while all DMPA sites would have sufficient capacity, there would be more controls required at the existing DMPA to ensure material is placed in the correct zone. The alternative DMPA sites would have no such limitations, and as such score slightly better in the DMPA ratings.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Capacity	4	5	5

3.4.2 Native Seabed Substrate Type

The seabed of the existing DMPA has been examined extensively during studies conducted for the Port Expansion Project EIS in 2010, while alternative DMPA sites A and B were investigated in March 2012. Benthic grabs were taken from 17 locations within the existing DMPA and from four locations within each of the alternative DMPAs (A and B). Particle size distributional analyses were also performed at six of the 17 locations within the existing DMPA, from six locations within the proposed channel extension area and from four locations in the existing Platypus Channel.

Existing DMPA

The existing DMPA is composed of sandy muds, with the sand fraction dominated by fine sands and containing smaller amounts of medium to coarse sands and gravels (Figure 3-6). The donor material from the proposed channel extension area is very similar to the sediments of the existing DMPA, except that it has a larger coarse sand fraction and is less silty. The existing channel has a slightly lower concentration of silt and has higher sand fractions than the donor material from the channel extension area. This is likely related to removal of fines from dredging and slight infilling from more mobile sands.

Alternative DMPAs

The sediments of the alternative DMPAs A and B appeared to be very similar to those of the existing DMPA and donor channel extension material. While particle size distribution analysis was not undertaken at the alternative DMPAs to quantify the bed composition, qualitative grab samples were obtained which were composed of deposited fine silty upper layer underlain by sandy muds (i.e. similar parts of sand and mud) (refer to Figure 3-7). This material was similar at all locations sampled in alternative DMPAs A and B and little heterogeneity was observed during video transects.

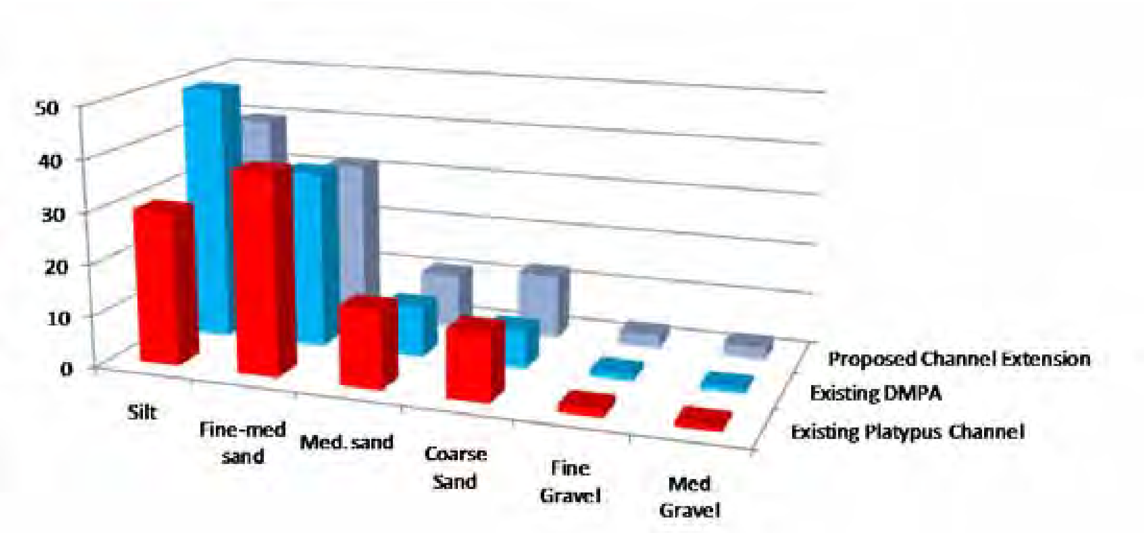


Figure 3-6 Particle size distributions of sediment from the proposed channel extension (grey), the existing DMPA (blue) and the existing Platypus Channel (red).

Figure 3-7 Sediments of alternative areas A and B were composed of sandy mud with a silty upper layer

Therefore, as all DMPA sites comprise a similar seabed substrate which is also similar to the donor material, all three DMPA sites are considered to be of equal suitability for dredged material placement.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Seabed Substrate	5	5	5

3.4.3 Dispersal and Resuspension Factors

Numerical modelling was undertaken to assess the relative magnitude of sediment resuspension from the existing DMPA compared to the alternative DMPAs. A description of the models that were used for this assessment is provided in the Hydrodynamic and Advection-Dispersion Modelling Technical Report in Appendix H1 of the EIS.

It is difficult to quantify the rate of natural resuspension of material from the existing DMPA due to uncertainties regarding the quality of historical bathymetric data and the nature and degree of consolidation of the sediment after placement. The long term change in bathymetry due to maintenance dredging appears to be minimal, and there is evidence that the capital dredging material placed in 1993 has been smoothed out.

An assessment of likely sediment resuspension and dispersion from the existing DMPA is presented in the Chapter B3 - Coastal Processes. It showed that during typical E-SE wind and wave conditions there is likely to be some resuspension from the existing DMPA site, and the plume will likely be dispersed towards the northern end of Magnetic Island. However, the quantities that would be resuspended from the DMPA are small compared to the total amount of ambient suspended sediment in Cleveland Bay. Only a very small proportion of the total suspended sediment measured at the northern end of Magnetic Island could be expected to have originated from the existing DMPA.

A similar assessment has been undertaken for the two alternative DMPA sites. A relatively low value of 0.12 Pa was adopted for the critical bed shear stress for erosion of clay and silts. However, during typical E-SE wind and wave conditions, resuspension from the alternative sites is unlikely to occur due to the deeper water at these locations. Figure 3-8 shows the modelled bed shear stress at the three DMPA sites, together with the assumed critical shear stresses for erosion and deposition (τ_{CE} and τ_{CD} respectively). The bed shear stress at the two alternative sites does not exceed the critical threshold for erosion and therefore resuspension is not likely during typical conditions.

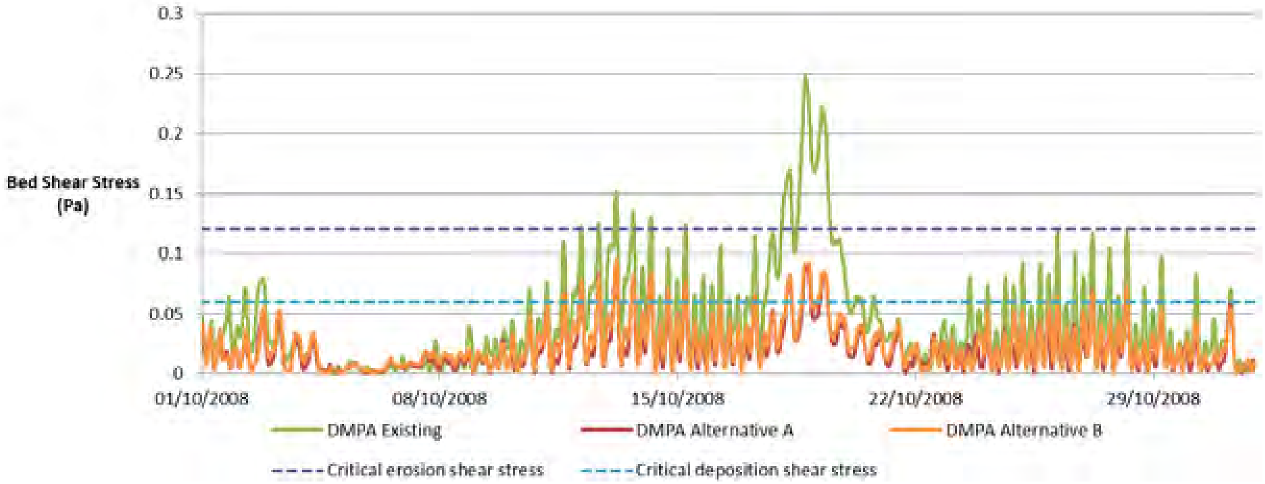


Figure 3-8 Comparison of bed shear stress at the three DMPA sites during typical conditions

Figure 3-9 presents a contour plot of the maximum modelled bed shear stress during the simulation period, indicating resuspension is unlikely to occur at the alternative DMPAs during typical conditions due to the generally low bed shear stresses at these locations.

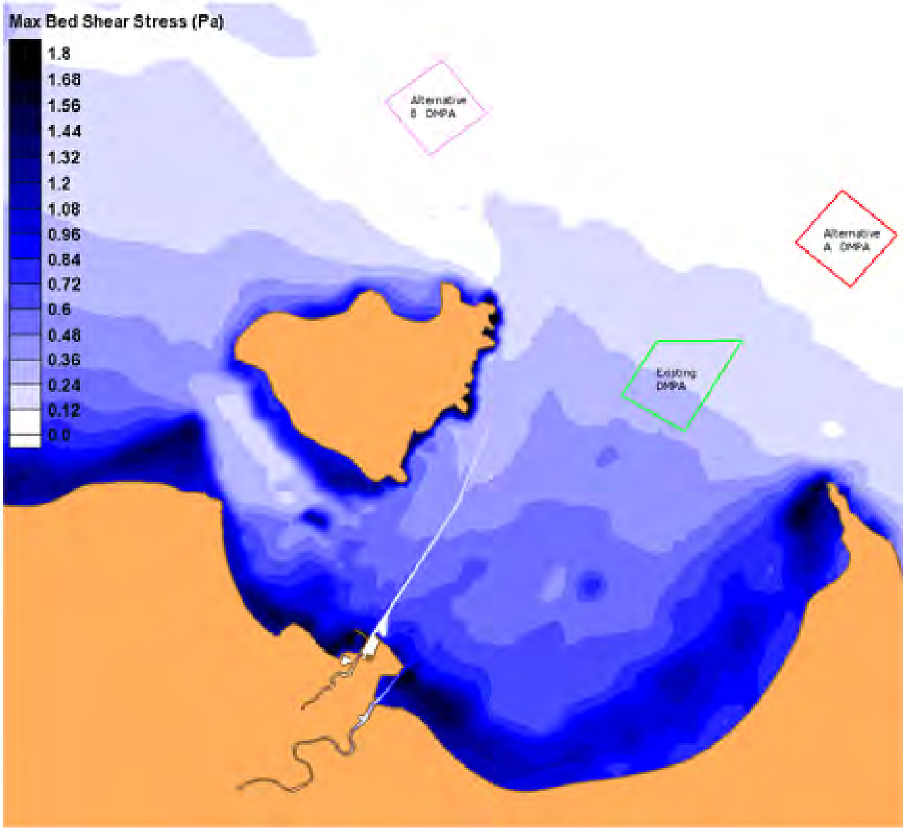


Figure 3-9 Contour plot of modelled maximum bed shear stress during the simulation period

During higher wind periods and extreme events (such as cyclones), resuspension would occur at all three DMPA sites. In this case, the dispersion of the material from the two alternative sites would be less likely to impact Magnetic Island than material from the existing DMPA since they are located further north. Both sites would also be less likely than the existing DMPA to cause additional infill of the shipping channel, again due to their more northerly locations.

In comparison to turbid plumes potentially resulting from resuspension, modelling results indicate that sediment plumes generated during placement activities will have a minimal impact on surrounding areas. Placement at the alternative sites would be similar in this respect.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Dispersal / Resuspension	3	4	4

3.4.4 Ecological Habitats and their Biota

Existing DMPA

The ecological habitats and their biota of the existing DMPA have been examined extensively during studies conducted for the PEP in 2010 (refer to Chapter B6 - Marine Ecology). Four minute video recordings and benthic grabs were taken from 17 locations within the existing DMPA. Survey results suggested that epibenthos assemblages in the DMPA were dominated by a type of burrowing goby. Of the 149 fish observed in video transects, 142 (95%) were burrowing gobies, and 124 of these were observed in the DMPA. There were also small patches of rock observed within the DMPA (see photo C in Figure 3-10) which provide habitat for reef-associated taxa such as sea pens, ascidians and some crinoids, and represent areas of higher biodiversity relative to other open sand / mud habitat. It is noted that the presence of the rock at the existing DMPA may be the result of dredged material placement from previous capital dredging campaigns.

The macrobenthic communities within the DMPA had similar characteristics to those located within adjacent control areas. Past monitoring studies suggest that macrobenthic communities within the DMPA are resilient to disturbance associated with dredged material disposal, and can rapidly recolonise shortly after dredging.

In regard to marine megafauna, it is likely that any marine turtles within the DMPA exist as transients rather than resident, primarily due to the lack of optimal or perennial feeding resources in this area. GHD (2009) notes that two dolphin species are common in nearshore environments throughout Cleveland Bay, and it is likely that both species transit through the DMPA.

Dugongs are abundant in Cleveland Bay, particularly in the dense seagrass around Cape Cleveland (refer to Chapter B6 - Marine Ecology). Dugongs are however likely to occur throughout the Bay as they move between feeding sites (seagrass meadows) within and outside of Cleveland Bay. Although sparse seagrass cover has been reported previously in the DMPA and surrounds by others, none was observed in the present study. It is possible that dugongs move through both of these areas from time to time, although aerial surveys do not indicate that dugongs have high abundance in these areas (GHD 2009).

In summary, visible benthic communities at the existing DMPA were generally sparse. Burrowing gobies were the most frequently observed taxon, followed by sea pens and bryozoans. The existing DMPA is not considered to be an important marine megafauna habitat.

Alternative DMPAs

The benthic flora and fauna assemblages between outer Cleveland Bay and the deeper part of the inner continental shelf between Magnetic Island and John Brewer Reef can be characterised and differentiated along depth and sediment gradients. In general, the sediment to be dredged and placed from Platypus and Sea Channels is likely to have similar sedimentary and biotic components to that of the inner shelf sediment and benthic assemblages characterised by Birtles and Arnold (1983 & 1988) in the inner zone (<22 m depth contour) compared to the outer zone benthic environment which is characterised by less active coastal process and the general absence of terrigenous sediment.

Given that harder substrate (generally of biotic origin) was an important signal for benthic diversity and abundance in the outer zone as outlined in Birtles and Arnold (1983 & 1988), it is important to ensure the alternative DMPAs do not contain reefs and similar hard substrate. Furthermore, these areas should not contain any deeper water seagrass or algal/sponge beds.

To confirm the ecological habitats present, the alternative DMPA sites A and B were investigated in March 2012. Four minute video recordings and benthic grabs were taken from four locations within each of the alternative DMPAs (A and B). The preliminary survey results indicate that visually conspicuous communities at the alternative sites were very sparse. Sea pens and sea cucumbers were observed in the Alternative A site. Burrows (bioturbation) were reasonably common at both alternative DMPAs (Figure 3-10). No reefs or similar hard substrates were found, and there was no evidence of deepwater seagrass or algal/sponge beds.

Figure 3-10 Screen grabs from Alternative A showing a sea pen (A); from Alternative B showing worm casings and bioturbation (B); and from the existing DMPA showing sponges bryozoans and algae (C).

In regard to marine megafauna at the alternative DMPAs, it is likely that marine turtles, dugongs and dolphins may transit through these areas. Furthermore, as the alternative DMPAs are located further offshore than the existing DMPA, there is a greater likelihood that migrating humpback whales may transit through the alternative DMPAs. However, due to the lack of feeding resources in these areas, it is unlikely that any marine megafauna would remain resident.

Potential Impacts

In terms of potential impacts from placement of dredged material at the DMPAs, in the short term smothering of most sessile flora (i.e. seagrass and algae) and fauna (e.g. soft corals, sea pens, gorgonians, sponges etc.) within the DMPA would be expected. Depending on the depth of placed dredged material, it is possible that some more mobile burrowing fauna will be able to migrate through the placed sediments.

While opportunistic species and primary colonisers will commence settlement shortly after disturbance, other less mobile species will take longer to re-colonise the DMPA. Some more mobile surface dwelling fauna such as prawns and shrimps, amphipods, isopods and some worms may move from adjacent undisturbed habitats into the DMPA. Most benthic fauna species have a planktonic stage, and in time would colonise the DMPA through larval settlement.

Seagrasses would in time also be expected to colonise the DMPA. Since seagrass will likely be completely buried by the placed dredged material, it will not be able to re-colonise via asexual vegetative growth. Instead, it is expected that dispersal of seagrass seeds from adjacent areas, together with resident seed banks, will represent the main routes for seagrass recolonisation. To demonstrate the potential for seagrass recolonisation, seagrass was found at the DMPA in the 2007/2008 seagrass survey approximately two months after dredged material placement at the DMPA from maintenance dredging activities.

Monitoring of benthic communities within and adjacent the existing DMPA by Cruz-Motta (2000) indicate benthic macroinvertebrate communities are resilient to changes in morpho-dynamics, and that despite a long history of dredged material placement activities, long-term changes in community structure within or adjacent to the existing DMPA have not been observed. Furthermore, the placement of material on substrate that is ‘like for like’ would reduce long term impacts on benthic communities associated with any habitat modifications.

These potential impacts are discussed in detail in Chapter B6 - Marine Ecology.

Summary

Studies indicate that the existing DMPA contains ecological habitats of a slightly higher biodiversity (i.e. small rock patches) relative to the alternative DMPAs (comprising mostly open sand / mud habitat). However, the existing DMPA has been exposed to numerous dredged material placements over a number of years and the small rock patches may be the result of previous capital dredging campaigns. Nevertheless, the existing DMPA is likely to comprise a resilient habitat structure as a result of the historical dredged material placements. Furthermore, despite indications that the ecological habitats at the alternative DMPAs comprise a minimal biodiversity, they have not been previously subjected to dredged material placement activities and therefore represent a more pristine environment. Also, humpback whales are less likely to migrate through the existing DMPA compared to the alternative DMPAs located further offshore in deeper water. As such, the existing DMPA site would be a more suitable location for dredged material placement, and therefore scores a better DMPA rating than the alternative DMPAs.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Ecological Habitats	4	2	2

3.4.5 Fishing and other Uses

The key commercial fisheries operating in the area are commercial trawl and net fisheries. Trawling operations are largely focused in the waters immediately north of Magnetic Island and, to a lesser extent, inner areas of Cleveland Bay (towards the Port of Townsville) and waters to the north and east of Cape Cleveland. The key trawl activity outside of the bay occurs within the shallower terrigenous section of the shelf, which is most likely associated with both the distribution of preferred habitat for the target species (i.e. prawns) and the higher likelihood of snagging gear on the non-terrigenous substrates of deeper waters. For the net fishery, there is little information available on the spatial distribution of effort or productivity within the project area. However, the key target species (e.g. Shark, Mackerel) are primarily pelagic fish that occur in open water. Compared with the predominantly demersal (bottom-dwelling) species targeted by the trawl fishery, species targeted by the net fishery are less likely to be directly affected by the offshore disposal of dredged materials.

Cleveland Bay supports significant recreational fisheries, and a number of inshore, reef and pelagic species are targeted. Recreational fishers generally target similar species to commercial fishers, with a strong focus on barramundi, mullet, whiting, bream and mud crabs in inshore areas; and reef fish such as coral trout (*Plectropomus* spp.), snapper (Lutjanidae), sweetlip (Lethrinidae) and trevally (*Caranx* spp.) when further from shore (Ludescher 1997).

Most line-based recreational fishing tends to occur around artificial structures such as navigation structures and breakwaters, as well as reef environments around Middle Reef and Magnetic Island. Some crabbing occurs within coastal creeks throughout the bay. The value of recreational fishing is likely to be considerably more than the commercial fishing industry.

In terms of potential impacts to fisheries, dredged material disposal activities may smother benthic fauna, resulting in the temporary loss of food resources of most economically significant species. While most fish and shellfish species of fisheries significance are not known to have highly selective diets, it is possible that the loss of food resources would result in the temporary avoidance of affected habitat patches. Case-studies undertaken in the study area and at other dredged material relocation areas in Queensland indicate that benthic ‘recovery’ typically occurs at timescales measured in months. Major, long term impacts to fisheries due to loss of benthic fauna are therefore not expected.

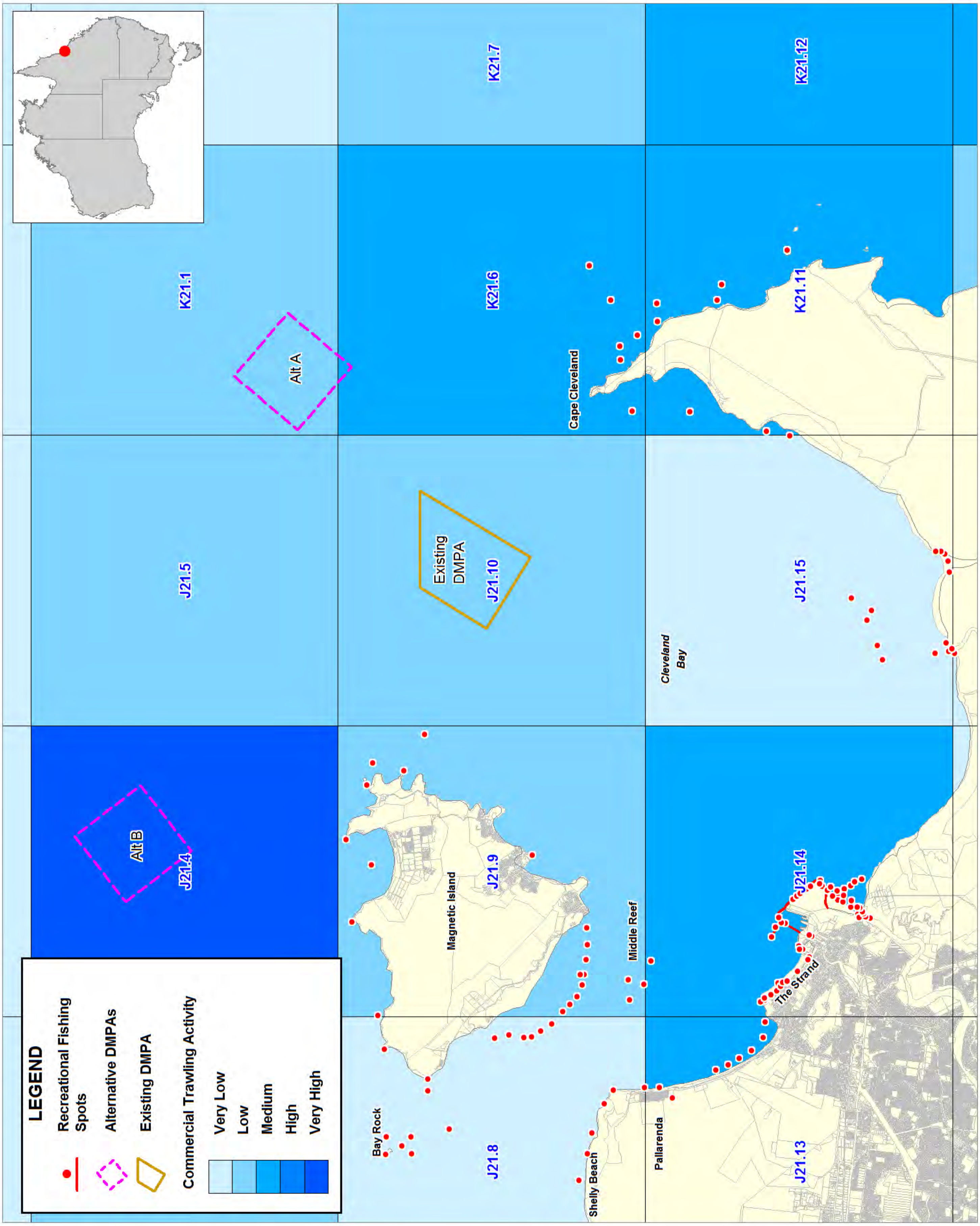
Notwithstanding the above, it is important that the selection of any new offshore dredged material relocation area should take into account commercial fisheries values. In particular, longer term changes in habitat type (i.e. change in sediment type, sediment mobilisation dynamics), or changes in bed topography that result in a change in operators ability to trawl an area, need to be considered in the site selection and dredging planning processes.

As per the Coastal Habitat Resources Information System (CHRIS) developed by the former Department of Primary Industries and Fisheries (DPI&F), the waters immediately north of Magnetic Island have been identified as having ‘very high’ commercial trawling activity, while the existing DMPA and Alternative A DMPA are located in areas identified as having ‘low’ commercial trawling activity (refer to Figure 3-11). It is noted that a small component of Alternative A is identified as having ‘medium’ commercial trawling activity, however this represents such a minor component that the whole DMPA is considered to be ‘low’. Therefore, of all three DMPAs, dredged material placement at Alternative B DMPA would pose the greatest potential impact on commercial trawling activities.

An additional consideration is the location of high-value fisheries habitats that would be sensitive to potential smothering or water quality changes resulting from offshore disposal activities. In the context of the prevalent fishing activities, the main habitats of concern are shallow-water seagrass beds and reef habitats surrounding Magnetic Island and Cape Cleveland and benthic habitats in the abovementioned key offshore trawl grounds, especially north of Magnetic Island. Hydrodynamic modelling of water quality from the offshore DMPAs as discussed in Section 3.4.3 indicates that these habitats would not be affected by turbidity and suspended solids as a result of turbid plumes from the DMPAs.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Fisheries	4	4	1



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Distribution of Commercial and Recreational Fishing Activity

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3.4.6 Marine Park Planning and Amenity

The Great Barrier Reef Marine Park (GBRMP) surrounds the Townsville area. The Port of Townsville has a designated port exclusion area within the GBRMP (refer to Figure 3-3), where any port development activities are exempt from the requirements under the *Great Barrier Reef Marine Park Act 1975* (GBMRP Act).

The existing DMPA is located within the port exclusion area and is therefore not within the GBRMP. As there is no other area within the port waters with suitable attributes, the alternative DMPAs are located outside of the port exclusion area and within the GBRMP. There are a number of various zones within the GBRMP, and the alternative DMPAs are located within the 'General Use' zone. The General Use zone is the least restrictive of the GBRMP zones, and the objective is to provide opportunities for reasonable use of the GBRMP while still allowing for the conservation of these areas.

In regard to dredged material placement in the GBRMP, the Great Barrier Reef Marine Park Authority (GBRMPA) has a Dredging and Spoil Disposal Policy which states that:

- Dredged material placement proposals will be assessed in accordance with the GBRMPA's policy for Environmental Impact Management.
- Proponents must comply with the National Assessment Guidelines for Dredging 2009.
- Spoil disposal must not damage sensitive environments.
- Disposal of dredged material is to only occur at a GBRMPA approved area.
- Annual maintenance dredged material volumes will be capped to a limit.
- An environmental levy, based on environmental risk and cubic metre of dredged material, will be charged by the GBRMPA.

Therefore, it is expected that approvals for the alternative DMPAs may be difficult to obtain due to their location within the boundary of the GBRMP. In contrast, the existing DMPA is not in the GBRMP and is currently an approved DMPA. The requirement to dredge and maintain navigation safety is a legislative requirement, and POTL cannot risk being unable to dredge due to difficulty in obtaining approvals or prohibitive costs imposed by approval conditions.

In regard to amenity issues, it is likely that the perception of impact by Magnetic Island residents on overall amenity (such as the presence of large dredge plumes) in the Bay around the Island will need to be considered. In this context, the selection and operation of a new DMPA in the GBRMP in proximity to Magnetic Island could be seen as controversial to at least part of that community.

Based on the planning and amenity issues discussed above, the existing DMPA achieves a higher DMPA rating relative to the alternative DMPAs.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Planning / Amenity	5	2	2

3.4.7 Project Cost

The distance between the channel (the dredge site) and the offshore DMPA is a key economic constraint as sailing time for the dredge increases but also has environmental implications in the context of a greater fuel requirement and greenhouse gas emissions as the overall duration of the dredge campaign increases.

As such, the distance from the dredge area to any one of the pre-selected DMPAs constitutes the main economical evaluation criterion. Following this principle, the existing DMPA would be the most economical as it is located closer to the channel. The alternative DMPAs A and B would be less economical, with Alternative A DMPA slightly less economical than Alternative B due to its location slightly further away from the channel. For the alterative DMPAs, the overall dredging time period would be increased due to more time being lost traveling between the dredge area and the DMPA.

An additional economic factor is the possibility of a dredge levy for disposal of dredged material in the GBRMP. The federal government is currently considering a proposal to charge a levy of between $5 and $15 per cubic metre of dredged material placed in the GBRMP from 1 July 2012. If either of the two alternative DMPAs located in the GBRMP were to be utilised, this proposed levy would result in significant additional dredging costs. Based on the volume of dredged material to be placed at an offshore DMPA (5.6 million m^3), these additional costs would be approximately $28 to $84 million.

The proposed dredge levy for the GBRMP would place a significant economic disadvantage to the utilisation of the two alternative DMPAs. While the levy is still being considered and may not be implemented, the DMPA ratings for the alternative DMPAs have been decreased relative to the existing DMPA to reflect the possibility of the levy being implemented at some stage.

DMPA Ratings (Scoring: 1=least suitable, 5=most suitable)

Criterion	DMPA		
	Existing	Alt A	Alt B
Project Cost	5	1	2

3.5 DMPA Selection Evaluation

A summary of the evaluation of DMPAs according to the discussed selection criteria is provided in Table 3-5. As this is a high level assessment only, this summary assumes that all selection criteria have equal weighting. Further work would be required to determine weighting of each criterion and to clearly differentiate the differences between the options.

Table 3-5 Summary of Evaluation of DMPAs

Selection Criteria	DMPA		
	Existing	Alt A	Alt B
Capacity	4	5	5
Seabed Substrate	5	5	5
Dispersal / Resuspension	3	4	4
Ecological Habitats	4	2	2
Fisheries	4	4	1
Planning / Amenity	5	2	2
Project Cost	5	1	2
Overall Score	**30**	**23**	**21**

Therefore, the final ranking of DMPA sites based on the multi-criteria assessment is:

1. Existing DMPA.
2. Alternative A.
3. Alternative B.

The findings indicate a preference for the existing DMPA site. Note the basis of the assessment is semi-quantitative. Primarily, the findings are a basis of identification of the preferred DMPA locations rather than a strict ranking.

3.6 Conclusion

Based on an assessment of three DMPAs using various selection criteria, the most suitable DMPA was found to be the existing DMPA. Nevertheless, offshore disposal at one or both alternative DMPAs would not be an unacceptable environmental outcome except for the following issues:

- Both in GBRMP and will require additional investigation, approval and attract a levy.
- Both located in areas not previously modified or disturbed by dredged material placement.
- More expensive due to distance from the channel.
- The overall dredging time period would be increased due to more time being lost traveling between the dredge area and the DMPA.
- Alternative B is in a high value commercial fishing area.

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Port Expansion Project EIS

Appendix F1

Townsville Port Expansion Geotechnical Review

AECOM BMT WBM

November 2012

TOWNSVILLE PORT EXPANSION PROJECT

Geotechnical Review

Submitted to:
AECOM Australia Pty Ltd

REPORT

Report Number. 117633023-002-R-Rev 1

Distribution:

AECOM - Electronic Version

Golder Associates

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1.0 INTRODUCTION

AECOM Australia Pty Ltd (AECOM) commissioned Golder Associates Pty Ltd (Golder) to provide geotechnical input to the EIS for the proposed Townsville Port Expansion Project. This report is based on reports produced by Golder and others between 1964 and 2011, and provided to Golder by Port of Townsville Limited (POTL) and others held within Golder's records and information on the proposed expansion provided by AECOM.

The site locality and proposed concept development layout of the Port Expansion Project (PEP) is presented on Figure 1. The development is to include reclamation of inundated areas extending seaward of the existing Eastern Reclamation Area, dredging adjacent to this proposed reclamation site and deepening of the Sea and Platypus channels.

2.0 THE SITE

2.1 Location of Outer Harbour

Figure 1 illustrates the location for the proposed outer harbour expansion to the Townsville Port.

The proposed new outer harbour of the PEP comprises reclaiming an area extending east and north-east of the existing Eastern Reclamation Area. The new basin for the outer harbour will ultimately be dredged to an average depth of -13.6m LAT to obtain a minimum navigation design depth of -12.9m LAT. The berth pockets will be dredged to an average dredged depth of -15.5m LAT. The dredged outer harbour basin will have an area of approximately 70 hectares

The reclaimed area will ultimately cover an area of nearly 100 hectares to a general elevation of +7.5m LAT. This will comprise mainly material dredged from the basin area with material for a capping layer sourced from land.

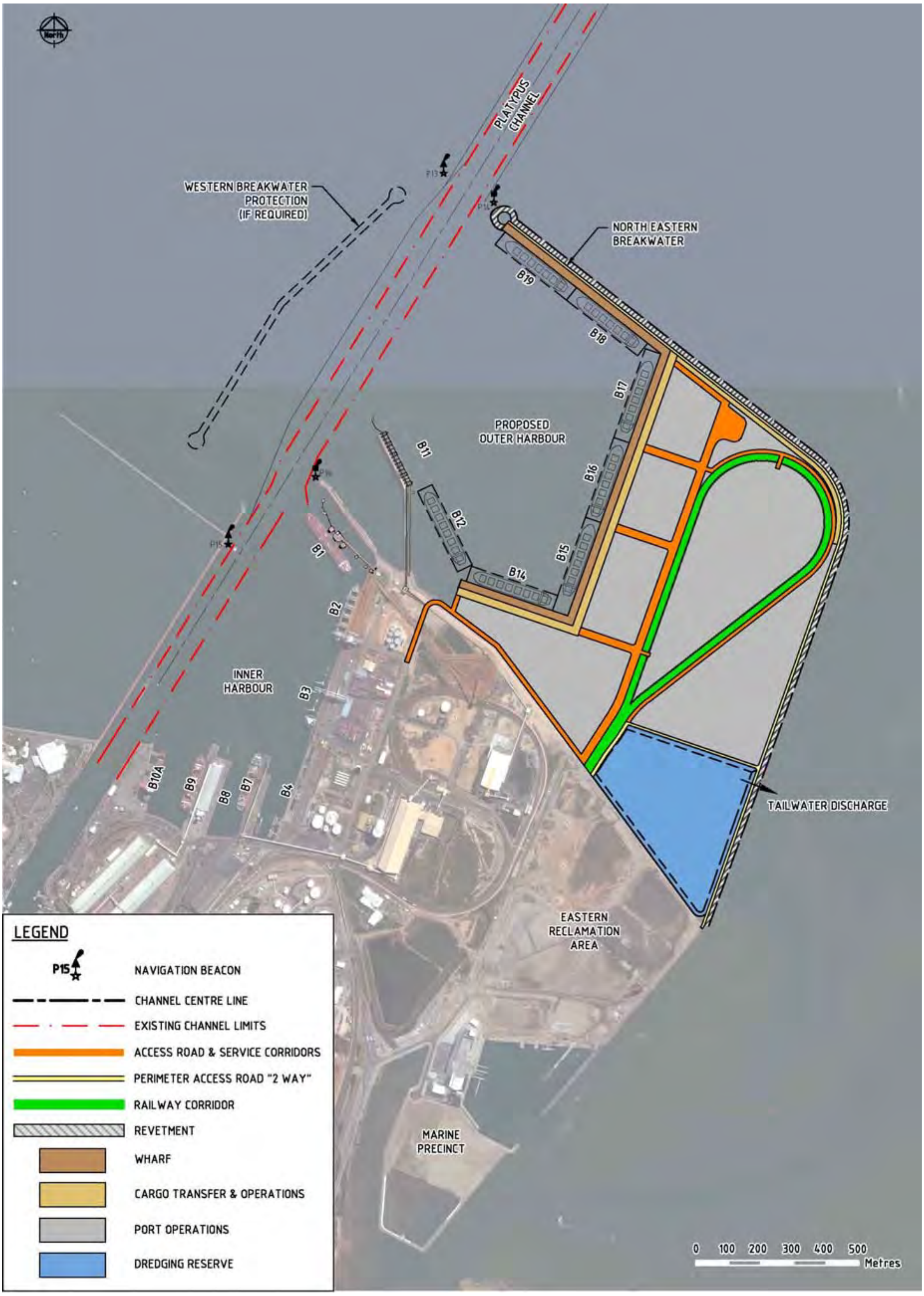

Figure 1 **Outer Harbour Location (*Source: AECOM*)**

2.2 Sea and Platypus Channels

The dredged Sea and Platypus channels provide shipping access to the Port of Townsville. The channels are approximately 13.75 km in length, 92 m in width and extend from the mouth of Ross Creek past the north-eastern side of Magnetic Island. It is understood that the channel was originally dredged during the early 1900’s and was most recently re-dredged to approximately -12.0m LAT in 1993. A component of the Townsville Port Expansion Project involves assessment to improve access through deepening of the channels and widening at the approach to the new outer harbour.

The location of the Sea and Platypus channels is shown on the sketch plan below:

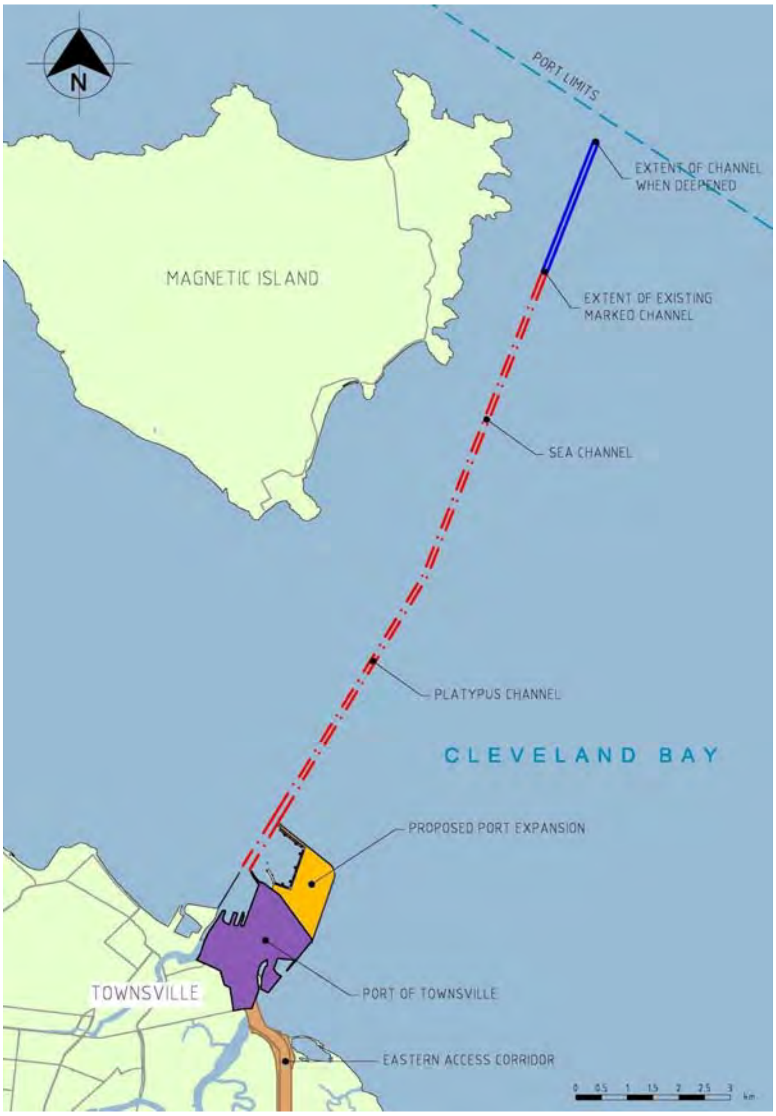

Figure 2 Sea and Platypus Channel Locations (source AECOM)

3.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

Published geological data (Queensland Department of Mines (1:250,000 scale) geological map of the Townsville Region) and findings reported indicate that the site is underlain by Quaternary-age alluvium and colluvium sediments, underlain by late-Palaeozoic age granite.

The Maritime Safety Queensland's "Tide Tables and Boating Safety Guide 2011" lists the following tidal data for Townsville Port:

- Lowest Astronomical Tide (LAT) is 0.00 m LAT = -1.86 m AHD
- Highest Astronomical Tide (HAT) is +4.11 m LAT = +2.25 m AHD

4.0 PAST INVESTIGATIONS

Previous investigations have been conducted on various parts of the site with subsurface information available dating back to 1964. The following reports detail the investigations that have been undertaken in and around the proposed location for the Townsville Port Expansion:

- Geophysical Survey of The Port of Townsville, 1964, Ground and Marine Geophysics Limited
- Sonar & Seismic Survey Cleveland Bay, 1978, Blain, Bremner and Williams Pty Ltd
- Factual Report on Geotechnical Investigation, Proposed Shipping Channel Dredging Cleveland Bay, Townsville, 1992, D.J. Douglas & Partners Pty Ltd, Project No. 12877B
- Factual Report on Supplementary Investigation, Proposed Swing Basin Dredging Adjacent to Western Breakwater Inner Harbour – Port of Townsville, 1992, D.J. Douglas & Partners Pty Ltd, Project No. 16321A
- Proposed Channel Deepening Cleveland Bay, 1992, D.J. Douglas & Partners Pty Ltd, Project No. 12877A
- Report on Supervision of Dredging to Assess Quantities of 'Nominated Conditions' Platypus Channel, Cleveland Bay, Townsville, 1993, D.J. Douglas & Partners Pty Ltd, Project No. 12877E
- Factual Report on Supplementary Investigation, Proposed Outer Harbour – Port of Townsville, 1995, D.J. Douglas & Partners Pty Ltd, Project No. 12877F
- Report on Geotechnical Investigation Cannington Offshore Facilities Port of Townsville, 1996, Douglas Partners, Project No. 17798
- Factual Report on Geotechnical Investigation Proposed Outer Harbour Berths Port of Townsville, 1997, Douglas Partners, Project No. 17835
- Report on Contract 559 – Offshore Geotechnical Investigation. Preliminary Geotechnical and Acid Sulphate Soils Investigation Townsville, Queensland, 2008, Golder Ref. 077692009-002-Rev1
- Marine Seismic Investigation of the PEP Site.

The approximate locations of the available historical data are shown on 087692015_002_L_F0001_Rev0 Figures 1, A1 to A3, B1 to B3 and C1 to C2.

4.1 Proposed Port Expansion Project

The development will form an extension to the existing harbour and port facilities (on the reclaimed portion which will adjoin the existing port to the east). The area to be dredged comprises an irregular rhomboid shaped area (approximately 70ha) located to the immediate north-east of the existing harbour, which will be referred to as the Outer Harbour. The proposed dredge footprint extends from the east side of the Platypus Channel to the reclamation area.

Drawing 60161996-SK1100 in Appendix A shows the dredge footprint broken down into a number of 'navigation areas' according to the proposed staging of development. The new outer harbour will include a number of deep berths (B14 through B19) which will supplement the 8 berths in the existing inner harbour.

The construction staging and summary of quantities is indicated on the drawing in Appendix A, which also includes the location of the existing port and the future Berth B12.

The reclamation area (approximately 100ha in area) comprises 10 bunded areas (numbered I through X) separated by a system of internal bunds and surrounded by an external revetment which joins the new breakwater with the existing reclaimed area portside.

Drawings 60161996-SK-1015 to SK-1018 (refer Appendix A) show the development of the development of the port in stages. The proposed development involves the disturbance (dredging and placement) of the following approximate quantities:

- **Stage A** (refer 60161996-SK-1015) - Involves dredging to create new navigation area 2 for berths B14 and B15 and deepening of existing areas 1a/1b. All soft marine surface sediments will be relocated to the offshore Dredge Material Placement Area (DMPA) and the remaining material will be used as fill in bunded areas I to VI.

  The excavation to -12.7m CD for the new navigation area from the current seabed, which ranges from -2.5m to -4m CD results in a dredged cut in the order of 8.5m to 10m. Berth pockets for B14 and B15 will be dredged to -15.1m CD**.**

  The Sea and Platypus channels will be deepened by 1m during Stage A and there will also be widening of the Platypus channel for 900m approaching the outer harbour.

- **Stage B** (refer 60161996-SK-1016) - Involves dredging to create new navigation area 3 for berth B16. All soft marine surface sediments will be relocated to the offshore DMPA and the remaining material will be used as fill in bunded areas VI and VII.

  The excavation to -12.7m CD for the basin from the current seabed which ranges from -3.25m to -5m CD results in a dredged cut in the order of 7.5m to 9.5m. The berth pocket for B16 will be dredged to -15.1m CD.

  There will be no channel dredging during Stage B.

- **Stage C** (refer 60161996-SK-1017) - Involves dredging to create new navigation area 4 for berths B17, B18 and B19 and deepening of existing areas 1a/1b, 2 and 3. All soft marine surface sediments will be relocated to the offshore DMPA and the remaining material will be used as fill in bunded areas VI to IX.

  The excavation to -13.6m CD for the basin from the current seabed which ranges from -3.5m to -5m CD results in a dredged cut in the order of 8.5m to 10m. Berth pockets for B17, B18 and B19 will be dredged to -15.1m CD**.**

  The Sea and Platypus channels will be deepened by a further 0.9m during Stage C.

- **Stage D** (refer 60161996-SK-1018) – No dredging is required for this stage.

- **Dredging for the combined harbour basin areas and berths** is expected to produce 4,762,000 m^3 of spoil, with a further 1,056,000 m^3 coming from excavations underneath the reclamation area bund system and new outer breakwater. Of this, approximately 1,482,000 m^3 will be soft sediments, predominantly Holocene alluvium likely to contain ASS. The remaining 4,337,000 m^3 of spoil with comprise the underlying stiffer Pleistocene alluvium and residual soils.

- **The combined bunded reclamation area** – comprising of 10 bunded areas will have capacity for as much as 7,000,000 m^3 of fill. Bunded areas I through VIII will be filled to 6.0m CD (4.1m AHD), while areas IX and X will temporarily hold large settling ponds for the retention, monitoring and decanting of dredge tailwater. The settling ponds will be constructed to 5.0m CD (3.14m AHD). The bund system and new breakwater will additionally be constructed from imported clean fill.

Dredging and construction of the reclamation area will be staged. The soft Holocene sediments will be excavated first and either separated out for ocean disposal below LAT or placed within the reclamation area at its lowest level, between -3.5m to 0.0m CD (i.e. also below LAT level). The remaining spoil would then be placed sequentially on top of the Holocene material, capping it and keeping it below sea level.

5.0 SUMMARY OF SUBSURFACE CONDITIONS

5.1 General

In general, the subsurface conditions reported across the area proposed for the extension to the Townsville Port and along Platypus Channel comprised two main material categories. As summarised in Golder Associates' Report No. 077692009-002-Rev1 (included as Appendix B of this report), these may be summarised as follows:

- Seabed Sediments. The surface layer of seabed sediment material is comprised of recent marine sediments generally consisting of a mixture of very soft to soft silty clay to clayey silt with very loose and loose sand to silty sand to clayey sand. Shell fragments and organic materials commonly occur within this layer. The seabed sediments are easily identified by their dark hue and "very soft" and "very loose" nature. The fine fraction of these materials is generally 45-50% clay, 45-55% silt and 0-10% sand.
- Older Clayey Materials. Materials underlying the seabed sediments are older stiff to hard clays and sandy clays and medium dense to very dense clayey sands and sands. These materials are much lighter in colour than the seabed sediments.

5.2 Location for Proposed Extension to Townsville Port

Table 1 below summarises the most recently reported surface sediment thicknesses in the proposed extension area to the existing Eastern Reclamation Area. The thicknesses reported by the seismic reflection testing in the 1970's generally ranged between 1.5 m to 2.0 m in the harbour mouth extending to 2.0 m to 4.0 m seaward. The inferred thicknesses of this surface sediment layer would be expected to be larger in the harbour within the protection of the breakwater than in the proposed reclamation extension area. It is further expected that the deposit thickness varies considerably across the site and also varies seasonally.

Table 1: Summary of Surface Sediment Thickness Reported Across Proposed Extension to Townsville Port

Test Location	Approximate Depth of Surface Sediment (m)	Approximate RL (LAT) at Base of Surface Sediment (m)	Test Location	Approximate Depth of Surface Sediment (m)	Approximate RL (LAT) at Base of Surface Sediment (m)
OB1	0.0	-3.3	**OB10**	1.2	-3.9
OB2	0.0	-3.6	**TPA1**	1.1	-5.1
OB3	0.7	-4.2	**TPA2**	1.5	-5.3
OB4	1.1	-3.4	**TPA3**	1.7	-5.1
OB5	0.2	-2.9	**TPA4**	1.2	-4.2
OB6	0.5	-3.1	**TPA7**	0.75	-3.5
OB7	1.0	-3.5	**TPA8**	0.8	-3.2
OB8	0.0	-3.2	**TPA22**	0.75	-5.1
OB9	0.4	-3.2	**TPA23**	1.5	-5.7

The seismic testing undertaken in the 1970's indicated horizons on the logs, suggesting some cementation at depth in the materials underlying the surface sediment layer. These results were reported as sporadic, inconsistent and do not correlate to results reported in boreholes drilled up to 30.45 m below seabed level (approx. RL 33.15m LAT) within the proposed reclamation extension area. More recent seismic assessment undertaken by Mapping and Hydrographic Surveys Pty Ltd confirms the absence of rock materials within the dredge zone.

5.3 Platypus Channel

Prior to the most recent dredging of Platypus Channel in 1993, the reported surface sediment thicknesses along Platypus Channel generally ranged from 0.1 m to 3.0 m thick. The approximate thickness and depth of surface sediment reported pre-dredging in 1993 are summarised in Table 2. These measurements were taken in 1992, and at the time of investigation the base of the channel was estimated as -11.5 m LAT but the seabed level down the centre of the channel has generally been reported as between -11.1 m and -13.0 m (LAT) and up to -9.4 m (LAT) on the outer edge of the channel.

Table 2: Summary of Surface Sediment Thickness along Platypus Channel Prior to 1993 Dredging Exercise

Chainage* (m)	Approximate Depth of Surface Sediment (m)	Approximate RL (LAT) at Base of Surface Sediment (m)
CH 0 to CH 1700	0.4 to 1.5	-12.0 to -13.1
CH 1700 to CH 3500	0.2 to 0.7	-11.9 to -12.4
CH 3500 to CH 5000	0.1 to 0.5	-11.7 to -12.4
CH 5000 to CH 6100	0.2 to 0.4	-11.8 to -12.0
CH 6100 to CH 9500	1.25 to 3.05	-11.3 to -14.6
CH 9500 to CH 13700	0.6 to 2.8	-12.1 to -14.7

* Measured from mouth of Ross Creek

The seismic testing undertaken in the 1970's indicated horizons on the logs, suggesting some cementation at depth in the materials underlying the surface sediment layer. No evidence of rock or cementation was reported within the boreholes excavated prior to dredging the channel in 1993. Excavation difficulty was encountered during dredging works comprising of excavating the channel to a design depth of -12.0 m (LAT) using a trailer hopper dredge. Further investigation resulting from the dredging difficulties indicated that very low strength cemented material existed in several location where the channel floor was generally at a relatively higher RL. Surveyors identified forty-six locations with a higher channel floor level, a grab dredge was mobilised to site and monitoring was undertaken during dredging on forty-three of these locations to better estimate the percentage of material comprising rock or cemented materials which would be classified by Australian Standard AS1276 *"Engineering Classification of Rock"* as exceeding the rock strength class 'extremely low'.

The observations made during dredging were generally consistent with inferred subsurface conditions reported from the previous geotechnical investigations. Observations indicated that the dredged material generally comprised very stiff to hard grey and brown sandy clay and clay, and medium to coarse grained clayey sand. Thin layers of surface sediment (up to an estimated depth of 50 mm) were noted in various locations. As expected these surface sediments would result in previously dredged areas from tidal and seasonal movement of loose and soft surface sediment.

The monitoring summarised that the conditions varied considerably across the areas, material strength and composition also varied greatly between consecutive grabs. As an average, it was estimated that 5 to 10% of the total surface area[1] monitored contained materials comprising 'low strength' rock or cemented materials. These materials were described as "*weakly cemented to very weakly cemented grey and brown medium to*

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[1] Total sum of the area at each of the forty-three locations nominated across channel as having the highest potential to contain the cemented soils or low strength rock.

coarse grained clayey sand and sandy clay often encountered as a 50 – 150 mm thick capping layer". Point load testing on cemented material indicated classifications within the Australian Standard AS1276 *"Engineering Classification of Rock"* of 'extremely low' to 'low' strength.

6.0 GENERAL ENGINEERING COMMENTS

6.1 Summary of Revetment Advice

A stability assessment was undertaken in 2008 on typical revetment profiles at sections generated from boreholes drilled in the proposed reclaim area advised by Port of Townsville. The boreholes used for this analysis are considered to be consistent with previously published material. Analysis were performed for what were considered to be "extreme" conditions in which the water level was at lowest astronomical tide (0 m LAT = -1.86 m AHD) and also for more "normal" conditions for which the water level was modelled at 1.0 m LAT. A construction case comprising "extreme conditions" with temporary loading from machinery under a simulated dewatered construction and a dynamic loading case (earthquake loading case) were performed on the worst case profile.

The findings indicate that an adequate factor of safety (FOS) against instability can be achieved under "extreme", "normal" and temporary loading conditions provided the following issues are addressed. These comments may need to be clarified and/or amended if further detailed investigation or detailed design can demonstrate otherwise:

- Soft silts/clays are removed from the entire footprint of the revetment embankments. Thicker zones of firm and/or firm to stiff clays (typically further seaward from the existing Eastern Reclamation area) may require at least partial removal.
- Batter slopes for the revetment walls are to be limited to no steeper than 1V:1.5H and additional toe support in the way of armour rock will be required across the seaward side of the revetment wall. This additional toe rock will need to be placed at a slope of no steeper than 1V:2H below approximately -1.0 m LAT (pending further investigation and detailed design).
- Dredged batter slopes are to be no steeper than 1V:3H (unless further detailed investigation and design can demonstrate that the materials at these locations can tolerate steeper batter slopes).

It is further reported that additional stability assessment will be required during the design stage of the project and on filling above the level of the revetment wall (i.e. for surcharging). Preliminary specifications limiting maximum batter slopes to 1V:2H and minimum toe setbacks for the surcharge at 10 m from the top of the revetment are reported. More detailed assessment and design will be required to confirm this during detailed design.

Laboratory testing of the seabed sediments indicates that the materials are of low strength and highly compressible. These properties result in a high potential for the materials to cause instability and significant settlement if left in place under revetment walls, filling and other structures. It has been recommended that these materials be removed from under the footprint of revetment walls and land reclamation areas prior to filling.

6.2 Summary of Earthworks Advice

6.2.1 General

It is understood that in general terms the proposed construction comprises the formation of revetted embankments around the reclamation area and filling with materials from surrounding areas that are proposed to be deepened for shipping channels, berth pockets and swing basins.

We understand that wet construction techniques will be used to form the reclamation

- Wet Construction. The wet construction option was the manner in which the previous reclamation was undertaken. Typically, wet construction would involve dredging and using the dredged spoil (or portion of it) as fill material in the reclamation area.

Another alternative option is suggested combining both wet and dry construction – for example bunding the reclamation area, dewatering of part of the reclamation area, “cutter suction” or grab dredging into the other part of the reclamation area, drying of the dredge materials and “conventional” filling. Dependant on the dredge material properties stabilisation (via say lime) or other material improvement technique may need to be added (eg for ASS/PASS treatment).

6.2.2 Dredgeability

The dredging operation undertaken across Platypus Channel in 1993 was predominantly done so using the Westham Dredging Contractors Pty Ltd (WH) Resolution, a trailer hopper dredge. It has been reported that the trailer hopper dredge was unable to achieve excavation to the required design level (-12 m LAT) at several locations comprising and attempts using the WH resolution and a ‘sweep bar’ pushed by the WH Reliance had very limited success. Dredging to design level was achieved at these locations using the grab dredge WH Goomai. No difficulties were reported dredging these locations using the grab dredge. Observations made during dredging suggest that the materials excavated at these locations comprised from 0% to 50% ‘extremely low’ to ‘low’ strength cemented materials and were generally found as a 50 mm to 150 mm thick capping layer.

Cemented material was not recorded in the boreholes excavated in either the proposed extension area to the existing Eastern Reclamation Area or along Platypus Channel. For removal of materials encountered in boreholes, conventional “cutter suction” dredging as used in the Port in the past is expected to be achievable. Mechanical dredging methods such as grab or bucket dredges may also be feasible. Appropriate dredge techniques should be assessed by an experienced dredging contractor once more detailed investigations have been undertaken.

6.2.3 Suitability of Dredged Materials as Fill

As mentioned in Section 6.1 the laboratory testing of the seabed sediments indicates that the materials are of low strength and highly compressible. If dredged to land, these materials will need to be confined within an excavation or bunds. If “dry” excavated and transported to land these materials may still need to be confined within an excavation or bunds as they have the potential to “liquefy” during this process. These materials are not considered to be suitable for reuse as fill without significantly drying and lime treatment.

Laboratory test results indicate that the seabed sediments have a low potential for dispersion in sea water. However, the laboratory test results also indicate that the seabed sediments have a low to high potential for dispersion in fresh water and therefore erosion control is likely to be required if these materials are exposed to rainfall.

Published material indicates that the substrata below the seabed sediment generally comprises stiff to hard clays/sandy clays and medium dense to very dense sand/clayey sand.

The geotechnical reports published on the site suggest these materials are expected to be suitable for re-use as fill provided organic materials, materials greater than 75 mm in size are removed and cemented materials are either crushed to less than 75 mm in size or removed (if encountered), and provided they are moisture conditioned for compaction. It has been noted that clayey fills have the potential to heave after construction, particularly if compacted dry of optimum moisture content. It is suggested that the potential use of dryer materials in the upper fill layers be assessed at the time of construction.

7.0 CONSTRAINTS AND OPPORTUNITIES

7.1 Constraints

- Seabed sediments are weak compressible and at high moisture contents. If left in place below revetments they are likely to cause instability and high volume reductions once loaded. These materials are fine grained with high percentages of clay sized particles.
- The materials below the sea bed sediments are generally clay, sandy clay and clayey sand. These materials if disturbed and mixed with water during dredging form fill material that requires significant treatment and drying back before they can be used as a structural fill.

- Cemented hard pan layers that are resistant to cutter section dredging have been encountered at several locations along Platypus Channel. Dredging of these areas required establishment of a clam shell dredge to achieve penetration.
- Dependent upon the load requirements for piles, driven pile penetration into some foundation zones may require chopping and pre-coring.
- No significant volumes of sand have been encountered within the historical investigations

7.2 Opportunities

- There is no indication within the Port Expansion area of materials that will be difficult to excavate using dredging techniques.
- The materials encountered below the sea bed sediments have been found to be able to be used as structural fill if appropriately moisture conditioned and compacted.

8.0 LIMITATIONS

Your attention is drawn to the document - “Limitations”, which is included in Appendix B of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks associated with the services provided for this project.

The document is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

GOLDER ASSOCIATES PTY LTD

W. Bi

Wyn Binmore
Associate/ Principal Geotechnical Engineer

WSB/wsb

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Appendix A
Results of Fieldwork

REPORT OF BOREHOLE: TPA01

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 483182 m E 7872658 m N 55 AMG66
SURFACE RL: -4.00 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 11.95 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: KSR DATE: 11/12/07
CHECKED: SE/SA-BT DATE: 14/3/08

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0		DS 0.00-0.25 m PP = 90 kPa			~~CH~~	Sandy CLAY Medium to high plasticity, dark grey, fine to coarse sand, wet, soft, occasional shell fragments	W	S	
				-4.15	DS 0.25-0.50 m PP = 220 kPa DS 0.50-0.75 m PP = 240 kPa DS 0.75-1.00 m PP = 220 kPa DS 1.00-1.25 m PP = 230 kPa U50 1.25-1.65 m PP = 260 kPa U50 2.50-2.90 m PP = 160 kPa			CH	CLAY High plasticity, dark grey, moist, some fine to coarse sand and trace of gravel	M	F	
			1	1.10 -5.20					. Grading to brown at 1.1m depth . Some fine to medium gravel at 1.2m depth			
			2	2.50 -6.50					. Grading to stiff and orange-brown at 2.5m depth		St	
			3	3.50 -7.50					. Grading to sandy CLAY at 3.5m depth			
			4	4.00 -8.00	U50 4.00-4.32 m PP = 250 kPa			CH	Sandy CLAY High plasticity, orange-brown, fine to coarse sand, with some fine to medium gravel			
			5	5.50 -9.50	SPT 5.50-5.95 m 7,11,17 N = 28 PP = 350 kPa				. Grading to pale brown with fine sand at 5.5m depth			
			6	6.50 -10.50				SC/ CI	Clayey SAND/Sandy CLAY Medium plasticity, brown, fine sand, moist		MD-Vst	
			7	7.20	SPT 7.00-7.45 m 8,11,15 N = 26				. Grading to pale brown at 7.2m depth			
				7.50 -11.50				CH	Sandy CLAY High plasticity, brown, fine to coarse sand			
			8	8.60	SPT 8.50-8.95 m 4,7,13 N = 20			SC	Clayey SAND Fine to coarse sand, red/brown, medium plasticity, wet, medium dense	W		
			9	8.95 -13.10					. Grading to sandy CLAY at 8.9m depth . Grading to clayey SAND at 9.1m depth	M	VSt	
			10	10.00 -14.00	SPT 10.00-10.45 m 13,17,21 N = 38 PP = 480 kPa			SC	Clayey SAND Fine to coarse sand, pale brown, medium plasticity, moist, dense		D	
			11	11.50 -15.50	SPT 11.50-11.95 m 7,12,19 N = 31			CI	CLAY Medium plasticity, dark brown, moist,dense, intermitted sand layers			
			12	11.95 -15.95					END OF BOREHOLE @ 11.95 m			
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF BOREHOLE: TPA02

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 483364 m E 7872392 m N 55 AMG66	DRILL RIG: Rason
PROJECT:	Offshore Drilling Project	SURFACE RL: -3.80 m DATUM: LAT	DRILLER: Double J Drilling
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR DATE: 10/12/07
JOB NO:	077692009	HOLE DIA: 100 mm HOLE DEPTH: 12.45 m	CHECKED: SE/SA-BT DATE: 14/3/08

Drilling				Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L			DS 0.00-0.25 m			CH	Sandy CLAY Medium to high plasticity, dark grey, fine to coarse sand, wet, soft	W	S	
			0.20 -4.00	DS 0.25-0.50 m PP = 180 kPa DS 0.50-0.75 m PP = 190 kPa DS 0.75-1.00 m PP = 190 kPa DS 1.00-1.25 m PP = 190 kPa			CH	CLAY High plasticity, dark grey, moist, trace of fine sand	M	F-St	
			1.50 -5.30	U50 1.50-1.80 m PP = 1.60 kPa				. Grading to pale grey at 1.5m depth			
			2.80					. Grading to orange/brown at 2.8m depth			
			3.00 -6.80	U50 3.00-3.40 m PP = 110 kPa				. Some pockets of sand at 3.2m depth		St	
			3.50 -7.30					. Grading to orange/brown CLAY at 3.5m depth			
			4.50 -8.30	SPT 4.50-4.95 m 7,6,7 N = 13 PP = 340 kPa				. Some fine to medium grave and fine to coarse sand at 4.5m depth			
			5.50 -9.30				SC	Clayey SAND Fine to coarse sand, orange/brown, medium plasticity, some fine to medium gravel, medium dense	W	MD	
			6.00 -9.80	SPT 6.00-6.45 m 8,12,15 N = 27				. Grading to fine sand, orange/grey at 6.0m depth	M		
			7.50 -11.30	SPT 7.50-7.95 m 8,7,12 N = 19			CH	Sandy CLAY High plasticity, grey, orange/brown, fine to medium sand, moist, very stiff		VSt	
			8.20 -12.00					. Grading to medium to high plasticity, orange/brown, fine to medium sand			
			9.00 -12.80	SPT 9.00-9.45 m 12,18,23 N = 41				. Grading to fine sand, high plasticity, pale brown/brown		H	
			10.50 -14.30	SPT 10.50-10.95 m 7,14,20 N = 34			MH	SILT High plasticity, orange/brown, trace of fine sand			
			12.00 -15.80	SPT 12.00-12.45 m 10,16,19 N = 35			CH	CLAY High plasticity, grey/brown, some fine to medium sand			
			12.45 -16.25					END OF BOREHOLE @ 12.45 m			

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF BOREHOLE: TPA03

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 483747 m E 7872147 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -3.40 m DATUM: LAT		DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 12/12/07
JOB NO:	077692009	HOLE DIA: 100 mm HOLE DEPTH: 12.45 m		CHECKED: SE/SA-BT	DATE: 14/3/08

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-3.40	DS 0.00-0.25 m DS 0.25-0.50 m DS 0.50-0.75 m DS 0.75-1.00 m PP = 190 kPa DS 1.00-1.25 m PP = 200 kPa U50 1.50-1.78 m PP = 230 kPa			CH	CLAY High plasticity, dark grey, wet, soft, some fine to coarse sand, occasional shell fragments	W	S-F	
				0.75 -4.15					. Trace of sand, firm at 0.75m depth	M	F	
				1.70					. Grading to orange-brown at 1.7m depth		St	
				2.00 -5.40					. Grading to dark grey, trace of fine sand and gravel at 2.0m depth			
				3.00 -6.40	U50 3.00-3.40 m PP = 160 kPa			CH	Sandy CLAY/CLAY High plasticity, orange-brown, fine sand			
				4.50 -7.90	SPT 4.50-4.95 m 5,8,10 N = 18 PP = 260 kPa			CH	CLAY High plasticity, orange-brown, intermitted layers of fine to medium white gravel with some sand		VSt	
				5.50 -8.90					. Becoming sandy CLAY at 5.5m depth			
				6.00 -9.40	U50 6.00-6.40 m PP = 420 kPa			CH	Sandy CLAY High plasticity, orange-brown, fine to coarse sand, some fine gravel			
				6.50 -9.90					. Grading to fine sand at 6.5m depth			
				7.00 -10.40	SPT 7.50-7.95 m 8,9,15 N = 24 PP = 320 kPa			CI/ CH	Sandy CLAY/CLAY Medium to high plasticity, orange-brown with some grey pockets of fine sand			
				9.00 -12.40	SPT 9.00-9.45 m 15,20,28 N = 48 PP = 550 kPa			CH	CLAY HIgh plasticity, pale grey, with some fine to coarse sand, moist, hard		H	
				10.50 -13.90	SPT 10.50-10.95 m 9,14,19 N = 33				. Grading to grey and orange/brown at 10.5m depth			
				12.00 -15.40	SPT 12.00-12.45 m 8,14,22 N = 36				. Grading to brown and grey at 12.0m depth			
				12.45 -15.85					END OF BOREHOLE @ 12.45 m			

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REPORT OF BOREHOLE: TPA04

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 484059 m E 7871715 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -3.00 m	DATUM: LAT	DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 13/12/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 12.45 m	CHECKED: SE/SA-BT	DATE: 14/3/08

Drilling				Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0.00 -3.00				CI	Sandy CLAY Medium to high plasticity, dark grey, fine to coarse sand	W	F	
			1.20					. Grading to clayey SAND at 1.2m depth	M	VSt	
			1.40 -4.40	U50 1.50-1.75 m PP = 280 kPa SPT 3.00-3.45 m 9,8,8 N = 16			SC	Clayey SAND Fine to coarse sand, dark grey, medium plasticity, wet, medium dense	W	MD	
			3.80 -6.80					. Grading to SAND with some clay			
			4.50 -7.50	SPT 4.50-4.95 m 7,8,8 N = 16			SW	SAND Fine to coarse sand, grey, wet, medium dense with some clay and fine to medium gravel			
			5.00 -8.00					. Grading to clayey SAND at 5.0m depth			
			5.50 -8.50					. Grading to SAND at 5.5m depth			
			6.00	SPT 6.00-6.45 m 7,8,12 N = 20				. Grading to brown/orange, grey with some clay at 6.0m depth			
			6.30					. Layer of fine to medium gravel at 6.3m depth			
			6.40 -9.40	SPT 7.50-7.95 m 9,9,8 N = 17			SW-SC	Clayey SAND/SAND Fine to coarse sand, brown, medium plasticity, wet, medium dense with some bands of fine to medium gravel			
			7.80 -10.80					. Band of fine to medium gravel at 7.8m depth			
			9.00 -12.00	SPT 9.00-9.45 m 10,10,9 N = 19			SC	Clayey Gravelly SAND Fine to coarse sand, grey and brown, medium plasticity, fine to medium gravel, wet, medium dense	M		
			10.50 -13.50	SPT 10.50-10.95 m 11,13,20 N = 33				. Grading to dense at 10.5m depth		D	
			12.00 -15.00	SPT 12.00-12.45 m 8,11,16 N = 27			SC	Clayey SAND Fine to coarse sand, grey, high plasticity, wet, medium dense	W	MD	
			12.45 -15.45					END OF BOREHOLE @ 12.45 m			

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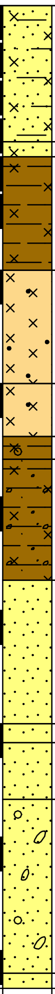
REPORT OF BOREHOLE: TPA05

Golder Associates

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 484361 m E 7871283 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -2.68 m DATUM: LAT		DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KJR	DATE: 14/12/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 13.00 m	CHECKED: SE/SA-BT	DATE: 14/3/08



Drilling					Sampling	Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-2.68	SPT 0.00-0.45 m RW/450mm SPT 0.50-0.95 m RW/450mm SPT 1.00-1.45 m RW/450mm SPT 1.50-1.95 m RW/450mm	SM	Clayey Silty SAND fine medium and coarse sand, dark grey high liquid limit, trace of organic material, wet, very soft	W	VS	
			1.80			SM	Silty SAND Fine grained, dark grey with trace of organic matter	M	VL	
			2.00	-4.68	SPT 2.00-2.45 m 2,3,5 N = 8 SPT 2.50-2.95 m 3,3,4 N = 7	CH	Silty CLAY light grey and pale brown, medium to course sand particles,moist stiff, trace of sand and gravel, . Some sand and gravel at 3.4m depth		St	
			3.40	-6.18	SPT 3.50-3.95 m 3,4,3 N = 7	ML	Sandy SILT Low liquid limit,pale brown and orange brown, fine grained sand,moist, stiff			
			5.00	-7.68	SPT 5.00-5.45 m 5,6,5 N = 11	MH	Sandy SILT High plasticity,pale brown, orange-brown and grey, fine to coarse sand, trace of gravel, with some clay, moist very stiff		VSt	
			5.70			CH	Gravelly Silty CLAY High plasticity, pale brown and grey, with some sand, moist very stiff			
			6.00	-8.68	SPT 6.50-6.95 m 10,14,18 N = 32	CH	Silty Sandy CLAY High plasticity, pale brown-grey, orange-brown and brown, moist, hard		H	
			7.60	-10.28	SPT 8.00-8.45 m 9,11,11 N = 22	SW	SAND Fine to coarse sand, pale brown, trace of silt and gravel,moist, medium dense		MD	
			8.35	-11.03			. Grey at 8.35m depth			
			9.50	-12.43	SPT 9.50-9.95 m 7,9,9 N = 18		SAND Fine to coarse sand, pale brown, moist medium dense . Gravelly SAND lense, fine to coarse sand, brown at 9.65m depth			
			10.50	-13.18	SPT 11.00-11.45 m 9,8,10 N = 18		SAND Fine to coarse sand, trace of silt, grey, moist, medium dense Gravelly SAND Fine to coarse sand, trace of silt, brown, moist, medium dense			
			12.80	-15.68	SPT 12.50-12.95 m 12,16,19 N = 25		SAND Fine to coarse sand, trace of gravel and silt, grey, moist, dense END OF BOREHOLE @ 13.00 m			

Depth scale (metres): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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Golder Associates

REPORT OF BOREHOLE: TPA06

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 484655 m E 7870882 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -2.64 m	DATUM: LAT	DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 18/12/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 9.50 m	CHECKED: SE/SA-BT	DATE: 14/3/08

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	0.20 -2.84				SM	Silty SAND Medium plasticity, dark grey, fine to coarse sand, occasional shell fragments and organic matter, wet, very soft	W	VS	
			1		DS 1.00-1.25 m			ML-SM	Sandy SILT/Silty SAND Medium plasticity, dark grey, fine to coarse sand, occasional shell fragments and organic matter, wet, very soft			
			2		U50 2.50-2.70 m PP = 20 kPa							
			3	3.50 -6.14					. Grading to sandy CLAY at 3.5m depth			
			4	4.00 -6.64	U50 4.00-4.40 m PP = 40 kPa			CH	CLAY High plasticity, dark grey, occasional shell fragments, with some fine to coarse sand and organic material	M	S	
			5	5.50 -8.14	U50 5.50-5.90 m				. Some fine to coarse sand and fine to medium gravel, stiff at 5.5m depth			
			6	6.00 -8.64					. Grading to pale brown and stiff at 6.0m depth		St	
			7	7.00 -9.64	U50 7.00-7.30 m PP = 500 kPa				. Grading to stiff to very stiff at 7.0m depth		St-VSt	
			8	7.80 -10.44					. Grading to clayey fine to coarse SAND at 7.8m depth		MD	
				8.30					. Grading to sandy CLAY at 8.3m depth			
			9	8.50 -11.14	SPT 8.50-8.93 m 17,26,30/130mm			CH	Sandy CLAY High plasticity, pale brown, fine to coarse sand, moist, hard		H	
			10	9.50 -12.14					END OF BOREHOLE @ 9.50 m			
			11									
			12									
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

REPORT OF BOREHOLE: TPA07

SHEET: 1 OF 1

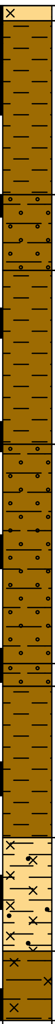
CLIENT: Townsville Port Authority	COORDS: 483439 m E 7871885 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: -2.78 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR	DATE: 7/12/07
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 13.42 m	CHECKED: SE/SA-BT	DATE: 14/3/08

Drilling — METHOD: WB — PENETRATION RESISTANCE: L — WATER

Sampling

DEPTH RL	SAMPLE OR FIELD TEST
0.20 -2.98	DS 0.00-0.25 m
0.75 -3.53	DS 0.25-0.50 m DS 0.50-0.75 m
1.40 -4.18	DS 0.75-0.10 m DS 1.00-1.25 m
2.00 -4.78	SPT 1.00-1.45 m 5,9,11 N = 20 PP = 420 kPa
2.50 -5.28	U50 2.50-2.80 m PP = 550 kPa
3.50 -6.28	U50 4.00-4.40 m PP = 210 kPa
5.50	
5.80 -8.58	U50 5.50-5.90 m PP = 180 kPa
7.00 -9.78	SPT 7.00-7.45 m 9,14,15 N = 29
8.00 -10.78	
8.70	SPT 8.50-8.95 m 6,13,16 N = 29
9.00 -11.78	
10.00 -12.78	SPT 10.00-10.45 m 7,9,11 N = 20 PP = 260 kPa
11.00 -13.78	SPT 11.50-11.95 m 9,12,18 N = 30
12.50 -15.28	SPT 13.00-13.42 m 15,25,30/120mm PP = >600 kPa
13.42 -16.20	

Field Material Description



USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION
ML	Sandy SILT
CH	Medium plasticity, dark grey, fine to coarse sand, moist, very soft CLAY High plasticity, dark grey, some fine to coarse sand, moist, soft then stiff . Grading to green-brown/light grey and stiff at 1m depth . Grading to sandy clay, low to medium plasticity, light grey, fine to coarse sand at 1.4m depth . Grading to sandy clay, fine to coarse sand, pale brown/grey, low to medium plasticity at 2.0m depth
CH	Sandy CLAY High plasticity, pale brown, fine to coarse sand, moist, very stiff
CH	CLAY High plasticity, orange/brown with some fine to coarse sand, moist, very stiff . Some fine gravel present at 5.5m depth
CI	Sandy CLAY Fine to medium sand, pale brown, low to medium plasticity, moist, very stiff . Grading to fine sand, grey and orange bands at 7.0m depth . Grading to orange-brown with fine to coarse sand from 8.0m depth
CI	Sandy CLAY Medium plasticity, grey/orange, fine sand, moist, very stiff
CH	CLAY Medium to high plasticity, orange-brown, trace of fine to coarse sand, moist, very stiff . Grading to clay with some fine sand, pale brown, medium high
MH	Sandy Clayey SILT High plasticity, brown mottled grey, fine to medium sand, moist, hard
CI	Silty CLAY Medium plasticity, grey-brown, with some fine to medium sand, moist, hard
	END OF BOREHOLE @ 13.42 m

MOISTURE: W, M, W, M, M

CONSISTENCY DENSITY: VS, S, St, VSt, VSt-H, H

STRUCTURE AND ADDITIONAL OBSERVATIONS

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REPORT OF BOREHOLE: TPA08

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 483738 m E 7871467 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -2.40 m	DATUM: LAT	DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 6/12/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 13.95 m	CHECKED: SE/SA-BT	DATE: 14/3/08

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-2.40				ML	Clayey SILT Low to medium plasticity, dark grey, traces of fine sand and shell fragments, wet, soft	W	S	
			0.80						. Grading to light grey, high plasticity at 0.8m depth			
			1.00		U50 1.00-1.40 m PP = 590 kPa			CH	CLAY High plasticity, light grey with some fine to coarse sand, fine gravel, moist, very stiff	M	VSt	
			1.20	-3.60								
			1.80	-4.20					. Grading to green/brown			
			2.20	-4.60	SPT 2.50-2.95 m 5,8,11 N = 19 PP = 340 kPa			CH	. Layer of clayey SAND/Sandy CLAY, fine to coarse sand, orange/brown CLAY High plasticity, orange/brown, trace of fine to coarse sand, moist, very stiff			
			4.00	-6.40	U50 4.00-4.35 m PP = 270 kPa				. Grading to sandy CLAY/CLAY, medium to high plasticity, fine to medium sand			
			5.00						. Layer of clayey SAND, fine to coarse sand, low to medium plasticity, orange/brown to 5.3m depth			
			5.30	-7.70	SPT 5.50-5.95 m PP = 260 kPa			CH	Sandy CLAY High plasticity, orange-brown, fine to coarse sand, with some fine to medium gravel, moist, very stiff			
			6.50	-8.90					. Grading to clayey SAND	W	MD	
			7.00	-9.40	SPT 7.00-7.45 m 5,8,14 N = 22			SC	Clayey SAND Fine to coarse sand, pale brown, low to medium plasticity, wet, medium dense, traces of fine gravel, moist, medium dense			
			8.50	-10.90	SPT 8.50-8.95 m 18,24,30/120mm				. Becoming more gravelly at 8.5m depth		VD	
			9.30	-11.70				CI	Sandy CLAY Medium plasticity, pale brown, with fine to coarse sand, moist, Hard	M	H	
			10.00	-12.40	SPT 10.00-10.45 m 19,30/140mm PP = >600 kPa			CH	CLAY High plasticity, pale brown, trace of fine to coarse sand, moist, hard			
			11.50	-13.90	SPT 11.50-11.95 m 16,17,21 N = 38 PP = 550 kPa			SC	Clayey SAND Fine to coarse sand, pale brown, low to medium plasticity, wet, dense	W	D	
			12.00	-14.40					. Becoming sandy CLAY/clayey SAND, fine to coarse sand, pale brown, low to medium plasticity at 12.0m depth			
			12.50	-14.90	SPT 13.00-13.45 m 12,18,26 N = 44 PP = >600 kPa			CH	CLAY High plasticity, pale brown, hard with some fine to coarse sand, moist, hard	M	H	
			13.95	-16.35					END OF BOREHOLE @ 13.95 m			

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Golder Associates

REPORT OF BOREHOLE: TPA09

SHEET: 1 OF 1

CLIENT: Townsville Port Authority	COORDS: 483958 m E 7871136 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: -2.20 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR	DATE: 13/11/07
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 13.95 m	CHECKED: WB	DATE: 7/12/07

Drilling: METHOD WB; PENETRATION RESISTANCE L; WATER —

DEPTH	RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
0.00		DS 0.00-0.30 m	SM	Silty SAND Fine-coarse sand, dark grey, low-medium plasticity, wet, very loose, occasional shell fragments	W	VL
0.20		DS 0.30-0.60 m	ML	Sandy SILT Medium plasticity, dark grey, fine-medium sand, wet, very soft, occasional shell fragments	W	VS
0.50	-2.70	DS 0.60-0.70 m DS 0.70-1.15 m U50 1.15-1.55 m	CH	Sandy CLAY High plasticity, dark grey, fine-medium sand, firm, wet	W	F
1.55	-3.75	SPT 1.55-2.00 m U50 2.50-2.90 m		. Grading to light grey at 1.55m	M	F
3.00	-5.20	SPT 3.00-3.45 m 6,8,11 N = 19 PP = 370 kPa		. Grading to light grey / pale brown with fine-coarse sand, very stiff	M	VSt
4.00	-6.20	U50 4.00-4.40 m		. Increasing sand from approximately 4m	M	VSt
4.50	-6.70	SPT 4.50-4.95 m 5,7,7 N = 14	SC	Clayey SAND Fine-medium sand, yellow-brown, medium plasticity, wet, medium dense	W	MD
5.50	-7.70	SPT 6.00-6.45 m 3,3,6 N = 9	CH	Sandy CLAY High plasticity, orange-brown, fine-coarse sand, moist, stiff with traces of fine gravel	M	St
7.50	-9.70	SPT 7.50-7.95 m 4,7,12 N = 19	SC	Clayey SAND Fine-coarse sand, light grey/pale brown, wet, medium dense	W	MD
9.00	-11.20	SPT 9.00-9.45 m 8,19,31 N = 50	SW	SAND Fine-coarse grained, light grey/pale brown, dense to very dense, traces of fine gravel, with some clay present	W	D-VD
10.50	-12.70	SPT 10.50-10.95 m 13,19,21 N = 40		. Grading to clayey SAND at 10.7m	W	D-VD
12.00	-14.20	SPT 12.00-12.45 m 15,15,21 N = 36	CI-CH	Sandy CLAY Medium-high plasticity, yellow-brown, fine-coarse sand, wet, hard	M	H
13.50	-15.70	SPT 13.50-13.95 m 14,22,33 N = 55	CH	CLAY High plasticity, light grey/pale brown, wet, hard, with some fine-coarse sand present	M	H
13.95	-16.15			END OF BOREHOLE @ 13.95 m		

STRUCTURE AND ADDITIONAL OBSERVATIONS

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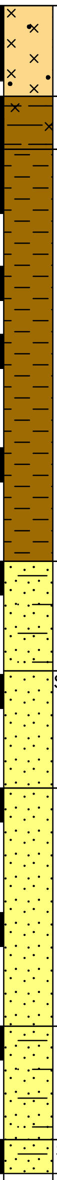
Golder Associates

REPORT OF BOREHOLE: TPA10

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 484195 m E 7870711 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -1.20 m DATUM: LAT		DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 9/11/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 15.45 m	CHECKED: WB	DATE: 7/12/07



Drilling				Sampling	Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		-1.20	DS 0.00-0.50 m DS 0.50-1.00 m	ML	Sandy SILT Low-medium plasticity, dark grey, fine to coarse sand, wet, very soft, occasional shell fragments	W	VS	
			1.20 -2.40	DS 1.20-1.50 m U50 1.50-1.90 m	CH	Silty CLAY High plasticity, dark grey, wet, stiff, trace of fine to coarse sand and organic material, occasional shells		St	
			1.90 -3.10	PP = 2.9 kPa SPT 1.90-2.35 m 3,3,6 N = 9 PP = 2 kPa U50 2.35-2.75 m	CH	CLAY High plasticity, light grey, stiff, trace of fine to coarse sand, moist	M		
			3.90 -5.10	SPT 3.45-3.90 m 4,7,11 N = 18 PP = 2.8 kPa		. Grading to light brown			
			4.35 -5.55	SPT 4.35-4.80 m 1,2,3 N = 5		. Grading to yellow-orange with some fine sand and firm		F	
			5.40 -6.60	SPT 5.85-6.30 m 6,10,10 N = 20		. Increasing to fine-coarse sand		VSt	
			7.35 -8.55	SPT 7.35-7.80 m 4,5,8 N = 13	SC	Clayey SAND fine to coarse sand, orange-light brown, low to medium plasticity, wet, medium dense	W	MD	
			8.80 -10.00	SPT 8.85-9.30 m 10,11,8 N = 19	SW-SC	SAND / Clayey SAND Fine to coarse sand, pale brown, wet,medium dense, occasional fine to medium gravel			
			9.80 -11.00			. Becoming clayey SAND pale brown/light grey, low to medium plasticity at approximately 9.8m			
			10.35 -11.55	SPT 10.35-10.80 m 6,8,6 N = 14 SPT 12.00-12.45 m 9,7,5 N = 12	SW	SAND Fine to coarse sand, pale brown/light grey, wet, medium dense, trace of fine gravel and some clay present			
			13.50 -14.70	SPT 13.50-13.95 m 9,12,14 N = 26	SC	Clayey SAND Fine to coarse sand, light brown/grey, medium plasticity, wet, medium dense			
			14.10 -15.30			. Becoming more uniformly graded sand			
			15.00 -16.20	SPT 15.00-15.45 m 10,26,30 N = 56	SC-CH	Clayey SAND / Sandy CLAY Fine to medium sand, light brown/grey, medium plasticity, moist, dense/hard	M	H/VD	
			15.45 -16.65			END OF BOREHOLE @ 15.45 m			

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GAP gINT FN. F01a
RL2

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REPORT OF BOREHOLE: TPA11

SHEET: 1 OF 1

CLIENT: Townsville Port Authority	COORDS: 484373 m E 7870511 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: -2.16 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR	DATE: 30/11/07
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 13.95 m	CHECKED: WB	DATE: 7/12/07

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-2.16			ML	Sandy SILT Low to medium plasticity, dark grey, fine to coarse sand, wet, very soft, occasional shell fragments	W	VS	
			1	*1.00* -3.16				. Grading to sandy clay at 1.0m depth			
				1.50 -3.66	SPT 1.50-1.95 m RW/450mm		CI	Sandy CLAY Low to medium plasticity, dark grey, fine to coarse sand, wet, very soft, occasional shell fragments			
			3	*3.00* -5.16	U50 3.00-3.40 m PP = 120 kPa			. Becoming more sandy and firm from 3m depth		F	
				3.90 -6.06	SPT 4.50-4.95 m 5,6,7 N = 13 PP = 300 kPa		CI	Sandy CLAY Medium plasticity, brown, mottled grey, fine to coarse sand, moist, very stiff	M	VSt	
				5.50 -7.66	SPT 6.00-6.45 m 8,13,16 N = 29 PP = >600 kPa			. Trace of white calcite and cemented calcite nodules from 5.5m depth			
				6.60 -8.76	SPT 7.50-7.95 m 4,5,6 N = 11 SPT 9.00-9.45 m 5,8,8 N = 16		SW	SAND Fine to coarse sand, brown, trace of silt and fine gravel, wet, medium dense	W	MD	
				10.70 -12.86	SPT 10.50-10.95 m 9,11,14 N = 25 SPT 12.00-12.45 m 9,12,14 N = 26			. With some clay from 10.7m depth			
				12.70 -14.86	SPT 13.50-13.95 m 13,18,25 N = 43		SC	Clayey SAND Fine to coarse sand, brown, medium plasticity clay, moist, dense, grading to hard sandy clay in places	M	D	
			14	*13.95* -16.11				END OF BOREHOLE @ 13.95 m			

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REPORT OF BOREHOLE: TPA12

SHEET: 1 OF 1

CLIENT: Townsville Port Authority	COORDS: 483846 m E 7870319 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: -0.80 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR	DATE: 28/11/07
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 14.95 m	CHECKED: WB	DATE: 7/12/07

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-0.80	SPT 1.00-1.45 m 1/450mm	MS	Sandy SILT/Sandy CLAY Low to medium plasticity, dark grey, fine to coarse sand, very soft, occasional shell fragments		VSo	
			2.20				Grading to sandy CLAY			
			2.50	-3.30	SPT 2.50-2.95 m 6,8,11 N = 19 PP = 3.5 kPa	CH	CLAY High plasticity, dark grey, wet, very stiff, occasional fine to coarse sand		VSt	
			4.00	-4.80	SPT 4.00-4.45 m 6,9,12 N = 21 PP = 3.5 kPa		Grading to brown with trace of fine to coarse sand			
			5.80	-6.60	SPT 5.50-5.95 m 7,8,10 N = 18 PP = 3.6 kPa		Grading to yellow-brown			
					SPT 7.00-7.45 m 10,13,21 N = 34 PP = 5.5 kPa					
			8.50	-9.30	SPT 8.50-8.95 m 10,9,12 N = 21	SW	SAND Fine to coarse, yellow-brown, wet with some clay		MD	
			10.00	-10.80	SPT 10.00-10.45 m 6,7,6 N = 13		SAND/Clayey SAND Fine to coarse, pale brown, low plasticity, loose			
			11.50	-12.30	SPT 11.50-11.95 m 9,11,10 N = 21		Clayey SAND Fine to coarse sand, pale brown, low plasticity, wet, medium dense			
					SPT 13.00-13.45 m 8,9,10 N = 19					
			13.70	-14.50			Grading to clay			
			14.50	-15.30	SPT 14.50-14.95 m 8,9,14 N = 23		CLAY High plasticity, brown/grey, wet, very stiff, with some fine to coarse sand present, friable		VSt	
			14.95	-15.75			END OF BOREHOLE @ 14.95 m			

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GAP gINT FN. F01a
RL2

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REPORT OF BOREHOLE: TPA13

SHEET: 1 OF 1

CLIENT: Townsville Port Authority	COORDS: 484080 m E 7870140 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: -0.90 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR	DATE: 29/11/07
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 14.50 m	CHECKED: WB	DATE: 7/12/07

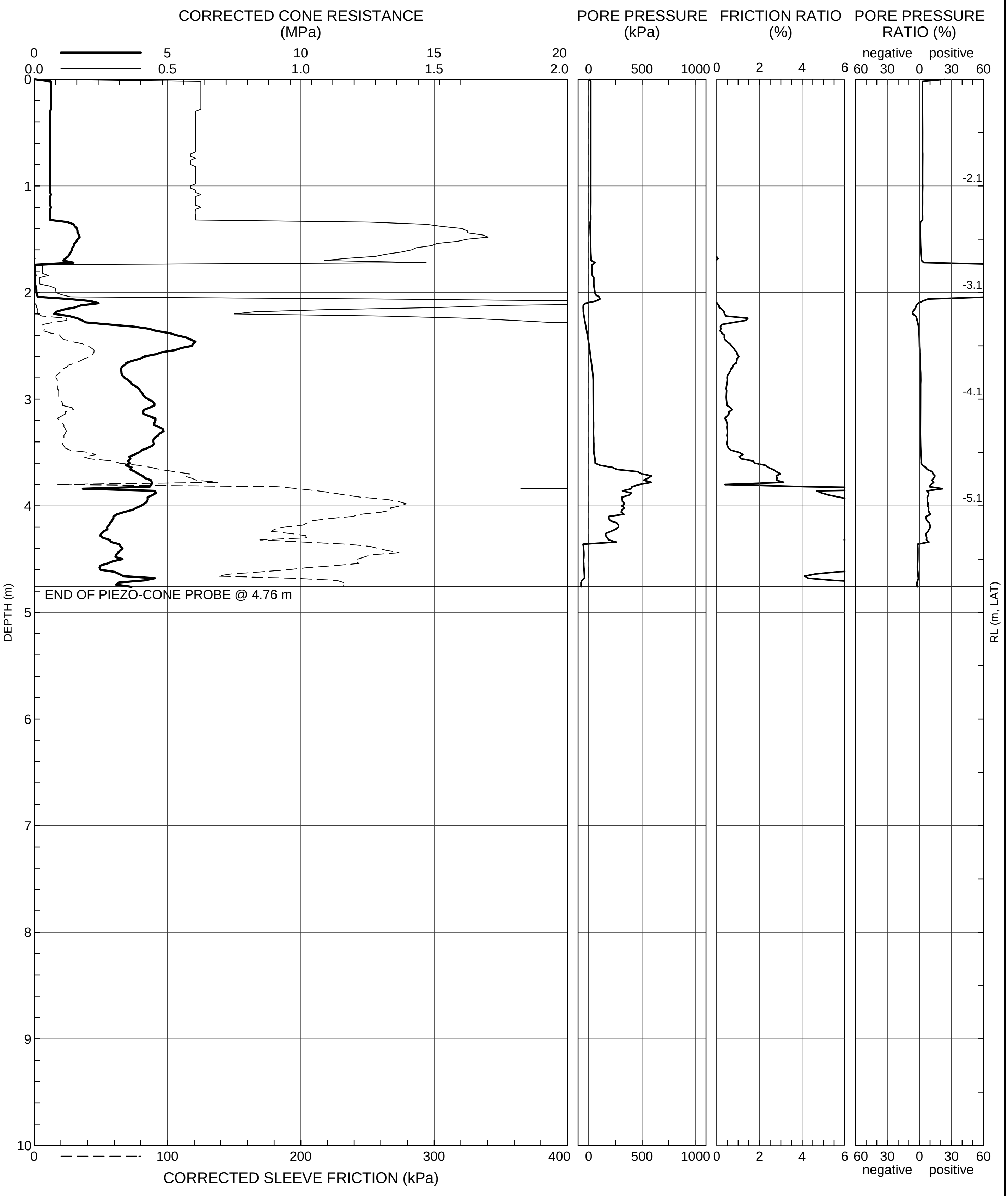
Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-0.90	DS 0.00-0.25 m DS 0.25-0.50 m DS 0.50-0.75 m DS 0.75-1.00 m			MI/ CI	Sandy SILT / Sandy CLAY Low-medium plasticity, dark grey, fine to coarse sand, wet, very soft, occasional shell fragments	W	VS	
			1	1.00 1.25 -2.15	SPT 1.00-1.45 m RW/450mm			CI CH	Sandy CLAY Low-medium plasticity, dark grey, fine to coarse sand, wet, very soft, occasional fine gravel CLAY High plasticity, dark grey, wet, very soft			
			2		SPT 2.50-2.95 m RW/450mm							
			3									
			4		U50 4.00-4.40 m SPT 4.50-4.95 m RW/450mm							
			5		U50 5.50-5.90 m							
			6		U50 6.50-6.90 m							
			7									
			8	8.25 -9.15 8.70 -9.60	SPT 8.00-8.45 m RW,1,4 N = 5			CI	Sandy CLAY Fine to coarse sand, dark grey, medium plasticity, moist, firm, occasional shell fragments, . Grading to fine to coarse sand		F	
			9	9.50 -10.40	SPT 9.50-9.95 m 7,7,2 N = 9			SC	Clayey SAND Fine to coarse sand, dark grey, low plasticity, wet, loose, lots of shell fragments present, fine gravel		L	
			10									
			11	11.00 -11.90	SPT 11.00-11.45 m 7,8,7 N = 15			SC	Gravelly Clayey SAND Fine to coarse sand, grey-brown, low plasticity, fine to medium gravel		MD	
			12	12.20					. Sandy clay layer at 12m to 12.2m depth			
				12.50 -13.40	SPT 12.50-12.95 m 7,14,17 N = 31			SC	Clayey SAND Fine to medium sand, grey, low plasticity, wet, dense		D	
			13	13.50 -14.40					. Grading to fine to coarse sand at 13.5m depth with some fine gravel			
			14	14.00 -14.90	SPT 14.00-14.50 m 17,18,20 N = 38			SC	Clayey SAND Fine to coarse sand, brown/grey, low to medium plasticity, wet, dense, with some gravel			
				14.50 -15.40					END OF BOREHOLE @ 14.50 m			
			15									
			16									
			17									
			18									
			19									
			20									

REPORT OF PIEZO-CONE PROBE: TPA14c

SHEET: 1 OF 1
CONE No.:
DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: KSR DATE: 19/11/07
CHECKED: WB DATE: 7/12/07

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 483011 m E 7870335 m N 55 AMG66
SURFACE RL: -1.10 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 4.76 m



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

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REPORT OF BOREHOLE: TPA14

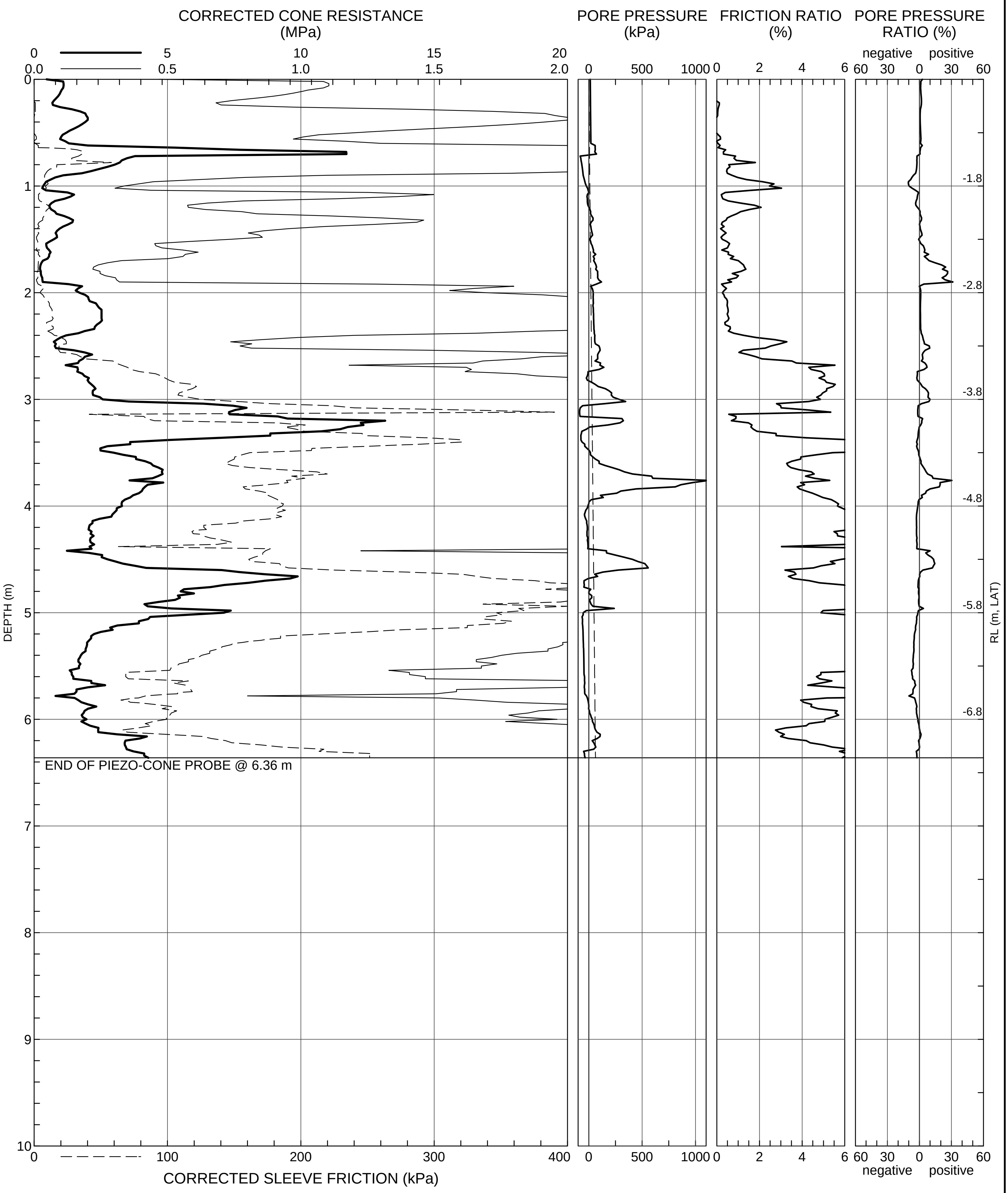
				SHEET: 1 OF 1	
CLIENT:	Townsville Port Authority	COORDS: 483011 m E 7870335 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -1.10 m	DATUM: LAT	DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 19/11/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 16.50 m	CHECKED: WB	DATE: 7/12/07

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0									
			4.76	*4.76*					Start Soil Borehole @ 4.76 m			
WB	L		5	*5.00* -6.10	SPT 5.00-5.45 m 7,11,13 N = 24 PP = 360 kPa			CH CI	Gravelly Sandy CLAY High plasticity, yellow-brown and grey, fine gravel with fine to coarse sand, wet very stiff, trace of shell fragments	M	VSt	
			6						CLAY Medium plasticity, light brown and grey, with some fine-coarse sand and fine gravel			
			7		SPT 6.50-6.95 m 5,6,9 N = 15 PP = 220 kPa							
				7.50 -8.60					. Becoming clayey sand at 7.5m depth			
			8	*8.00* -9.10	SPT 8.00-8.45 m 20,22,27 N = 49			CI- SC	Sandy CLAY / Clayey SAND Low to medium plasticity, light grey/brown, fine to coarse sand, light grey/brown, moist, hard to very dense, traces of shell fragments		H	
			9	*9.20*					. Layer of clay at 9.2m depth			
				9.40 *9.50* -10.60	SPT 9.50-9.95 m 16,21,27 N = 48			SC	. Becoming clayey sand at 9.4m depth Clayey SAND Fine to coarse grained, yellow-brown, low to medium plasticity, wet, dense		D	
			10									
			11	*11.00* *11.30* -12.40	SPT 11.00-11.45 m 12,14,17 N = 31			CI	Sandy CLAY Medium plasticity, yellow-brown, fine sand, moist, hard, fissuring . Becoming clay at 11.3m depth		H	
			12	*12.00* -13.10					. Becoming sandy clay at 12m depth			
				12.50 *12.80* -13.90	SPT 12.50-12.95 m 14,16,12 N = 28				. Grading to light grey/yellow-brown with fine-coarse sand, and very stiff . Trace of fine to medium gravel from 12.8 -12.95m			
			13									
			14		SPT 14.00-14.30 m 19,38 N = 38							
			15	*15.50* -16.60	SPT 15.50-15.95 m 15,20,28 N = 48				. Grading to orange brown with fine sand			
			16	*16.50* -17.60					END OF BOREHOLE @ 16.50 m			
			17									
			18									
			19									
			20									

REPORT OF PIEZO-CONE PROBE: TPA15c

SHEET: 1 OF 1
CONE No.:

CLIENT:	Townsville Port Authority	COORDS: 483291 m E 7870117 m N 55 AMG66	DRILL RIG: Rason
PROJECT:	Offshore Drilling Project	SURFACE RL: -0.80 m DATUM: LAT	CONTRACTOR: Double J Drilling
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°	RECORDED: KSR DATE: 19/11/07
JOB NO:	077692009	HOLE DEPTH: 6.36 m	CHECKED: WB DATE: 7/12/07



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

REPORT OF BOREHOLE: TPA15

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 483291 m E 7870117 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -0.80 m DATUM: LAT		DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 19/11/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 17.45 m	CHECKED: WB	DATE: 7/12/07

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0–6.36	6.36					Start Soil Borehole @ 6.36 m			
WB	L		6.36	-7.16	SPT 6.50-6.95 m 2,4,6 N = 10			CI-CH	CLAY Medium to high plasticity, yellow-brown, with some fine to coarse sand, moist, stiff, traces of fine gravel	M	St	
			8.00	-8.80	SPT 8.00-8.42 m 16,26,30/120mm				. Grading to yellow-brown and grey and hard		H	
			9.50	-10.30	SPT 9.50-9.90 m 13,28,30/100mm				. Grading to pale-brown and grey			
			11.00	-11.80	SPT 11.00-11.45 m 14,16,22 N = 38				. Grading to medium plasticity and orange-brown with pockets of fine-medium grained sand			
			12.50	-13.30	SPT 12.50-12.95 m 8,14,17 N = 31			SW-SC	Clayey SAND/SAND Fine to medium sand, pale brown, low plasticity, wet, dense	W	D	
			13.00	-13.80					. Grading to sand at 13m depth			
			14.00	-14.80	SPT 14.00-14.45 m 10,13,18 N = 31 SPT 15.50-17.00 m 14,20,18 N = 38			SW	SAND Fine to coarse sand, yellow-brown, wet, dense			
			16.50	-17.30					. Grading to clayey sand at 16.5m depth			
			17.00	-17.80				CI	Sandy CLAY Medium plasticity, brown-yellow, fine to coarse sand	M	H	
			17.45	-18.25					END OF BOREHOLE @ 17.45 m			

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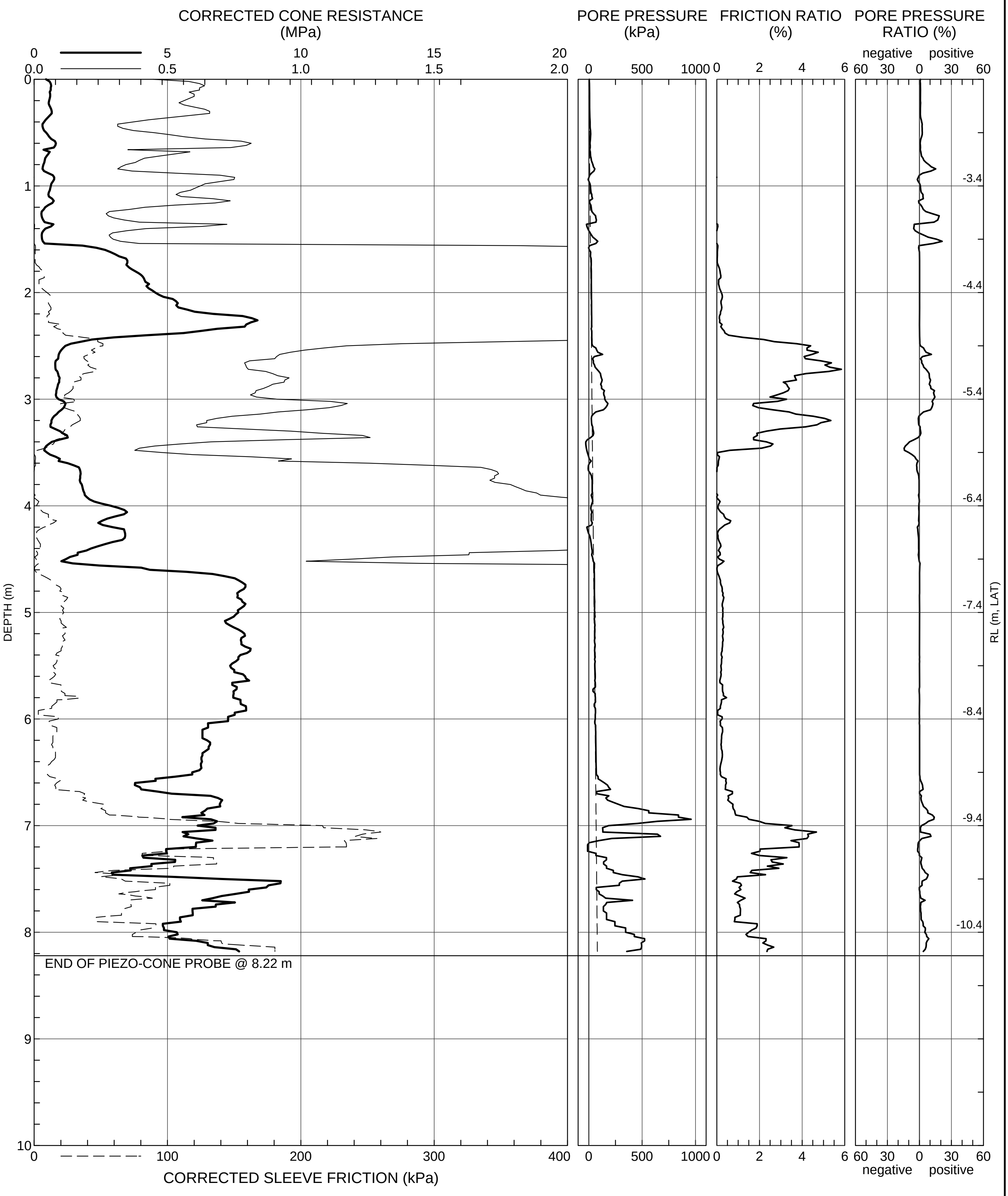
REPORT OF PIEZO-CONE PROBE: TPA16c

SHEET: 1 OF 1
CONE No.:
DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: KSR DATE: 19/11/07
CHECKED: WB DATE: 7/12/07

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482734 m E 7869897 m N 55 AMG66
SURFACE RL: -2.38 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 8.22 m



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

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REPORT OF BOREHOLE: TPA16

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482734 m E 7869897 m N 55 AMG66
SURFACE RL: -2.38 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 17.92 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: KSR DATE: 19/11/07
CHECKED: WB DATE: 7/12/07

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0–8	8.22					Start Soil Borehole @ 8.22 m			
WB	L			8.50				SW	SAND Fine to coarse sand, grey, wet	W	MD	
			9	-11.08	SPT 8.50-8.95 m 3,9,8 N = 17 PP = 400 kPa			CI	Sandy CLAY Medium plasticity, brown/grey/black, fine to coarse sand, moist, very stiff . Becoming less sandy at 8.7m depth		VSt	
				9.60 -11.98					. Grading to clayey sand/sand at 9.6m depth			
			10	10.00 -12.38	SPT 10.00-10.45 m 6,11,14 N = 25			SC	Clayey SAND Fine to coarse sand , pale brown, low-medium plasticity, wet, medium dense,		MD	
			11	10.40 -12.78					. Grading to orange			
			12	11.50 -13.88	SPT 11.50-11.95 m 14,18,20 N = 38				. Grading to pale brown with sandy CLAY layer at11.5m			
				12.50 -14.88					. Grading to clayey sand at 12.5m depth			
			13–15	13.00 -15.38	SPT 13.00-13.45 m 18,22,28 N = 50 SPT 14.50-14.80 m 22,31/150mm			SC	Clayey SAND Fine to medium sand, pale brown-yellow, low plasticity, very dense		VD	
			16–17	16.00 -18.38	SPT 16.00-16.45 m 10,18,32 N = 50			CH/ CI	Sandy CLAY Medium to high plasticity, yellow-brown, fine to coarse sand, moist, hard	M	H	
				17.50 -19.88	SPT 17.50-17.92 m 12,27,30/120mm				. Intermittent layers of clayey SAND present from 17.5m			
			18–20	17.92 -20.30					END OF BOREHOLE @ 17.92 m			

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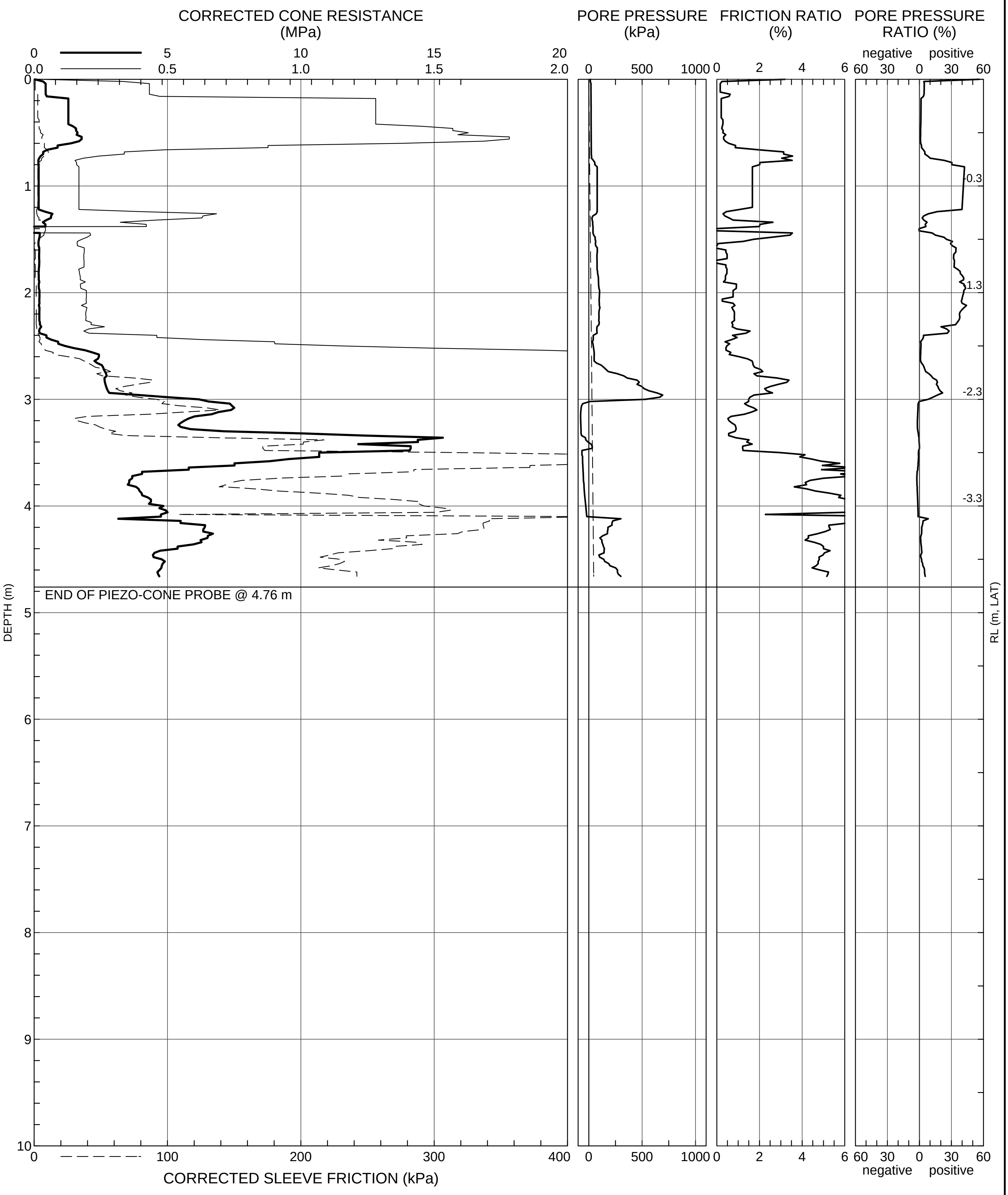
REPORT OF PIEZO-CONE PROBE: TPA17c

SHEET: 1 OF 1
CONE No.:

CLIENT:	Townsville Port Authority	COORDS: 482961 m E 7869724 m N 55 AMG66	DRILL RIG: Rason
PROJECT:	Offshore Drilling Project	SURFACE RL: 0.70 m DATUM: LAT	CONTRACTOR: Double J Drilling
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°	RECORDED: KSR DATE: 26/11/07
JOB NO:	077692009	HOLE DEPTH: 4.76 m	CHECKED: WB DATE: 7/12/07



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

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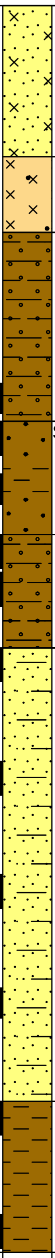
REPORT OF BOREHOLE: TPA17

SHEET: 1 OF 1

CLIENT: Townsville Port Authority	COORDS: 482961 m E 7869724 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: 0.70 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: KSR	DATE: 26/11/07
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 16.50 m	CHECKED: WB	DATE: 7/12/07



Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	0.70				SM	Silty SAND Fine to coarse sand, dark grey, low plasticity, wet, occasional shell fragments, very loose	W	VL	
			2	2.00 -1.30				MH	Sandy SILT Medium to high plasticity, dark grey, fine to medium sand, wet, soft	W	S	
			3	3.00 -2.30				CI	Sandy CLAY Medium plasticity, dark grey, fine to coarse sand, wet, hard	M	H	
			4	4.00 -3.30	U50 5.00-5.40 m			CH	. Grading to high plasticity and brown with fine to medium sand	M	H	
			5	5.40					. Grading to clayey sand at 5.4m depth			
				5.50	SPT 5.50-5.95 m 11,18,12 N = 30			SW-SC	Clayey SAND/SAND Fine to coarse sand, orange-brown, low to medium plasticity, wet, medium dense	W	MD	
				5.70					. Grading to sand at 5.7m depth	W	MD	
			6	6.10 -5.40	U50 6.20-6.60 m				. Grading to sandy clay at 6.1m depth, high plasticity, orange-brown, fine to medium sand, wet	W	MD	
			7	7.00 -6.30	SPT 7.00-7.45 m 12,17,18 N = 35 PP = 400 kPa U50 7.50-7.90 m			CH	Sandy CLAY Medium to high plasticity, dark red and grey, fine sand, wet, hard	M	H	
			8	8.50 -7.80	SPT 8.50-8.95 m			SC	Clayey SAND Fine to coarse sand, yellow-brown, low plasticity, wet, medium dense	W	MD	
			10	10.00 -9.30	SPT 10.00-10.45 m 7,8,11 N = 19				. Grading to pale brown, low to medium plasticity, wet, medium dense	W	MD	
			11	11.50 -10.80	SPT 11.50-11.95 m 13,18,23 N = 41				. Becoming dense at 11.5m	W	D	
			13	13.00 -12.30	SPT 13.00-13.40 m 18,30,30/100mm PP = 370 kPa				. Becoming very dense at 13m	W	VD	
			14	14.50 -13.80	SPT 14.50-14.95 m 9,16,19 N = 35 PP = >600 kPa			CH	CLAY Medium to high plasticity, orange-brown, moist, hard, some fine to medium sand	M	H	
			16	16.00 -15.30	SPT 16.00-16.45 m 11,16,28 N = 44				Grading to high plasticity, blue-grey / brown	M	H	
				16.50 -15.80					END OF BOREHOLE @ 16.50 m			
			17									
			18									
			19									
			20									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

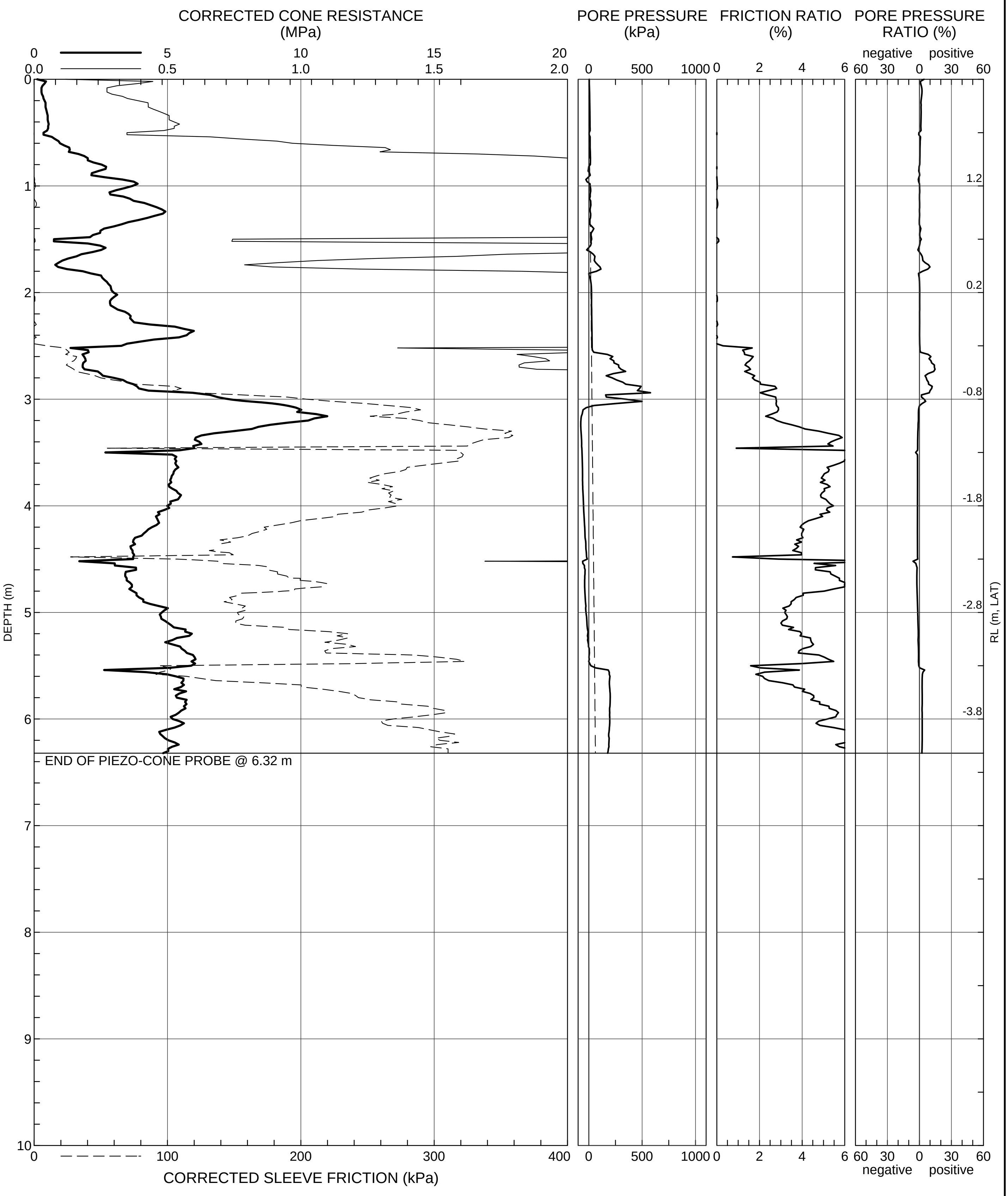
REPORT OF PIEZO-CONE PROBE: TPA18c

SHEET: 1 OF 1
CONE No.: GAP 3721

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482597 m E 7869389 m N 55 AMG66
SURFACE RL: 2.20 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 6.32 m

DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: KSR DATE: 20/12/07
CHECKED: RJ DATE: 22/1/08



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

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Golder Associates

REPORT OF BOREHOLE: TPA18

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482597 m E 7869389 m N 55 AMG66
SURFACE RL: 2.20 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 17.45 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: KSR DATE: 20/12/07
CHECKED: RJ DATE: 22/1/08

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0 – 6						Start Soil Borehole @ 6.50 m			
WB	L			6.50 -4.30	SPT 6.50-6.95 m 8,10,15 N = 25 PP = 490 kPa			CH	CLAY High plasticity, brown with pockets of black, with some fine to coarse sand, moist, very stiff	M	VSt	
				8.00 -5.80	SPT 8.00-8.45 m 13,16,21 N = 37 PP = >600 kPa				. Grading to brown, moist, hard at 8.0m depth		H	
				9.50 -7.30	SPT 9.50-9.95 m 10,15,27 N = 42			CH	Sandy CLAY High plasticity, pale brown, fine to coarse sand, moist, hard			
				10.50 -8.30					. Decreasing sand from 10.50m depth			
				11.00 -8.80	SPT 11.00-11.45 m 9,12,17 N = 29 PP = >600 kPa			CH	CLAY High plasticity, pale brown, trace of fine to coarse sand, moist, hard			
				12.50 -10.30	SPT 12.50-12.98 m 10,16,24 N = 40 PP = >600 kPa			CH	Sandy CLAY/CLAY High plasticity, yellow-brown, fine to coarse sand, moist, hard			
				13.80					. Increasing sand from 13.8m depth			
				-11.80	SPT 14.00-14.45 m 13,16,19 N = 35			SW	SAND Fine to coarse sand, pale grey with some clay, wet, dense	W	D	
				15.00 -12.80					. Grading to clayey SAND at 15.0m depth			
				15.50 -13.30	SPT 15.50-15.95 m 10,15,19 N = 34			SC	Clayey SAND Fine to coarse sand, pale brown, high plasticity clay fines, wet, dense			
				17.45 -15.25					END OF BOREHOLE @ 17.45 m			
			18 – 20									

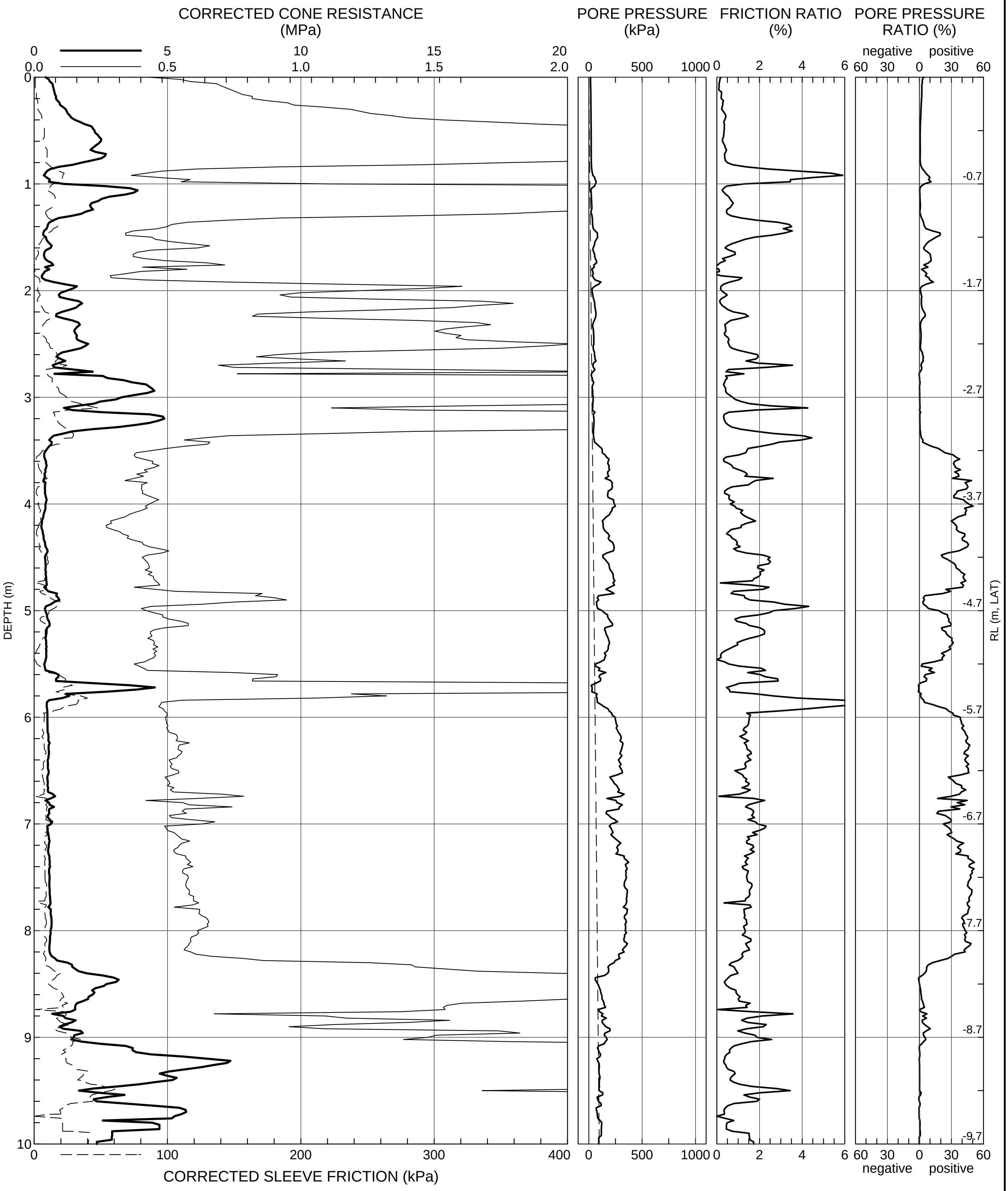
GAP6_0-1BETA_BRISCOLOUR.GLB FULL PAGE J:\2GEO07\077692009 - TPA - PORT EXPANSION PROJECT\GINT\077692009 GEO.GPJ GAP5_1.GDT 19/06/2008 12:42:04 PM

REPORT OF PIEZO-CONE PROBE: TPA19c

SHEET: 1 OF 2
CONE No.: GAP 3721
DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: KSR DATE: 19/12/07
CHECKED: RJ DATE: 22/1/08

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 483761 m E 7869734 m N 55 AMG66
SURFACE RL: 0.30 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 13.80 m



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

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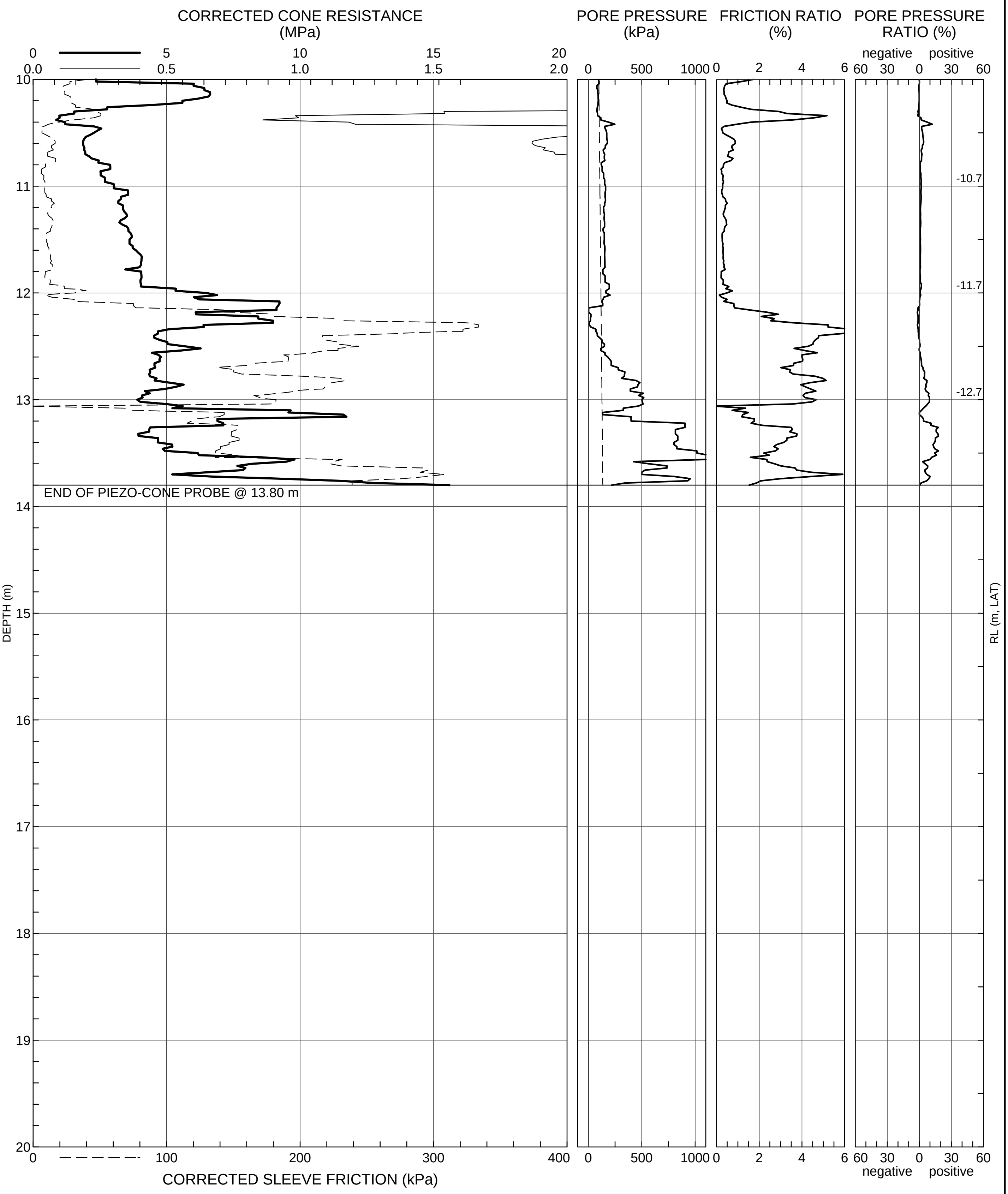
REPORT OF PIEZO-CONE PROBE: TPA19c

SHEET: 2 OF 2
CONE No.: GAP 3721
DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: KSR DATE: 19/12/07
CHECKED: RJ DATE: 22/1/08

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 483761 m E 7869734 m N 55 AMG66
SURFACE RL: 0.30 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 13.80 m



COMMENT:

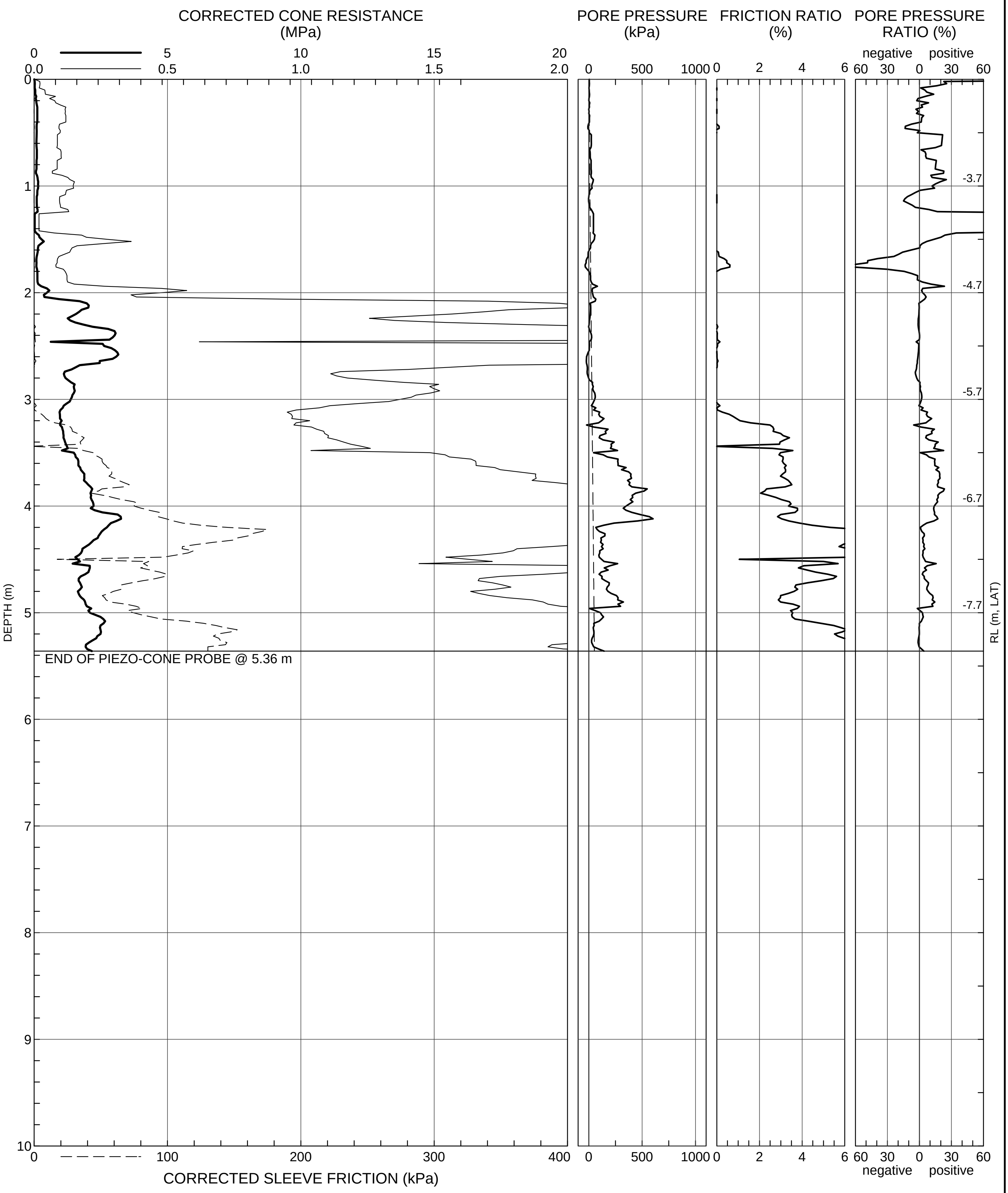
This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

REPORT OF PIEZO-CONE PROBE: TPA20c

SHEET: 1 OF 1
CONE No.:

CLIENT:	Townsville Port Authority	COORDS: 483446 m E 7869315 m N 55 AMG66	DRILL RIG: Rason
PROJECT:	Offshore Drilling Project	SURFACE RL: -2.70 m DATUM: LAT	CONTRACTOR: Double J Drilling
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°	RECORDED: KSR DATE: 23/11/07
JOB NO:	077692009	HOLE DEPTH: 5.36 m	CHECKED: WB DATE: 7/12/07



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

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Golder Associates

REPORT OF BOREHOLE: TPA20

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 483446 m E 7869315 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -2.70 m DATUM: LAT		DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 23/11/07
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 16.95 m	CHECKED: WB	DATE: 7/12/07

Drilling					Sampling	Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0–5.36	5.36				Start Soil Borehole @ 5.36 m			
WB	L			-8.06	SPT 6.00-6.45 m 5,7,10 N = 17		CH	CLAY High plasticity, orange-brown, moist, very stiff with some fine sand	M	VSt	
				7.00 -9.70				. Becoming sandy clay at 7m depth			
				7.50 -10.20	SPT 7.50-7.95 m 7,8,15 N = 22		CI/ CH	Sandy CLAY Medium to high plasticity, grey-orange/brown, fine to coarse sand, moist, very stiff, pockets of fine sand with occasional fine to medium gravel			
				9.00 -11.70	SPT 9.00-9.42 m 17,24,30/120mm			. Grading to pale brown, hard with traces of fine gravel		H	
				10.50 -13.20	SPT 10.50-10.77 m 19,30/120mm		SC	Clayey SAND Fine to medium sand, pale brown, low-medium plasticity, wet, very dense	W	VD	
				12.00 -14.70	SPT 12.00-12.50 m 13,19,29 N = 48		CI	Sandy CLAY Medium plasticity, pale brown, fine sand, wet, hard	M	H	
				13.50 -16.20	SPT 13.50-13.95 m 9,10,12 N = 22		SW	SAND Fine to coarse, orange-brown, wet, medium dense, some clay present	W	MD	
				15.00 -17.70	SPT 15.00-15.43 m 13,23,30/130mm			. Grading to pale brown/ brown and very dense		VD	
				16.50 -19.20	SPT 16.50-16.95 m 12,24,30 N = 54		SW- SC	Clayey SAND/SAND Fine to medium, pale brown, wet, very dense			
				16.95 -19.65				END OF BOREHOLE @ 16.95 m			

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GAP gINT FN. F01a
RL2

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Golder Associates

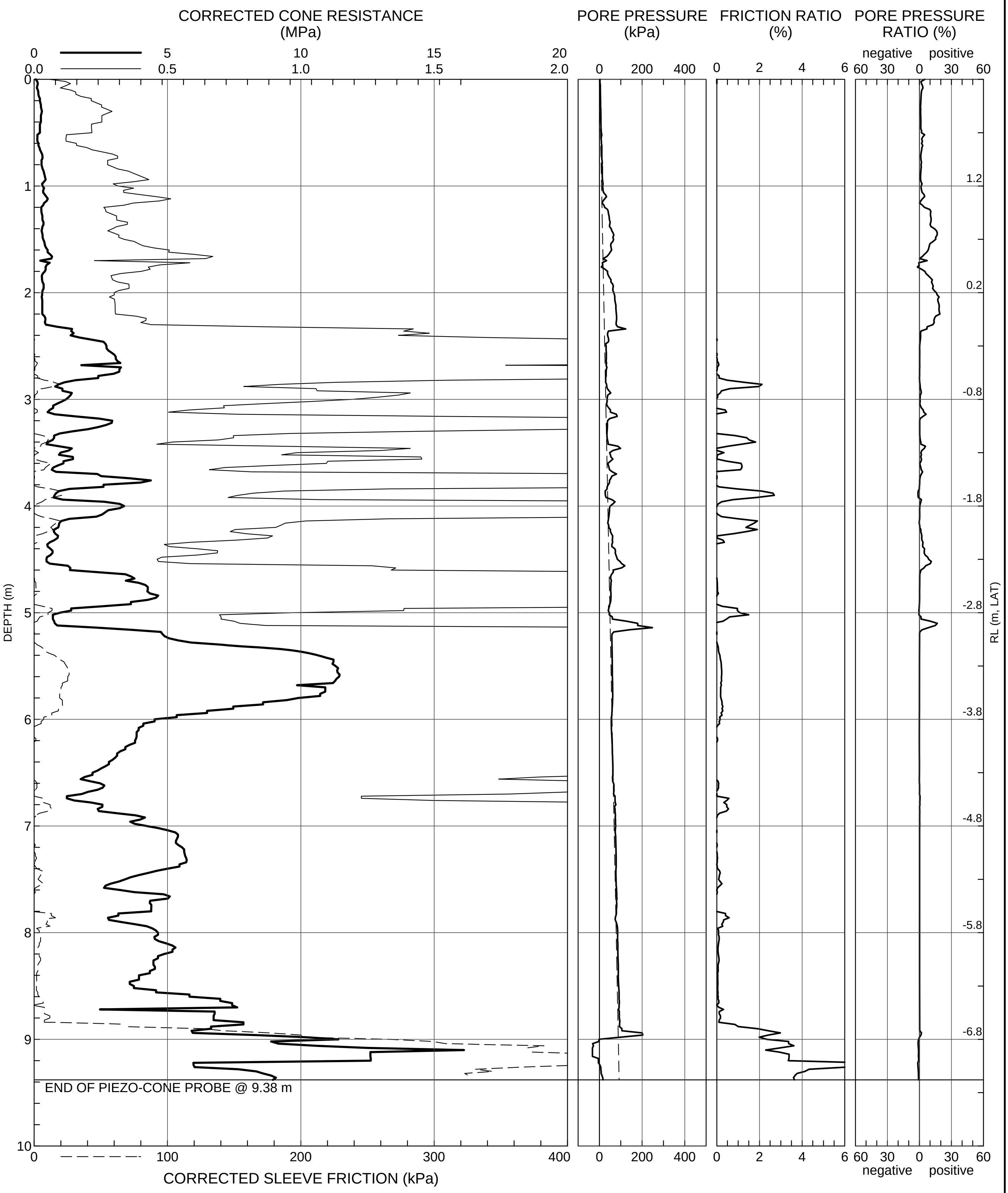
REPORT OF PIEZO-CONE PROBE: TPA21c

SHEET: 1 OF 1
CONE No.: GAP 3721

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 483018 m E 7868982 m N 55 AMG66
SURFACE RL: 2.21 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 9.38 m

DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: KSR DATE: 4/1/08
CHECKED: RJ DATE: 22/1/08



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

GAP6_0-1BETA_BRISCOLOUR.GLB PIEZO CONE J:\2GEO07\077692009 - TPA - PORT EXPANSION PROJECT\GINT\077692009 GEO.GPJ GAP5_1.GDT 19/06/2008 12:45:04 PM

REPORT OF BOREHOLE: TPA21

CLIENT: Townsville Port Authority	COORDS: 483018 m E 7868982 m N 55 AMG66	SHEET: 1 OF 1	
PROJECT: Offshore Drilling Project	SURFACE RL: 2.21 m DATUM: LAT	DRILL RIG: Rason	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	DRILLER: Double J Drilling	
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 17.95 m	LOGGED: KSR	DATE: 4/1/08
		CHECKED: RJ	DATE: 22/1/08

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0 – 9	9.41					Start Soil Borehole @ 9.41 m			
WB	L		10	-7.20	SPT 10.00-10.45 m 9,14,23 N = 37			CH	CLAY high plasticity, brown, some fissuring, moist, hard	M	H	
			11	11.00 -8.79	SPT 11.50-11.94 m 14,25,30 for 140mm			SC	Clayey SAND fine to coarse sand, brown, wet, very dense	W	VD	
			12 – 14	12.00 -9.79	SPT 13.00-13.45 m 7,13,23 N = 39			CI-CH	Silty CLAY medium to high plasticity, brown with some sand and fine gravel, moist, hard	M	H	
			15	14.50 -12.29	SPT 14.50-14.95 m 8,18,27 N = 45				. Grading to pale brown at 14.5m			
			16 – 17	16.00 -13.79	SPT 16.00-16.45 m 10,16,27 N = 43				. Grading to pale brown, trace of fine to coarse sand from 16m depth			
				17.50 -15.29	SPT 17.50-17.95 m 11,15,22 N = 37				. Brown			
			18 – 20	17.95 -15.74					END OF BOREHOLE @ 17.95 m			

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Golder Associates

REPORT OF BOREHOLE: TPA22

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 484011 m E 7872893 m N 55 AMG66		DRILL RIG: Rason	
PROJECT:	Offshore Drilling Project	SURFACE RL: -4.31 m DATUM: LAT		DRILLER: Double J Drilling	
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°		LOGGED: KSR	DATE: 2/1/08
JOB NO:	077692009	HOLE DIA: 100 mm	HOLE DEPTH: 10.95 m	CHECKED: RJ	DATE: 22/1/08

Drilling: METHOD WB; PENETRATION RESISTANCE L; WATER; DEPTH (metres) 0–20

DEPTH / RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
-4.31	DS 0.00-0.25 m DS 0.25-0.50 m DS 0.50-0.75 m	CI-CH	Sandy CLAY medium to high plasticity, dark grey, fine to coarse sand, occasional shell fragments, wet, soft	W	S	
0.50			. Decreasing sand from 0.5m depth			
0.75 / -5.06	DS 0.75-1.00 m PP = 160 kPa DS 1.00-1.25 m U50 1.50-1.90 m PP = 190 kPa	CH	CLAY high plasticity, dark gey, with some sand, moist, stiff	M	St	
2.00 / -6.31			. Grading brown and grey at 2.0m depth			
3.00 / -7.31	U50 3.00-3.37 m PP = 230 kPa		. With some fine to coarse sand at 3.0m depth			
3.50 / -7.81	U50 4.50-4.90 m PP = 240 kPa		. Brown from 3.5m depth			
5.80			. Grading to sandy clay at 5.8m			
6.00 / -10.31	SPT 6.00-6.45 m 11,12,13 N = 25	CH	Sandy CLAY high plasticity, brown, fine to coarse sand, moist, very stiff		VSt	
7.50 / -11.81	SPT 7.50-7.95 m 9,16,22 N = 38	SW-SC	Clayey Sand/SAND fine to coarse sand, brown/pale brown, medium plasticity clay, moist, dense		D	
9.00 / -13.31	SPT 9.00-9.45 m 12,13,18 N = 31	SC	Clayey SAND fine to coarse sand, pale brown to orange brown, moderate plasticity clay, moist dense			
10.30			. Increasing silt from 10.3m depth			
-14.81	SPT 10.50-10.95 m 9,16,21 N = 37	MH	Sandy SILT high plasticity, orange-brown/pale brown, fine sand, moist, hard		H	
10.95 / -15.26			END OF BOREHOLE @ 10.95 m			

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF BOREHOLE: TPA23

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 484033 m E 7872397 m N 55 AMG66
SURFACE RL: -4.16 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 10.95 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: KSR DATE: 3/1/08
CHECKED: RJ DATE: 22/1/08

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0					CH	Sandy CLAY High plasticity, dark grey, fine to coarse sand, occasional shell fragments, wet, soft	W	S	
				0.30 -4.46				CH	Silty CLAY High plasticity, brown, soft, wet			
				1.50 -5.66	U50 1.50-1.90 m PP = 100 kPa				. Firm, moist from 1.5m depth	M	F	
				2.50 -6.66	U50 3.00-3.40 m PP = 180 kPa				. Grading brown, stiff from 2.5m depth		St	
				4.50 -8.66	SPT 4.50-4.95 m 3,4,8 N = 12				. Grading to grey and brown with traces of fine to coarse sand from 4.5m depth			
				6.00 -10.16	U50 6.00-6.40 m PP = 380 kPa				. Grading brown, very stiff from 6m depth		VSt	
				7.50 -11.66	SPT 7.50-7.95 m 8,11,14 N = 25			CH	Sandy CLAY High plasticity, brown, moist, very stiff			
				8.50 -12.66				CI-CH	Sandy CLAY Medium to high plasticity, orange to brown, fine to coarse sand, moist, very stiff			
				9.00 -13.16	SPT 9.00-9.45 m 4,9,16 N = 25			CI	Clayey Sand/Sandy CLAY Fine to coarse sand, orange to brown, medium to high plasticity, traces of fine to medium gravel, moist, very stiff/medium dense		VSt-MD	
				10.70	SPT 10.50-10.95 m 8,13,20 N = 33			ML	Clayey SILT Low liquid limit, brown, moist, hard, trace of fine gravel		H	
				10.95 -15.11					END OF BOREHOLE @ 10.95 m			

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

Golder Associates

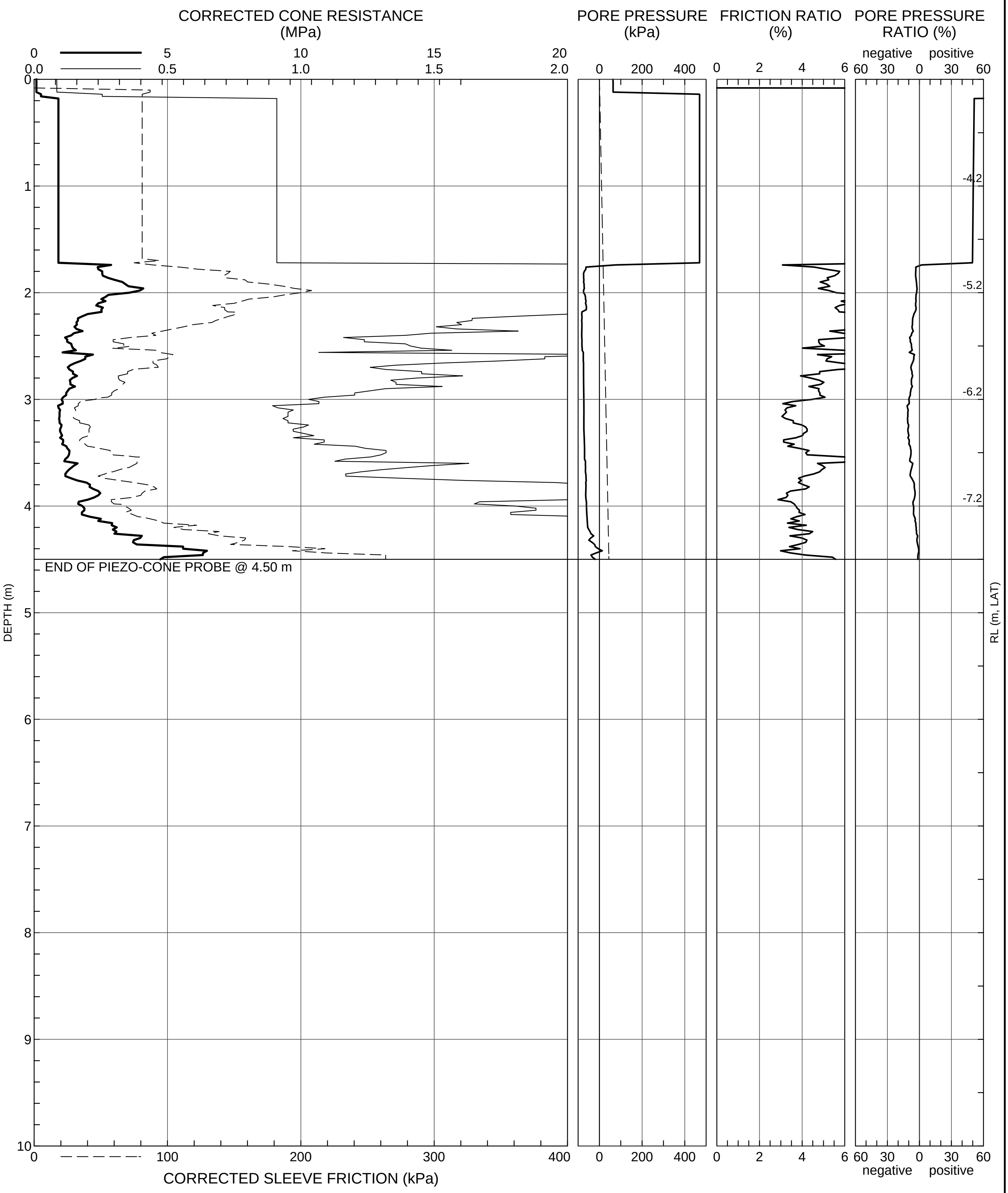
REPORT OF PIEZO-CONE PROBE: TPA101c

SHEET: 1 OF 1
CONE No.: GAP 3721

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482728 m E 7871865 m N 55 AMG66
SURFACE RL: -3.22 m DATUM: LAT
INCLINATION: -90°
HOLE DEPTH: 4.50 m

DRILL RIG: Rason
CONTRACTOR: Double J Drilling
RECORDED: SRL DATE: 10/1/08
CHECKED: RJ DATE: 22/1/08



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

REPORT OF BOREHOLE: TPA101

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482728 m E 7871865 m N 55 AMG66
SURFACE RL: -3.22 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 12.45 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: SRL DATE: 10/1/08
CHECKED: RJ DATE: 22/1/08

Drilling				Sampling	Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		-3.22		CI	Silty CLAY Medium plasticity, grey, moist, very soft	M	VS	. CPTu from seabed to 4.53m depth
			2.00 -5.22		CI/ CH	Silty CLAY Medium to high plasticity, pale brown with orange brown, some fine to coarse sand and gravel, moist, firm		F	
			4.50 -7.72	SPT 4.50-4.95 m 7,8,10 N = 18 PP = 160 to 430 kPa	CI/ CH	Sandy CLAY Medium to high plasticity, pale brown with orange brown, some fine to coarse sand and gravel, moist, very stiff		VSt	
			6.00 -9.22	SPT 6.00-6.45 m 10,16,21 N = 37 PP = >600 kPa		. Becoming hard, less gravel from 6m depth		H	
			7.50 -10.72	SPT 7.50-7.95 m 7,10,13 N = 23 PP = 240 to 400 kPa		. Becoming very stiff from 7.5m depth		VSt	
	M		9.00 -12.22	SPT 9.00-9.45 m 9,14,21 N = 35 PP = >600 kPa SPT 10.50-10.95 m 9,14,21 N = 35 PP = >600 kPa	CI	Silty CLAY Medium plasticity, pale brown with orange brown, some sandy zones moist, hard		H	
			12.00 -15.22	SPT 12.00-12.45 m 15,19,29 N = 48 PP = >600 kPa		. Grey brown with some fine sand, hard			
			12.45 -15.67			END OF BOREHOLE @ 12.45 m			

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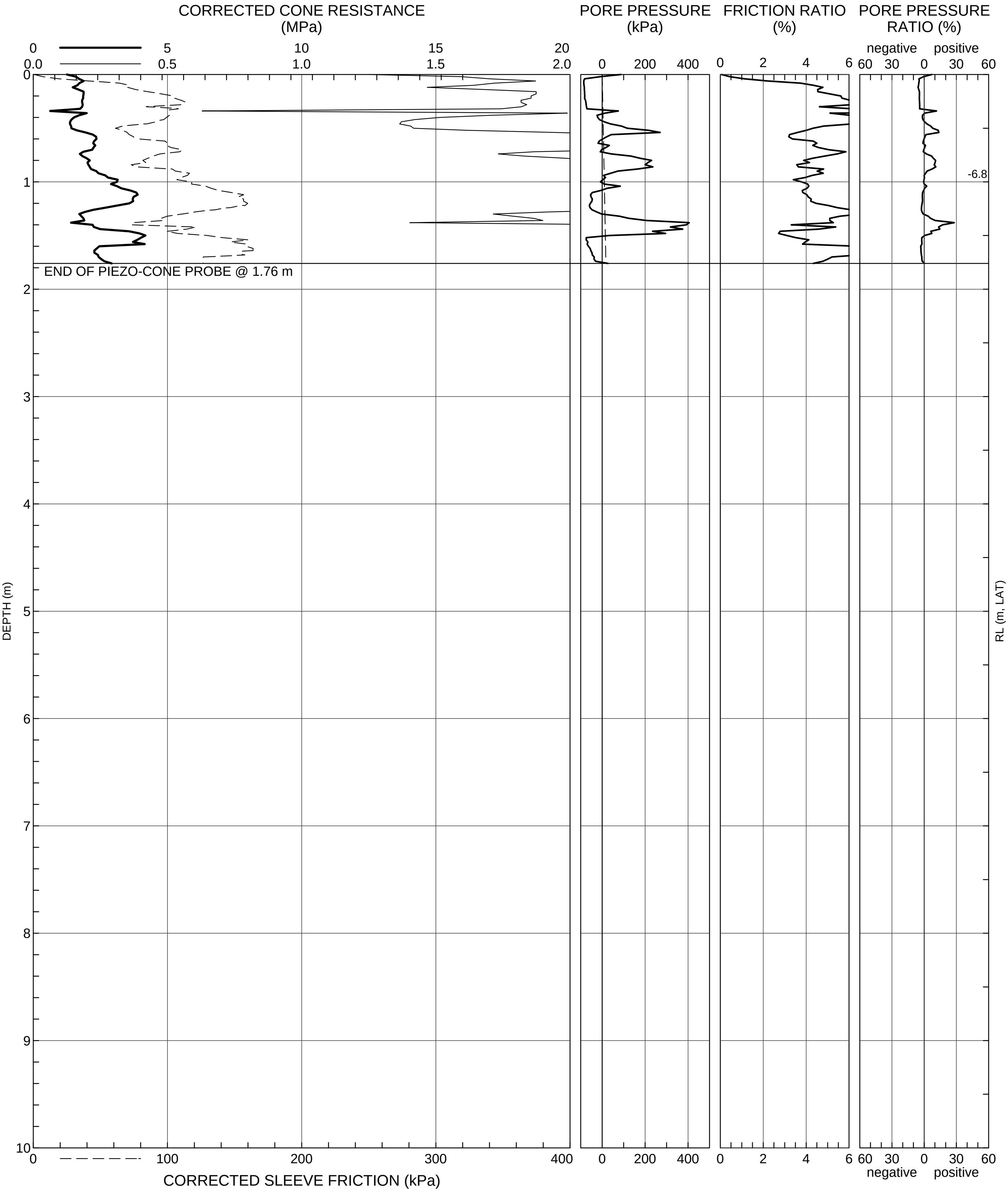
REPORT OF PIEZO-CONE PROBE: TPA102c

SHEET: 1 OF 1
CONE No.: GAP 3721

CLIENT:	Townsville Port Authority	COORDS: 482696 m E 7871898 m N 55 AMG66	DRILL RIG: Rason
PROJECT:	Offshore Drilling Project	SURFACE RL: -5.77 m DATUM: LAT	CONTRACTOR: Double J Drilling
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°	RECORDED: KSR DATE: 8/1/08
JOB NO:	077692009	HOLE DEPTH: 1.76 m	CHECKED: RJ DATE: 22/1/08



COMMENT:

This report of piezo-cone probe must be read in conjunction with accompanying notes and abbreviations.

GAP gINT FN. F10
RL2

Golder Associates

REPORT OF BOREHOLE: TPA102

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482696 m E 7871898 m N 55 AMG66
SURFACE RL: -5.77 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 9.95 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: KSR DATE: 8/1/08
CHECKED: RJ DATE: 22/1/08

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0									. CPTu from seabed to 1.76m depth
			1.76						Start Soil Borehole @ 1.76 m			
WB	L			-7.53	SPT 2.00-2.45 m 5,6,10 N = 16 PP = 300 kPa	■		CH	CLAY High plasticity, brown and grey with some fine to coarse sand and fine gravel, moist, very stiff	M	VSt	
			2.40	-8.17					. Band of calcrete at 2.4m depth			
			3.50	-9.27	SPT 3.50-3.95 m 9,12,16 N = 28	■			. Grading to very stiff and medium plasticity with some fine sand at 3.5m depth			
			5.00	-10.77	SPT 5.00-5.45 m 5,6,9 N = 15	■		CI/ SC	Sandy CLAY/Clayey SAND Medium plasticity, grey and brown, mostly fine sand, moist, very stiff/medium dense		VSt - MD	
			6.50	-12.27	SPT 6.50-6.95 m 8,13,18 N = 31	■			. Grading to low plasticy, pale brown with fine to coarse sand, hard from 6.5m depth		H	
			8.00	-13.77	SPT 8.00-8.45 m 8,13,19 N = 32	■		ML	Sandy SILT Low to medium liquid limit, orange-brown, fine sand, moist, hard			
			8.80	-14.57				CH	CLAY High plasticity, brown, orange-brown, moist, hard			
			9.50	-15.27	SPT 9.50-9.95 m 9,14,19 N = 33	■		SC	Clayey SAND Fine to medium sand, pale brown and pale grey, moist, dense		D	
			9.95	-15.72					END OF BOREHOLE @ 9.95 m			

Golder Associates

REPORT OF BOREHOLE: TPA103

SHEET: 1 OF 1

CLIENT: Townsville Port Authority	COORDS: 482321 m E 7871036 m N 55 AMG66	DRILL RIG: Rason	
PROJECT: Offshore Drilling Project	SURFACE RL: -0.92 m DATUM: LAT	DRILLER: Double J Drilling	
LOCATION: Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: SRL	DATE: 11/1/08
JOB NO: 077692009	HOLE DIA: 100 mm HOLE DEPTH: 11.15 m	CHECKED: RJ	DATE: 22/1/08

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-0.92				CI	Silty CLAY Medium plasticity, grey brown, some coarse sand to fine gravel, moist, soft	M	S	
				0.50 -1.42					. Shell present to approximately 1m depth			
			1	1.00 -1.92	SPT 1.00-1.45 m 7,10,12 N = 22 PP = >600 kPa				. Brown with dark grey specks, decreasing sand, very stiff		VSt	
			2	2.50 -3.42	SPT 2.50-2.95 m 6,7,8 N = 15 PP = 390-430 kPa			CI	Sandy CLAY Medium plasticity, grey and pale brown, fine to medium sand, moist, very stiff			
			3	3.50 -4.42					. Brown with coarse sand			
			4	4.00 -4.92	SPT 4.00-4.45 m 4,4,7 N = 11 PP = 130-200 kPa				. Increasing silt, brown with mostly fine sand and trace rounded coarse gravel, stiff		St	
			5	5.00 -5.92					. Pale brown and orange brown, some shell, trace gravel			
				5.50 -6.42	SPT 5.50-5.95 m 13,15,20 N = 35			SC	Clayey SAND Fine to medium sand, pale brown and orange-brown, moist, dense		D	
			6	6.70 -7.62	SPT 7.00-7.45 m 15,21,30 N = 51			SM	Silty SAND Fine sand, brown, moist, very dense		VD	
			7 8	7.90 -8.82	SPT 8.50-8.95 m 13,19,24 N = 43 PP = >600 kPa			CI	Sandy Silty CLAY Medium plasticity, grey brown, fine sand, moist, hard		H	
	M		9 10	10.00 -10.92	SPT 10.00-10.28 m 15,30/130mm,HB			SM	Silty SAND (RS GRANITE) Fine, pale brown and orange brown, moist, dense		D	
	L		11	11.00 -11.92 -12.07					. Grading to GRANITE, yellow red, coarse, high strength, slightly weathered to fresh			
									END OF BOREHOLE @ 11.15 m			
			12 13 14 15 16 17 18 19 20									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

REPORT OF BOREHOLE: TPA104

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482298 m E 7871031 m N 55 AMG66
SURFACE RL: -9.72 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 4.00 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: SRL DATE: 12/1/08
CHECKED: RJ DATE: 22/1/08

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-9.72	SPT 1.00-1.45 m RW/450mm	■		CL	Sandy CLAY Low plasticity, grey, fine sand, wet, very soft	W	VS	
	H		2	2.00 -11.72	SPT 2.20-2.45 m 31/130mm,30/120mm	■		SM	Silty SAND (RS GRANITE) Fine to coarse, pale brown, some yellow red granite fragments up to 40mm in size, moist, very dense; grading to distinctly to extremely weathered granite with depth	M	VD	
			4	4.00 -13.72					END OF BOREHOLE @ 4.00 m			

REPORT OF BOREHOLE: TPA105

SHEET: 1 OF 1

CLIENT: Townsville Port Authority
PROJECT: Offshore Drilling Project
LOCATION: Townsville Port - Cleveland Bay
JOB NO: 077692009

COORDS: 482328 m E 7871076 m N 55 AMG66
SURFACE RL: -9.46 m DATUM: LAT
INCLINATION: -90°
HOLE DIA: 100 mm HOLE DEPTH: 4.30 m

DRILL RIG: Rason
DRILLER: Double J Drilling
LOGGED: SRL DATE: 16/1/08
CHECKED: RJ DATE: 22/1/08

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-9.46 0.50				CI	Sandy CLAY Medium plasticity, grey, fine sand, wet, very soft	W	VS	
			1	-9.96 2.10	SPT 1.00-1.45 m 15,25,28 N = 53	■		SM	Silty SAND Mostly fine to medium sand with trace of coarse sand, pale brown, moist, very dense	M	VD	
			2 3	-11.56 4.00	SPT 2.50-2.95 m 6,7,13 N = 20 PP = 420-470 kPa	■		CI	Silty CLAY Medium plasticity, pale brown, trace fine sand, moist, hard		H	
			4	4.30 -13.76	SPT 4.00-4.30 m 9,30/150mm PP = 400-600 kPa	■		CI	Sandy Silty CLAY Medium plasticity, pale brown, fine sand, moist, hard			
			5						END OF BOREHOLE @ 4.30 m			
			6									
			7									
			8									
			9									
			10									
			11									
			12									
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

Golder Associates

REPORT OF BOREHOLE: TPA106

SHEET: 1 OF 1

CLIENT:	Townsville Port Authority	COORDS: 482361 m E 7871279 m N 55 AMG66	DRILL RIG: Rason		
PROJECT:	Offshore Drilling Project	SURFACE RL: -12.00 m DATUM: LAT	DRILLER: Double J Drilling		
LOCATION:	Townsville Port - Cleveland Bay	INCLINATION: -90°	LOGGED: SRL	DATE: 17/1/08	
JOB NO:	077692009	HOLE DIA: 100 mm HOLE DEPTH: 4.95 m	CHECKED: RJ	DATE: 22/1/08	

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	L		0	-12.00				CI	CLAY Medium plasticity, grey, trace fine sand, wet, very soft	W	VS	
				0.80 -12.80				CI	Silty CLAY Medium plasticity, pale brown, trace fine to coarse sand, moist, hard	M	H	
					SPT 1.50-1.95 m 18,21,30 N = 51 PP = >600 kPa							
				3.00 -15.00	SPT 3.00-3.44 m 19,23,30/140mm PP = >600 kPa				. occasional zones of white calcitic material			
				4.95 -16.95	SPT 4.50-4.95 m 16,22,30 N = 52 PP = >600 kPa				END OF BOREHOLE @ 4.95 m			

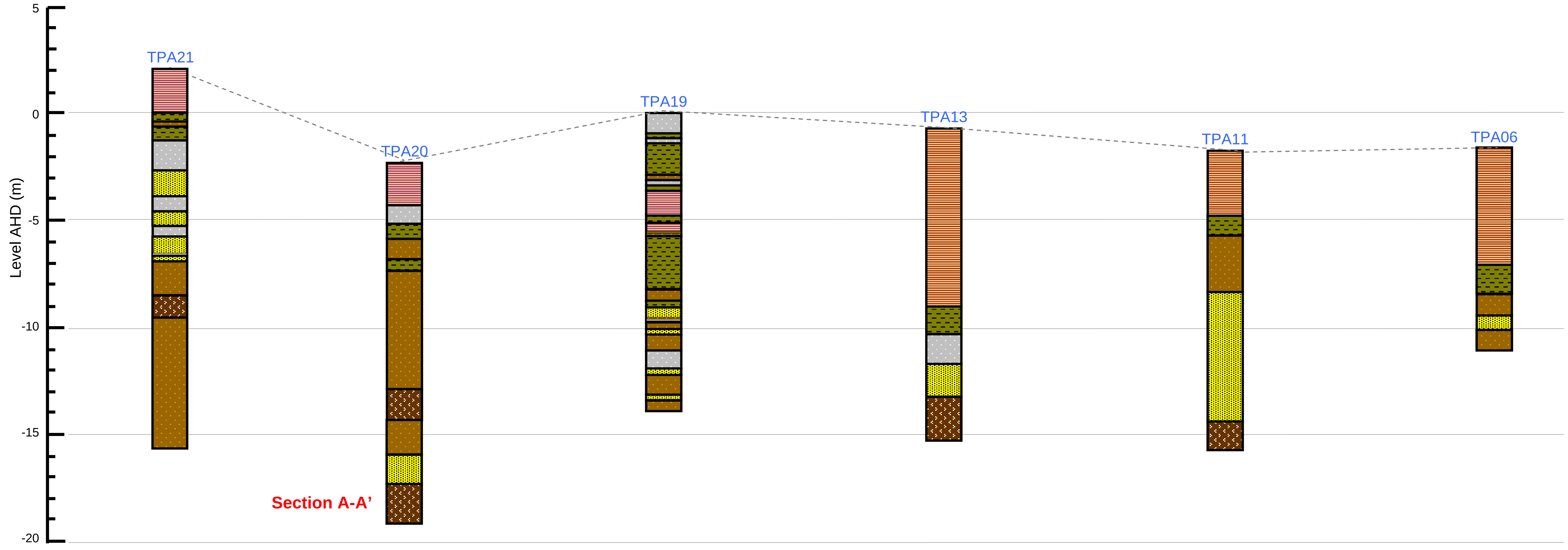
Depth scale (metres): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

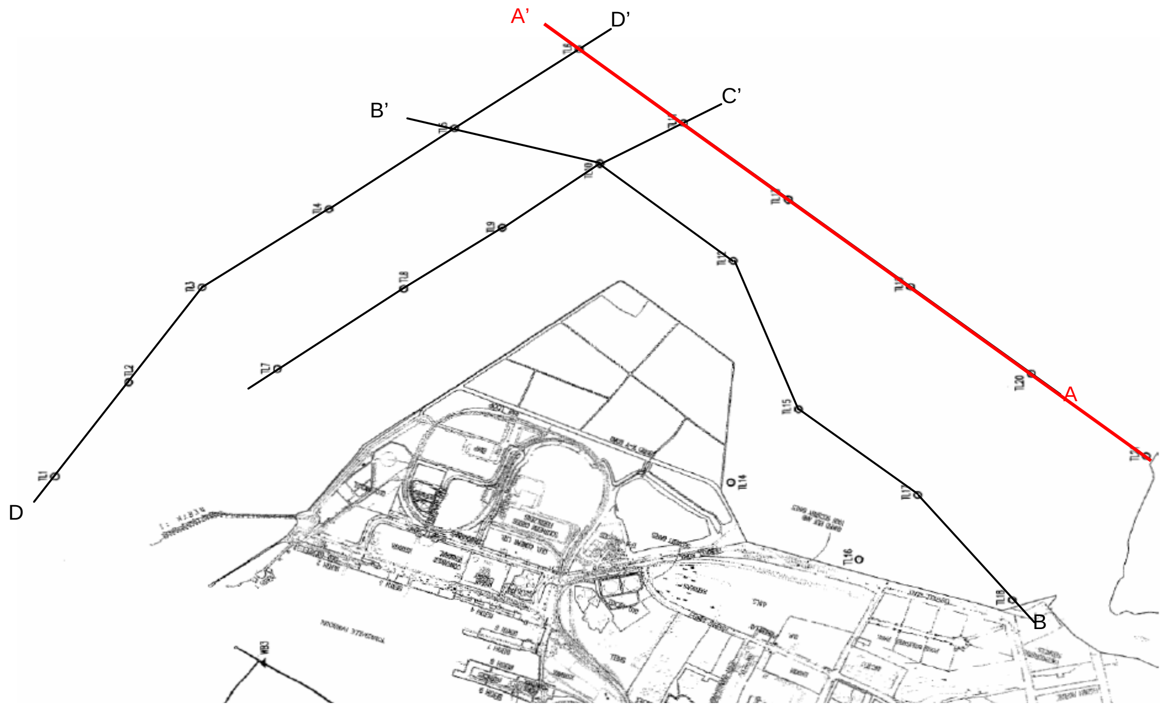
This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a
RL2

GAP6_0-1BETA_BRISCOLOUR.GLB FULL PAGE J:\2GEO07\077692009 - TPA - PORT EXPANSION PROJECT\GINT\077692009 GEO.GPJ GAP5_1.GDT 19/06/2008 12:41:50 PM

Appendix B
Subsurface Cross Sections and Diagrams





▨ soft and very soft

▨ loose and very loose

▨ firm and stiff

▨ medium dense

▨ very stiff and hard clay

▨ dense and very dense

NOTES:

This figure is diagrammatic only and is not precise in all details. It provides one interpretation of the Borehole and CPTu data (other interpretations could be made). Refer to Borehole records and CPTu test reports in Appendix A for detailed information. Sea bed surface shown is diagrammatic only. This figure should not be used for design or costing.

Golder Associates

CLIENT
Port Of Townsville

PROJECT
Offshore Drilling Project

DRAWN WSB
DATE 13/03/08

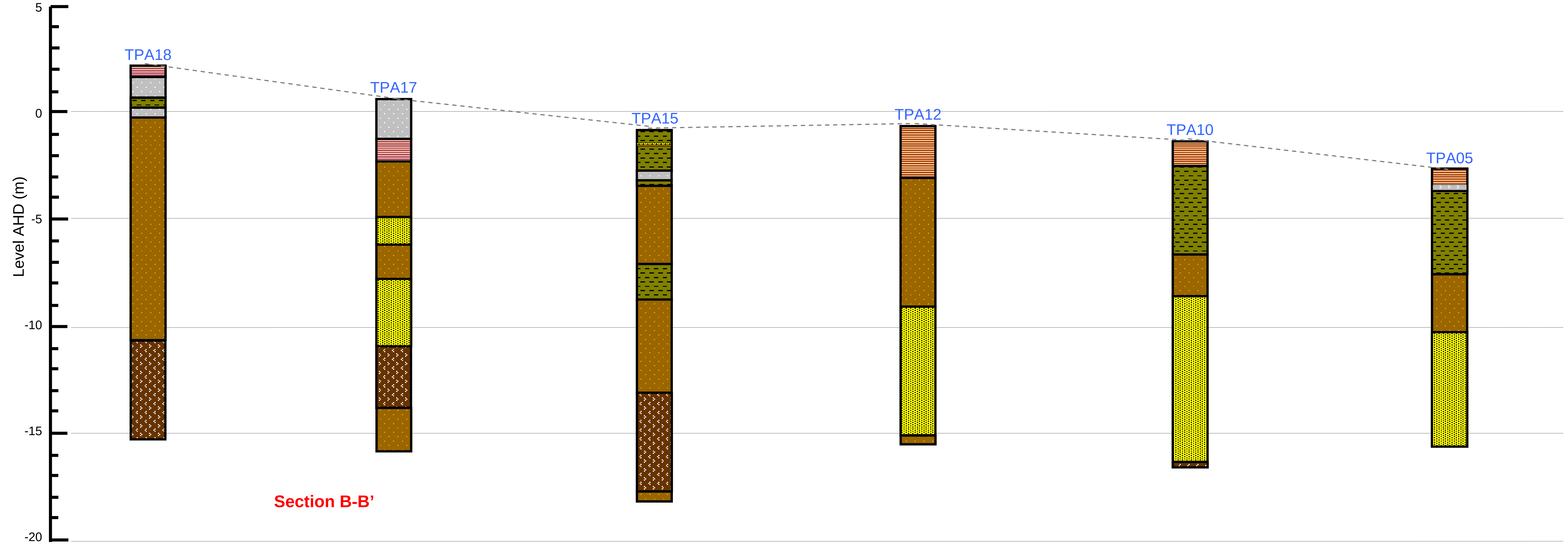
CHECKED WSB
DATE 13/03/08

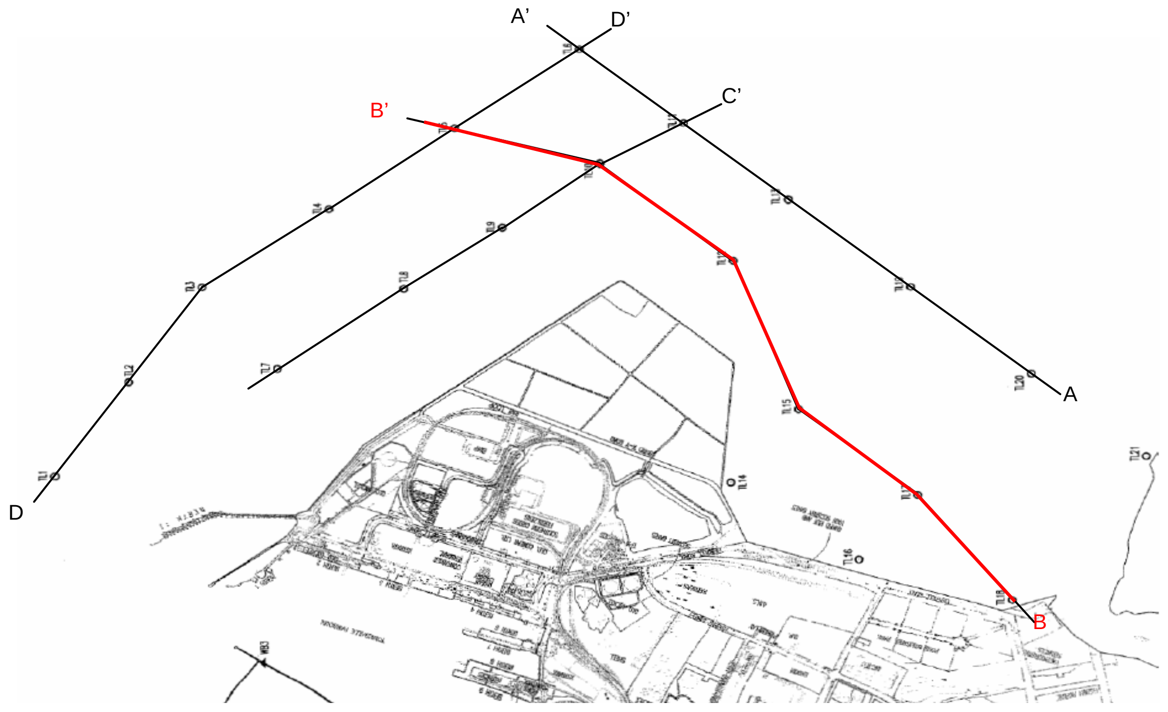
TITLE
Cross Section A-A'

SCALE NTS
A3

PROJECT No 077692009

FIGURE No **B1**





▤	soft and very soft	▩	medium dense
░	loose and very loose	■	very stiff and hard clay
▦	firm and stiff	▨	dense and very dense

NOTES:

This figure is diagrammatic only and is not precise in all details. It provides one interpretation of the Borehole and CPTu data (other interpretations could be made). Refer to Borehole records and CPTu test reports in Appendix A for detailed information. Sea bed surface shown is diagrammatic only. This figure should not be used for design or costing.

Golder Associates

CLIENT
Port Of Townsville

PROJECT
Offshore Drilling Project

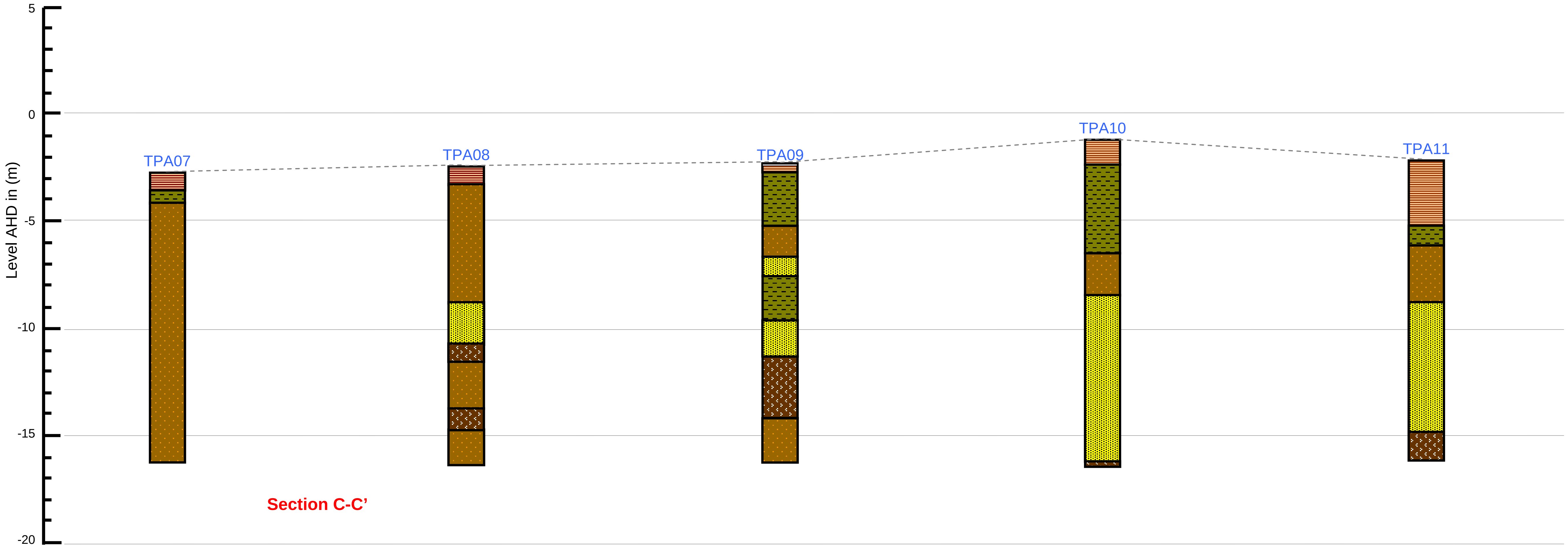
DRAWN WSB
DATE 13/03/08

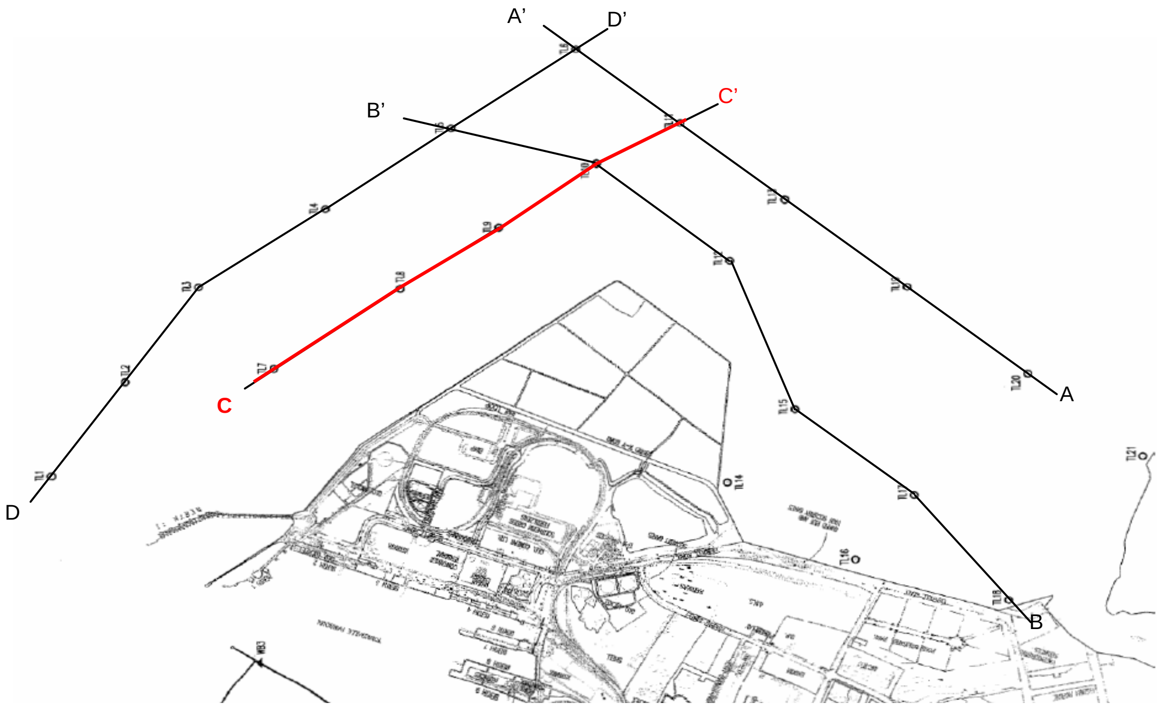
CHECKED WSB
DATE 13/03/08

TITLE
Cross Section B-B'

SCALE NTS
A3

PROJECT No 077692009
FIGURE No **B2**





🟧 soft and very soft

▒ loose and very loose

🟩 firm and stiff

🟨 medium dense

🟫 very stiff and hard clay

▩ dense and very dense

NOTES:

This figure is diagrammatic only and is not precise in all details. It provides one interpretation of the Borehole and CPTu data (other interpretations could be made). Refer to Borehole records and CPTu test reports in Appendix A for detailed information. Sea bed surface shown is diagrammatic only. This figure should not be used for design or costing.

Golder Associates

CLIENT
Port Of Townsville

PROJECT
Offshore Drilling Project

DRAWN
WSB

DATE
13/03/08

CHECKED
WSB

DATE
13/03/08

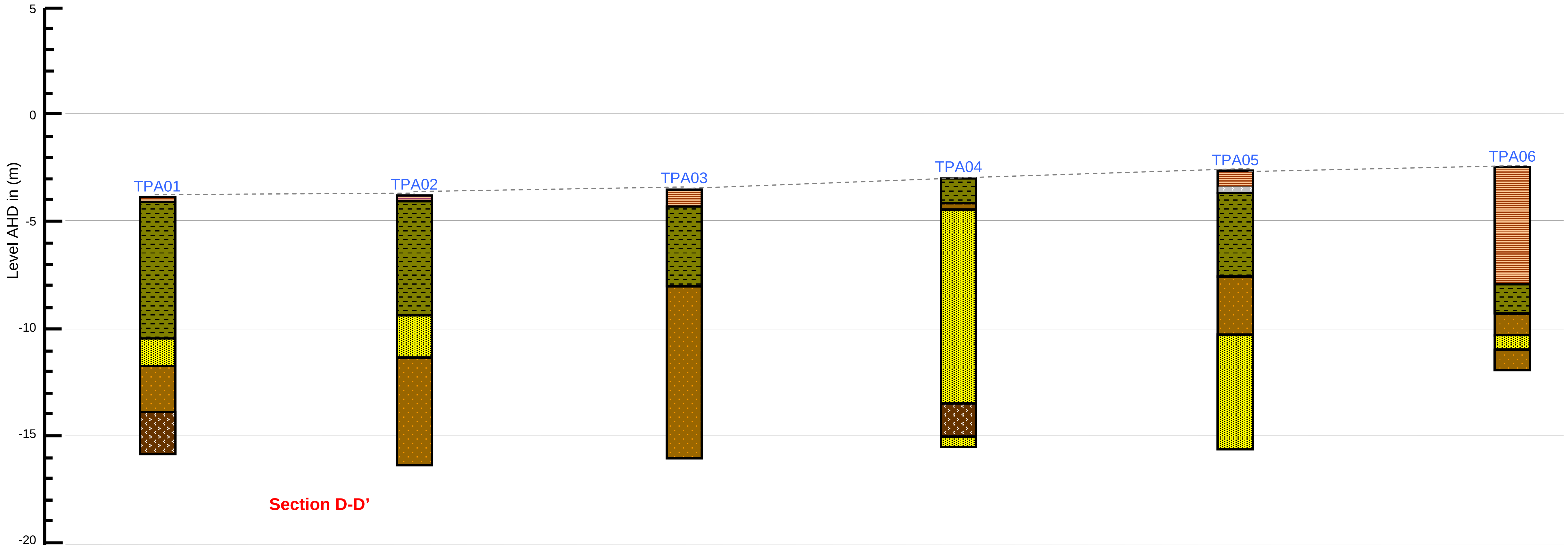
TITLE
Cross Section C-C'

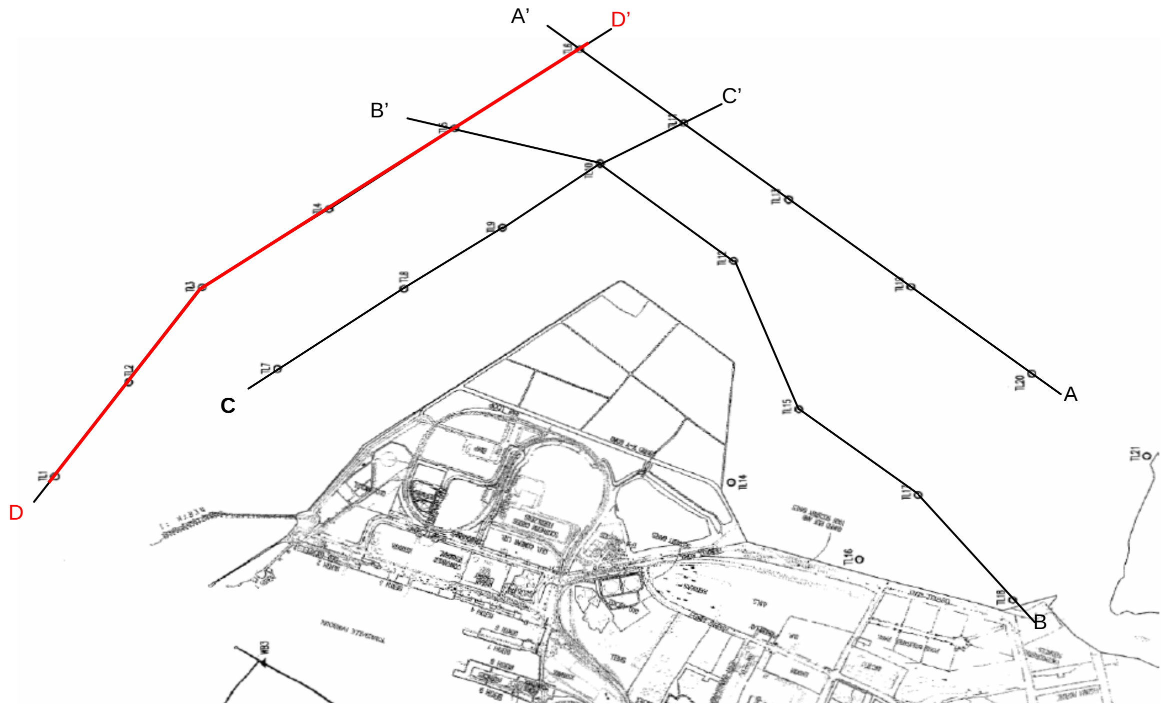
SCALE
NTS

A3

PROJECT No
077692009

FIGURE No
B3





- ▤ soft and very soft
- ░ loose and very loose
- ▤ firm and stiff
- ▨ medium dense
- ■ very stiff and hard clay
- ▩ dense and very dense

NOTES:

This figure is diagrammatic only and is not precise in all details. It provides one interpretation of the Borehole and CPTu data (other interpretations could be made). Refer to Borehole records and CPTu test reports in Appendix A for detailed information. Sea bed surface shown is diagrammatic only. This figure should not be used for design or costing.

Golder Associates

CLIENT
Port Of Townsville

PROJECT
Offshore Drilling Project

DRAWN
WSB

DATE
13/03/08

CHECKED
WSB

DATE
13/03/08

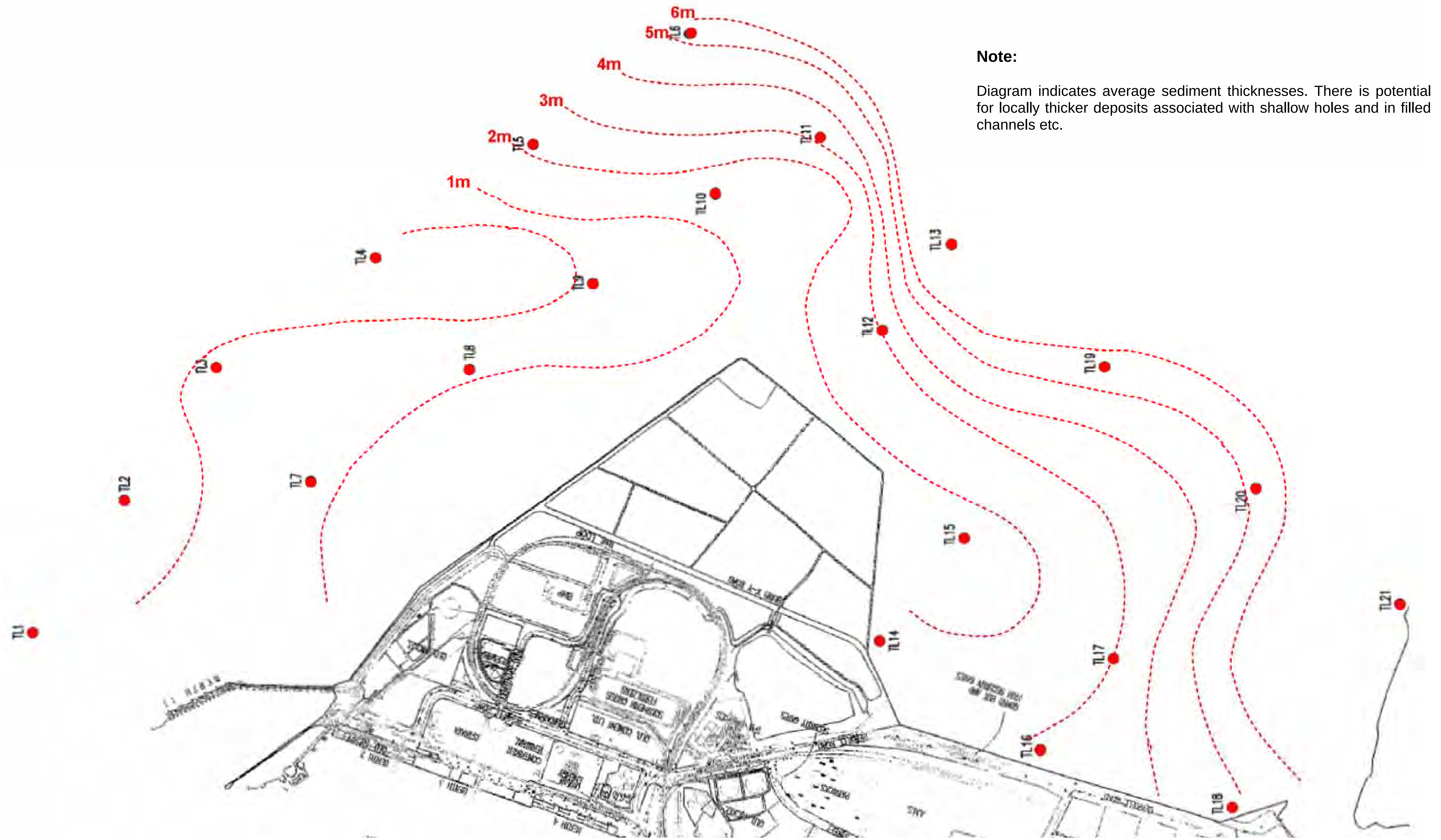
TITLE
Cross Section D-D’

SCALE
NTS

A3

PROJECT No
077692009

FIGURE No
B4



Note:

Diagram indicates average sediment thicknesses. There is potential for locally thicker deposits associated with shallow holes and in filled channels etc.

Golder Associates

CLIENT Port Of Townsville		PROJECT **Offshore Drilling Project**	
DRAWN WSB	DATE 13/03/08	TITLE **Contour diagram of surface sediment thickness**	
CHECKED WSB	DATE 13/03/08		
SCALE NTS	A3	PROJECT No 077692009	FIGURE No **B5**

Appendix C
Geotechnical Laboratory Records

Australian
Geomechanical
Laboratories Pty Ltd
ABN 25 065 630 506

1/29 Finchley Street, Milton, Qld. 4064
P.O. Box 434, Paddington, Qld. 4064
Telephone: (07) 3217 5535
Facsimile: (07) 3217 5311
Email: aglabs@bigpond.net.au

ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	Golder Associates Pty Ltd	Report No.	801524-AL
Project:	077692009	Test Date:	11/2/08
		Report Date:	14/2/08

Client ID: TPA 1 Depth(m): 2.5-2.9 Sample No. 801524

Liquid Limit (%):	38	Linear Shrinkage (%):	9.0*+
Plastic Limit (%):	21	Field Moisture Content (%):	23.4
Plasticity Index (%):	17		

Client ID: TPA 3 Depth(m): 9.0-9.45 Sample No. 801535

Liquid Limit (%):	43	Linear Shrinkage (%):	10.0+
Plastic Limit (%):	22	Field Moisture Content (%):	17.3
Plasticity Index (%):	21		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred.

Sample/s supplied by the client

This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards

N ATA Accredited Laboratory Number 9926

Form Number:GT004-5

Authorised Signatory

James Russell

J. Russell

Manager

Australian
Geomechanical
Laboratories Pty Ltd
ABN 25 065 630 506

1/29 Finchley Street, Milton, Qld. 4064
P.O. Box 434, Paddington, Qld. 4064
Telephone: (07) 3217 5535
Facsimile: (07) 3217 5311
Email: aglabs@bigpond.net.au

ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	Golder Associates Pty Ltd	Report No.	802325-AL
Project:	077692009	Test Date:	21/02/08 – 26/02/08
		Report Date:	04/03/08

Client ID: TPA 7 Depth(m): 10.0 – 10.45 Sample No. 802325

Liquid Limit (%):	40	Linear Shrinkage (%):	10.5*
Plastic Limit (%):	22	Field Moisture Content (%):	23.7
Plasticity Index (%):	18		

Client ID: TPA 12 Depth(m): 5.5 – 5.95 Sample No. 802335

Liquid Limit (%):	39	Linear Shrinkage (%):	11.5
Plastic Limit (%):	18	Field Moisture Content (%):	21.6
Plasticity Index (%):	21		

Client ID: TPA 13 Depth(m): 4.0 – 4.4 Sample No. 802341

Liquid Limit (%):	45	Linear Shrinkage (%):	10.5+
Plastic Limit (%):	25	Field Moisture Content (%):	46.3
Plasticity Index (%):	20		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred.

Sample/s supplied by the client

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ACCREDITED FOR TECHNICAL COMPETENCE

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Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards

Authorised Signatory
James Russell
J. Russell
Manager

N ATA Accredited Laboratory Number 9926

Australian Geomechanical Laboratories Pty Ltd
ABN 25 065 630 506

1/29 Finchley Street, Milton, Qld. 4064
P.O. Box 434, Paddington, Qld. 4064
Telephone: (07) 3217 5535
Facsimile: (07) 3217 5311
Email: aglabs@bigpond.net.au

ATTERBERG LIMITS TEST REPORT

TEST METHOD: AS1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client:	Golder Associates Pty Ltd	Report No.	801847-AL
Project:	077692009	Test Date:	20/02/08
		Report Date:	25/02/08

Client ID: TPA 17	Depth(m): 5.0 – 5.4	Sample No. 801847	
Liquid Limit (%):	32	Linear Shrinkage (%):	6.0
Plastic Limit (%):	18	Field Moisture Content (%):	15.7
Plasticity Index (%):	14		

Client ID: TPA 20	Depth(m): 6.0 – 6.45	Sample No. 801855	
Liquid Limit (%):	36	Linear Shrinkage (%):	10.0
Plastic Limit (%):	17	Field Moisture Content (%):	17.9
Plasticity Index (%):	19		

Client ID: TPA22	Depth(m): 1.5 – 1.9	Sample No. 801861	
Liquid Limit (%):	63	Linear Shrinkage (%):	19.0+
Plastic Limit (%):	21	Field Moisture Content (%):	26.5
Plasticity Index (%):	42		

Remarks: The sample/s were tested oven dried, dry sieved and in a 125 – 250mm mould.
*Crumbling occurred.
+Curling occurred.

Sample/s supplied by the client

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ACCREDITED FOR TECHNICAL COMPETENCE

This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards

Authorised Signatory

James Russell

J. Russell

Manager

N ATA Accredited Laboratory Number 9926

Form Number:GT004-5

Australian
Geomechanical
Laboratories Pty Ltd
ABN 25 085 630 506

1/29 Finchley Street, Milton, Qld. 4064
P.O. Box 434, Paddington, Qld. 4064
Telephone: (07) 3217 5535
Facsimile: (07) 3217 5311
Email: aglabs@bigpond.net.au

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client: Golder Associates Pty Ltd

Project: 077692009

Report No. 801523-EM DIST

Test Date: 11/2/08
Report Date: 14/2/08

DISTILLED WATER

Sample No.	801523	801524	801525	801526	801527
Client ID:	TPA 1	TPA 1	TPA 1	TPA 1	TPA 2
Depth (m):	1.25-1.65	2.5-2.9	4.0-4.32	5.5-5.95	7.5-7.95
Description:	Sandy Clay	Sandy Silt	Gravelly Sandy Clay	Clayey Sand	Silt
Emerson Class No.:	6	5	6	6	2

Sample No.	801531	801532	801533	801534	801535
Client ID:	TPA 3	TPA 3	TPA 3	TPA 3	TPA 3
Depth (m):	1.5-1.78	3.0-3.4	6.0-6.4	7.5-7.95	9.0-9.45
Description:	Clay	Clay	Clayey Sand	Clayey Sand	Sandy Clay
Emerson Class No.:	2	6	2	2	2

Sample No.	801539	801540	801541	801542
Client ID:	TPA 6	TPA 6	TPA 6	TPA 6
Depth (m):	2.5-2.7	4.0-4.4	5.5-5.9	7.0-7.3
Description:	Sandy Silt	Clay	Gravelly Sandy Clay	Clay
Emerson Class No.:	2	2	2	2

Remarks: Tested with distilled water at 24^{o}C as requested by the client.

Sample/s supplied by the client

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N ATA Accredited Laboratory Number 9926

Form Number: GT007-5

Authorised Signatory

James Russell

J. Russell

Manager

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client: Golder Associates Pty Ltd

Project: 077692009

Report No. 801523-EM SALT

Test Date: 11/2/08
Report Date: 14/2/08

SALT WATER

Sample No.	801523	801524	801525	801526	801527
Client ID:	TPA 1	TPA 1	TPA 1	TPA 1	TPA 2
Depth (m):	1.25-1.65	2.5-2.9	4.0-4.32	5.5-5.95	7.5-7.95
Description:	Sandy Clay	Sandy Silt	Gravelly Sandy Clay	Clayey Sand	Silt
Emerson Class No.:	6	6	5	5	6

Sample No.	801531	801532	801533	801534	801535
Client ID:	TPA 3	TPA 3	TPA 3	TPA 3	TPA 3
Depth (m):	1.5-1.78	3.0-3.4	6.0-6.4	7.5-7.95	9.0-9.45
Description:	Clay	Clay	Clayey Sand	Clayey Sand	Sandy Clay
Emerson Class No.:	6	5	6	4	6

Sample No.	801539	801540	801541	801542
Client ID:	TPA 6	TPA 6	TPA 6	TPA 6
Depth (m):	2.5-2.7	4.0-4.4	5.5-5.9	7.0-7.3
Description:	Sandy Silt	Clay	Gravelly Sandy Clay	Clay
Emerson Class No.:	6	4	4	6

Remarks: Tested with salt water at 24^{o}C as requested by the client.

Sample/s supplied by the client

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	Golder Associates Pty Ltd	Report No.	802322-EM
Project:	077692009	Test Date:	25/02/08
		Report Date:	04/03/08

DISTILLED WATER

Sample No.	802322	802323	802324	802325	802327
Client ID:	TPA 7	TPA 7	TPA 7	TPA 7	TPA 7
Depth (m):	4.0 – 4.4	5.5 – 5.95	7.0 – 7.45	10.0 – 10.45	13.0 – 13.42
Description:	*	*	*	*	*
Emerson Class No.:	2	1	1	1	1

Sample No.	802331	802332	802333	802334	802335
Client ID:	TPA 11	TPA 12	TPA 12	TPA 12	TPA 23
Depth (m):	3.0 – 3.4	1.0 – 1.45	2.5 – 2.95	4.0 – 4.45	5.5 – 5.95
Description:	*	*	*	*	*
Emerson Class No.:	6	6	1	1	1

Sample No.	802336	802341	802342	802343
Client ID:	TPA 12	TPA 13	TPA 13	TPA 13
Depth (m):	7.0 – 7.45	4.0 – 4.4	5.5 – 5.9	6.5 – 6.9
Description:	*	*	*	*
Emerson Class No.:	1	5	5	5

Remarks: Tested with distilled water at 19°C
*No description as requested by the client.

Sample/s supplied by the client

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	Golder Associates Pty Ltd	Report No.	802322-EMSALT
Project:	077692009	Test Date:	25/02/08
		Report Date:	04/03/08

SALT WATER

Sample No.	802322	802323	802324	802325	802327
Client ID:	TPA 7	TPA 7	TPA 7	TPA 7	TPA 7
Depth (m):	4.0 – 4.4	5.5 – 5.95	7.0 – 7.45	10.0 – 10.45	13.0-13.42
Description:	*	*	*	*	*
Emerson Class No.:	2	6	6	6	5

Sample No.	802331	802332	802333	802334	802335
Client ID:	TPA 11	TPA 12	TPA 12	TPA 12	TPA 12
Depth (m):	3.0 – 3.4	1.0 – 1.45	2.5 – 2.95	4.0 – 4.45	5.5 – 5.95
Description:	*	*	*	*	*
Emerson Class No.:	6	6	6	6	6

Sample No.	802336	802341	802342	802343
Client ID:	TPA 12	TPA 13	TPA 13	TPA 13
Depth (m):	7.0 – 7.45	4.0 – 4.4	5.5 – 5.9	6.5 – 6.9
Description:	*	*	*	*
Emerson Class No.:	6	5	5	5

Remarks: Tested with salt water at 19°C
*No description as requested by the client.

Sample/s supplied by the client

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	Golder Associates Pty Ltd	Report No.	801847-EM
Project:	077692009	Test Date:	20/02/08
		Report Date:	26/02/08

DISTILLED WATER

Sample No.	801847	801849	801851	801852	801854
Client ID:	TPA 17	TPA 17	TPA 17	TPA 16	TPA 16
Depth (m):	5.0 – 5.4	7.5 – 7.9	14.5 – 14.9	8.5 – 8.95	16.0 – 16.45
Description:	-	-	-	-	-
Emerson Class No.:	2	2	2	2	2

Sample No.	801855	801856	801857	801859	801860
Client ID:	TPA 20	TPA 20	TPA 20	TPA 21	TPA 21
Depth (m):	6.0 – 6.45	9.0 – 9.42	12.0 – 12.45	10.0 – 10.45	13.0 – 13.45
Description:	-	-	-	-	-
Emerson Class No.:	2	2	2	2	2

Sample No.	801861	801862	801867	801868
Client ID:	TPA 22	TPA 22	TPA 23	TPA 23
Depth (m):	1.5 – 1.9	3.3 – 3.7	3.0 – 3.4	6.0 – 6.4
Description:	-	-	-	-
Emerson Class No.:	2	2	2	2

Remarks: Tested with distilled water at 24°C. No description as requested by the client

Sample/s supplied by the client

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client: Golder Associates Pty Ltd
Project: 077692009

Report No. 801847-EMSALT
Test Date: 20/02/08
Report Date: 26/02/08

SALT WATER

Sample No.	801847	801849	801851	801852	801854
Client ID:	TPA 17	TPA 17	TPA 17	TPA 16	TPA 16
Depth (m):	5.0 – 5.4	7.5 – 7.9	14.5 – 14.9	8.5 – 8.95	16.0 – 16.45
Description:	-	-	-	-	-
Emerson Class No.:	6	6	6	6	6

Sample No.	801855	801856	801857	801859	801860
Client ID:	TPA 20	TPA 20	TPA 20	TPA 21	TPA 21
Depth (m):	6.0 – 6.45	9.0 – 9.42	12.0 – 12.45	10.0 – 10.45	13.0 – 13.45
Description:	-	-	-	-	-
Emerson Class No.:	6	6	6	6	6

Sample No.	801861	801862	801867	801868
Client ID:	TPA 22	TPA 22	TPA 23	TPA 23
Depth (m):	1.5 – 1.9	3.3 – 3.7	3.0 – 3.4	6.0 – 6.4
Description:	-	-	-	-
Emerson Class No.:	6	6	6	6

Remarks: Tested with salt water at 24°C

Sample/s supplied by the client

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801523-OED

Project: 077692009

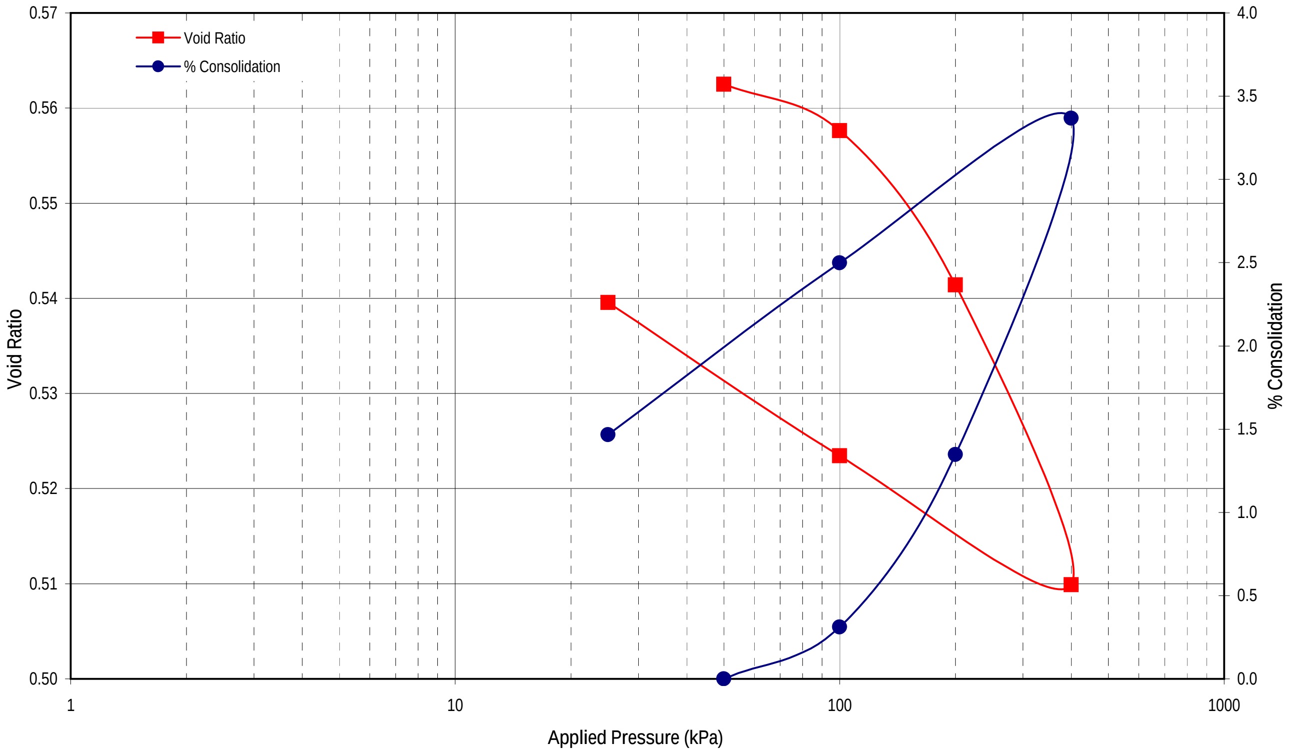
Test Date: 17/01/2008

Report Date: 5/02/2008

Client Id.: TPA1

Depth (m): 1.25-1.65

Description: (CH) SILTY CLAY- brown, trace of fine gravel



Load (kPa)	50-100	100-200	200-400	400-100	100-25							
Cc	0.016	0.054	0.105	0.023	0.027							
Cv (m^2/yr) t_{50}	1.74	4.21	0.44	0.70	0.18							
t_{90}	96.24	12.85	10.84	15.57	6.65							
Mv ($kPa^{-1}x10^{-3}$)	0.062	0.104	0.102	0.030	0.141							
C_a x 10^{-3}	0.6	0.9	2.6	0.8	2.0							
% Consolidation	0.3	1.3	3.4	2.5	1.5							

Wet Density (t/m^3): 2.06
Initial Moisture (%): 22.5
Test Condition: Inundated on load
Particle Density (t/m^3): 2.61
Initial Voids Ratio: 0.551
Initial Degree of Saturation (%): 107.0
Undisturbed sample supplied by the client
Remarks: Tested As Received
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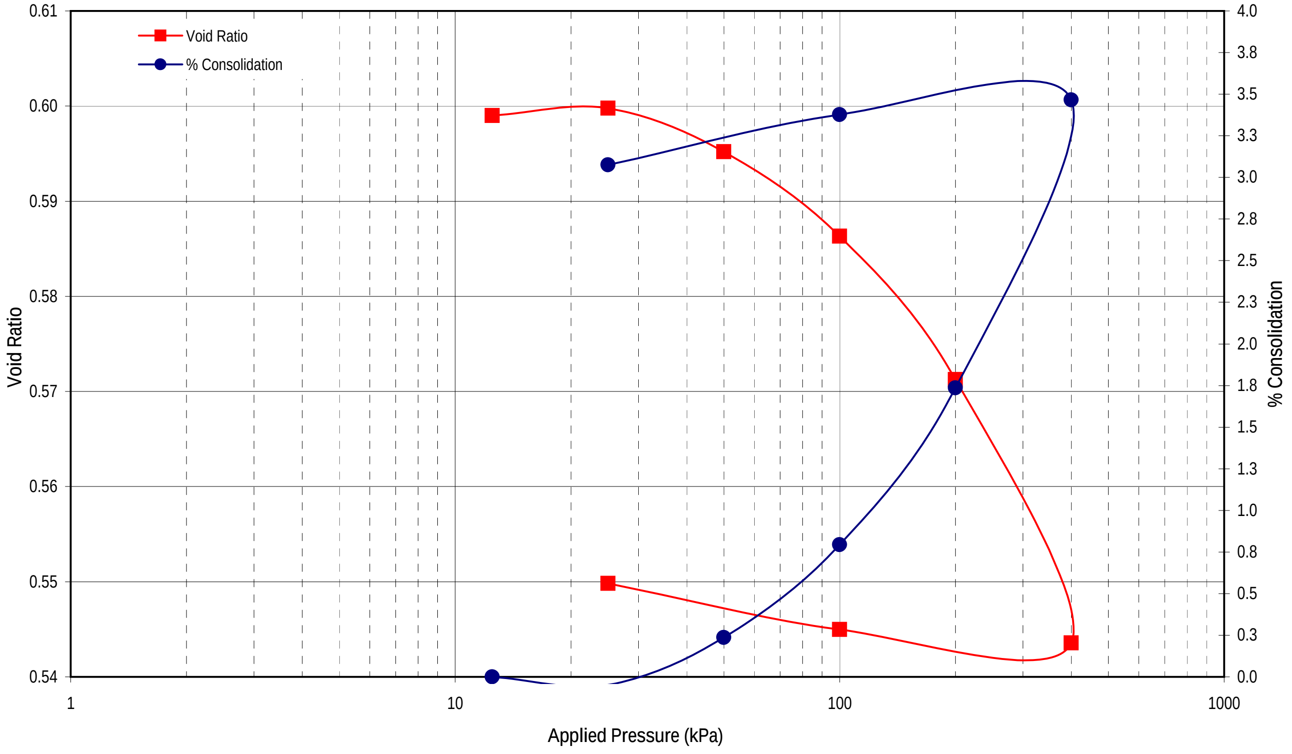
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd
Report No.: 801524-OED
Project: 077692009
Test Date: 23/01/2008
Report Date: 5/02/2008
Client Id.: TPA 1
Depth (m): 2.5-2.9
Description: (ML) SANDY SILT- grey brown



Load (kPa)		12.5-25	25-50	50-100	100-200	200-400	400-100	100-25					
Cc		-0.003	0.015	0.030	0.050	0.092	0.002	0.008					
Cv (m^2/yr)	t_{50}	142.65	150.14	172.55	182.99	96.96	30.78	16.27					
	t_{90}	442.24	425.30	318.42	324.73	560.95	794.45	12.08					
Mv (kPa^{-1}x10^{-3})		-0.039	0.114	0.112	0.095	0.088	0.003	0.042					
C_a x 10^{-3}		0.4	1.2	2.0	3.1	3.7	0.4	0.9					
% Consolidation		0.0	0.2	0.8	1.7	3.5	3.4	3.1					

Wet Density (t/m^3): 2.00
Initial Moisture (%): 23.4
Test Condition: Inundated on load
Particle Density (t/m^3): 2.60
Initial Voids Ratio: 0.599
Initial Degree of Saturation (%): 101.7

Undisturbed sample supplied by the client
Remarks:
Page 1 of 1

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801525-OED

Project: 077692009

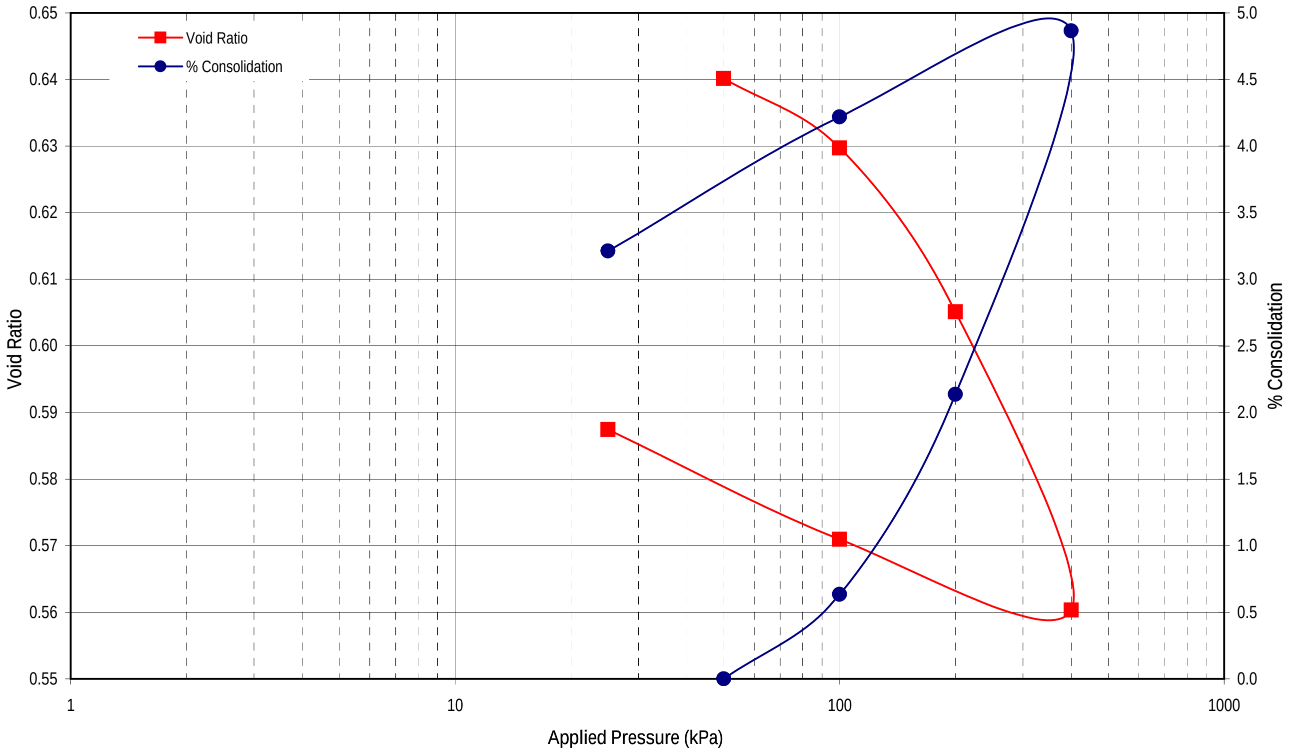
Test Date: 29/01/2008

Report Date: 5/02/2008

Client Id.: TPA 1

Depth (m): 4.0-4.32

Description: (CI) GRAVELLY SANDY SILTY CLAY- grey orange brown mottled



Load (kPa)	50-100	100-200	200-400	400-100	100-25							
Cc	0.034	0.082	0.149	0.018	0.027							
Cv (m^2/yr) t_{50}	174.24	96.62	161.81	120.37	1.03							
t_{90}	418.95	549.21	397.39	370.00	58.44							
Mv ($kPa^{-1}x10^{-3}$)	0.127	0.151	0.139	0.023	0.140							
C_a x 10^{-3}	1.3	1.9	4.2	1.8	1.9							
% Consolidation	0.6	2.1	4.9	4.2	3.2							

Wet Density (t/m^3): 2.00

Initial Moisture (%): 22.6

Test Condition: Inundated on load

Particle Density (t/m^3): 2.69

Initial Voids Ratio: 0.628

Initial Degree of Saturation (%): 95.8

Undisturbed sample supplied by the client

Remarks: Tested As Received

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OEDOMETER TEST REPORT

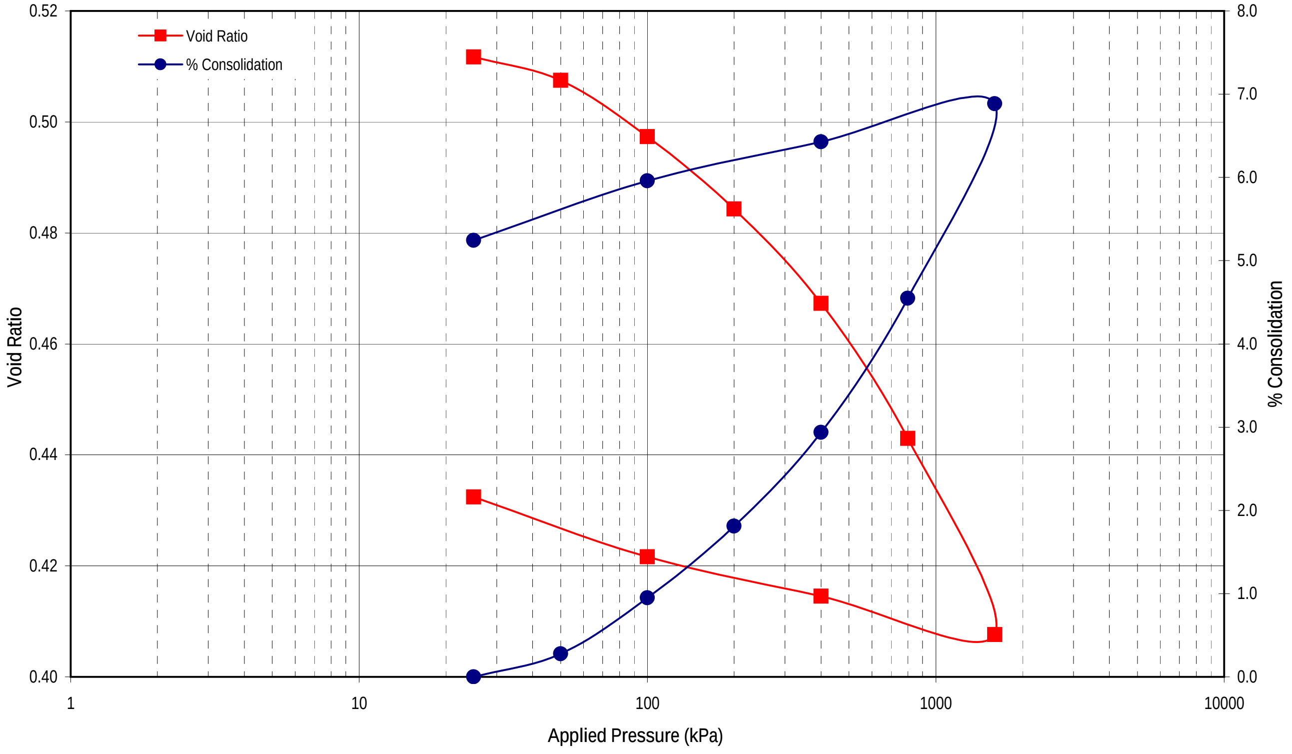
Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd
Report No.: 801531-OED

Project: 077692009
Test Date: 31/01/2008
Report Date: 14/02/2008

Client Id.: TPA 3
Depth (m): 1.5-1.78

Description: (CI) SANDY CLAY-pale grey brown



Load (kPa)	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100	100-25			
Cc	0.014	0.034	0.043	0.056	0.081	0.117	0.011	0.012	0.018			
Cv (m^2/yr) t_{50}	193.59	187.68	180.84	43.84	105.13	51.85	117.30	16.99	1.97			
t_{90}	95.14	452.03	599.84	132.16	344.42	408.34	136.20	383.88	20.59			
Mv (kPa^{-1}x10^{-3})	0.111	0.135	0.087	0.057	0.042	0.031	0.004	0.017	0.101			
C_a x 10^{-3}	0.6	0.8	1.1	1.3	1.9	2.3	0.3	1.0	1.4			
% Consolidation	0.3	0.9	1.8	2.9	4.5	6.9	6.4	6.0	5.2			

Wet Density (t/m^3): 1.99
Initial Moisture (%): 14.3
Test Condition: Inundated on load

Particle Density (t/m^3): 2.62
Initial Voids Ratio: 0.505
Initial Degree of Saturation (%): 74.1

Undisturbed sample supplied by the client
Remarks: Tested as received.
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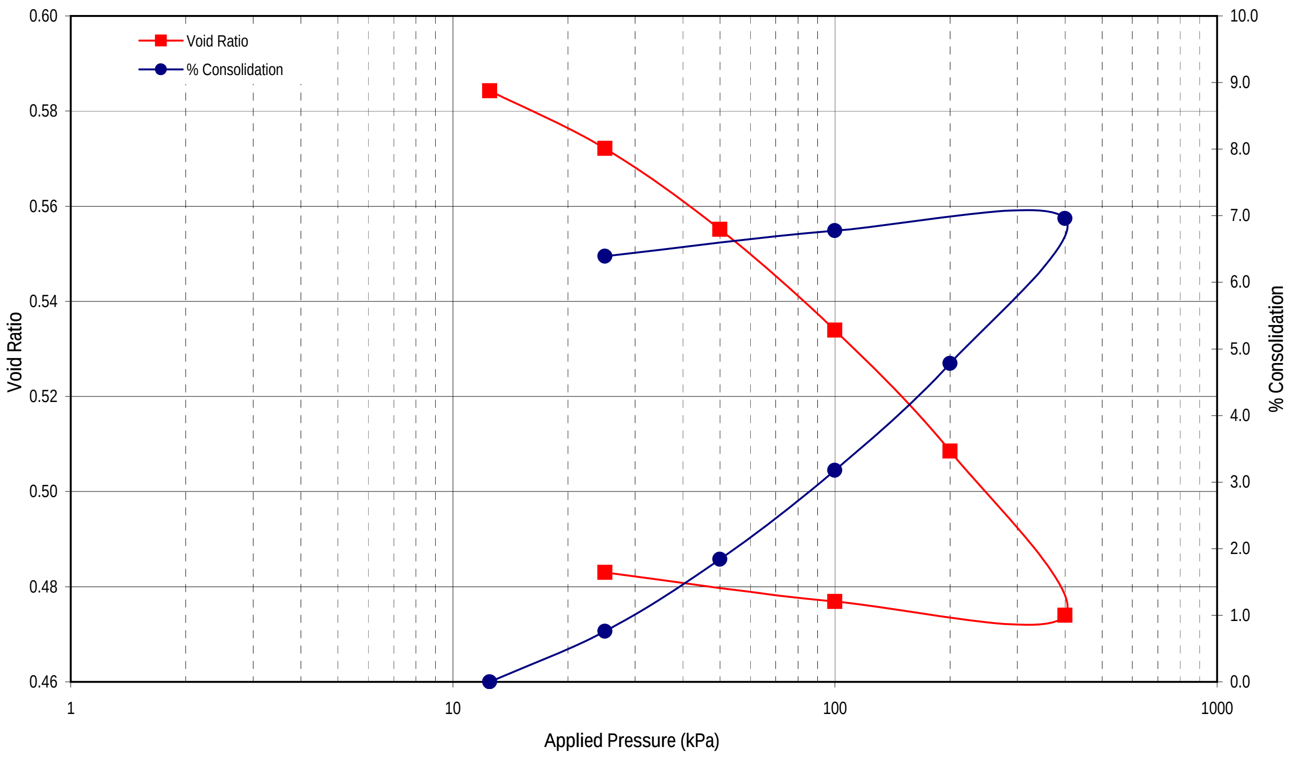
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801532-OED
Project:	077692009	**Test Date:**	22/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA3	**Depth (m):**	3.0-3.4

Description: (ML) SANDY SILT- grey brown, fine to medium sand



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-100	100-25				
Cc	0.040	0.057	0.070	0.084	0.115	0.005	0.010				
Cv (m^2/yr) t_{50}	9.63	23.16	26.70	30.51	41.43	71.56	17.97				
t_{90}	95.88	77.17	89.27	118.98	112.12	523.60	17.27				
Mv ($kPa^{-1}x10^{-3}$)	0.609	0.434	0.272	0.166	0.114	0.007	0.056				
C_a x 10^{-3}	0.9	1.1	1.3	1.9	2.0	0.2	0.7				
% Consolidation	0.8	1.8	3.2	4.8	7.0	6.8	6.4				

Wet Density (t/m^3):	2.11	Initial Moisture (%):	24.9	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.67	Initial Voids Ratio:	0.583	Initial Degree of Saturation (%):	116.8
Undisturbed sample supplied by the client		Remarks:	Tested As Received		Page 1 of 1

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801533-OED

Project: 077692009

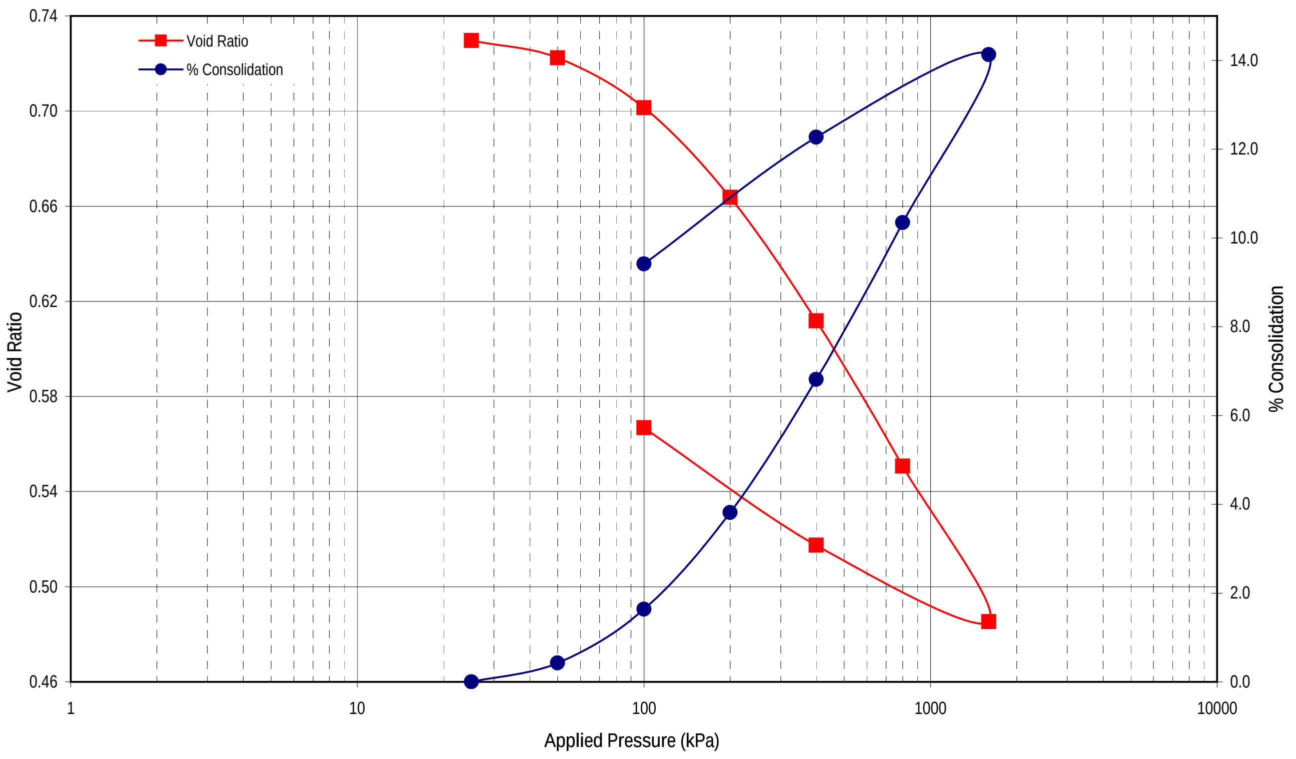
Test Date: 31/01/2008

Report Date: 14/02/2008

Client Id.: TPA 3

Depth (m): 6.0-6.4

Description: (CH) SILTY CLAY- grey green brown



Load (kPa)	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100			
Cc	0.024	0.070	0.125	0.172	0.203	0.217	0.053	0.082			
Cv (m^2/yr) t_{50}	1.20	0.66	0.37	0.27	0.20	0.16	0.21	0.06			
t_{90}	33.99	7.23	2.64	0.43	0.31	0.20	4.77	0.21			
Mv ($kPa^{-1}x10^{-3}$)	0.169	0.244	0.221	0.156	0.095	0.053	0.018	0.108			
C_a x 10^{-3}	0.6	1.0	1.7	3.6	3.4	3.9	1.1	3.5			
% Consolidation	0.4	1.6	3.8	6.8	10.3	14.1	12.3	9.4			

Wet Density (t/m^3): 1.96

Initial Moisture (%): 28.4

Test Condition: Inundated on load

Particle Density (t/m^3): 2.64

Initial Voids Ratio: 0.722

Initial Degree of Saturation (%): 103.5

Undisturbed sample supplied by the client

Remarks: Tested As Received

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TECHNICAL COMPETENCE

NATA Accredited Laboratory
Number 9926

This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards.

Authorised Signatory

James Russell

J. Russell

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OEDOMETER TEST REPORT

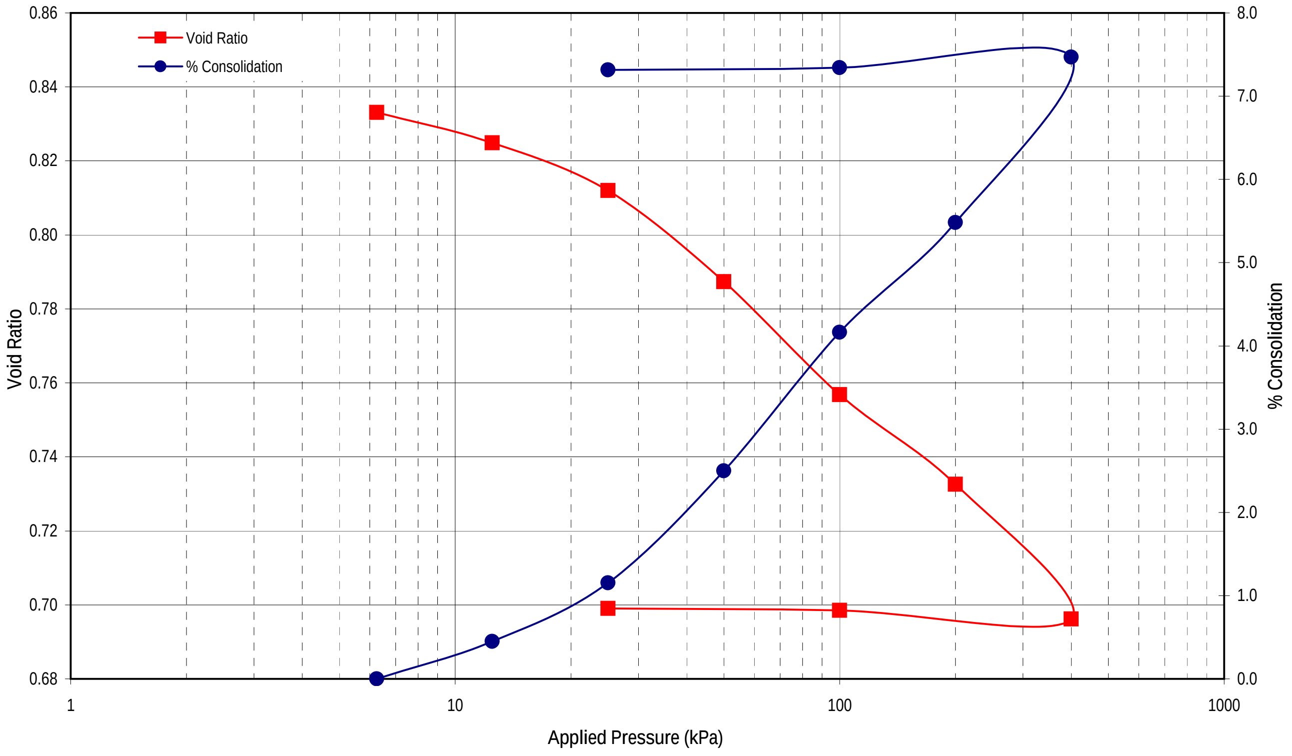
Test Method: AS1289.6.6.1, 3.5.1

Client: Golder AssociateS Pty Ltd
Report No.: 801539-OED

Project: 077692009
Test Date: 22/01/2008
Report Date: 4/02/2008

Client Id.: TPA6
Depth (m): 2.5-2.7

Description: (MH) SANDY SILT-dark grey



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-100	100-25				
Cc	0.027	0.043	0.082	0.101	0.081	0.121	0.004	0.001				
Cv (m^2/yr) t_{50}	1.87	9.50	12.05	25.73	41.56	85.70	92.50	120.75				
t_{90}	10.29	176.35	404.42	20.54	391.34	254.23	734.08	319.85				
Mv ($kPa^{-1}x10^{-3}$)	0.720	0.566	0.543	0.341	0.138	0.105	0.005	0.004				
C_a x 10^{-3}	1.0	1.6	2.5	2.3	2.6	2.7	0.2	0.7				
% Consolidation	0.5	1.2	2.5	4.2	5.5	7.5	7.3	7.3				

Wet Density (t/m^3): 1.94
Initial Moisture (%): 34.0
Test Condition: Inundated on load

Particle Density (t/m^3): 2.65
Initial Voids Ratio: 0.834
Initial Degree of Saturation (%): 108.1

Undisturbed sample supplied by the client
Remarks: Tested As Received
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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801540-OED

Project: 077692009

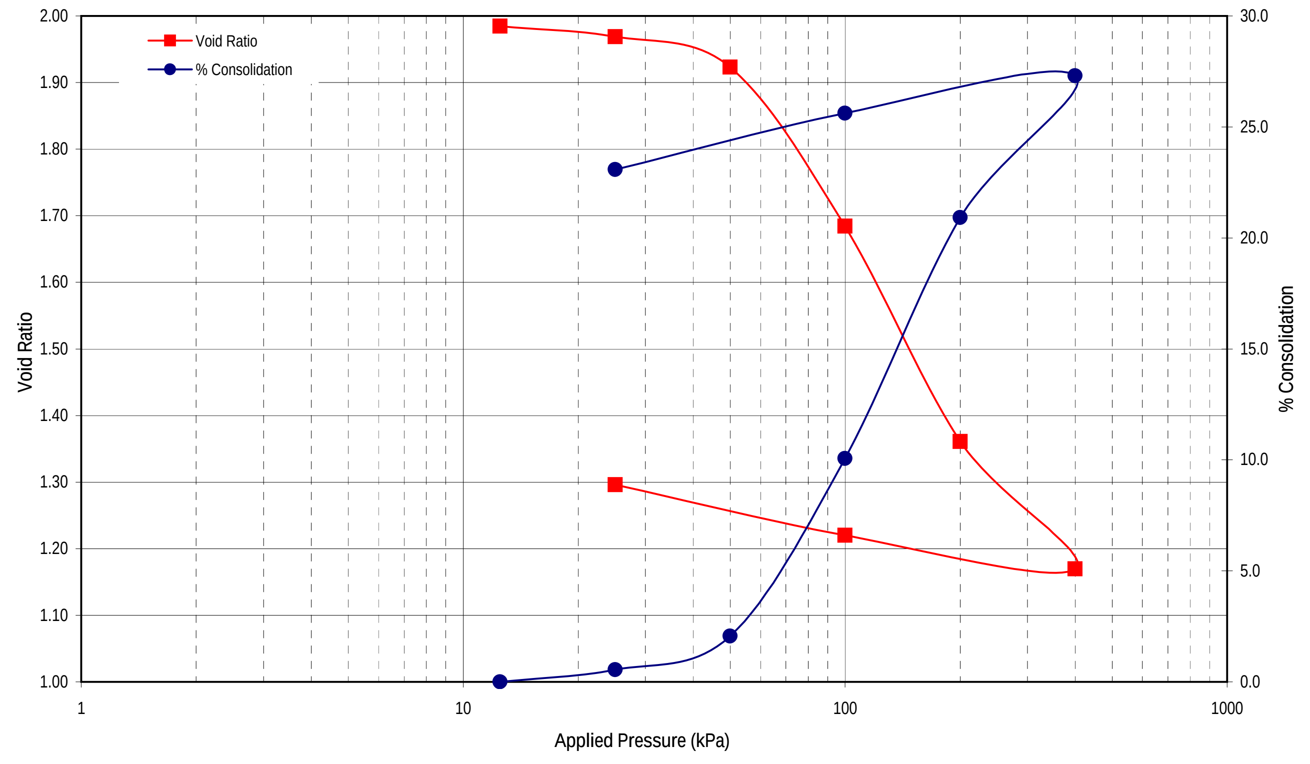
Test Date: 17/01/2008

Report Date: 5/02/2008

Client Id.: TPA6

Depth (m): 4.0-4.4

Description: (CH) SILTY CLAY- grey



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-100	100-25					
Cc	0.054	0.151	0.793	1.076	0.634	0.083	0.126					
Cv (m^2/yr) t_{50}	2.36	2.84	0.19	0.24	0.43	0.58	0.15					
t_{90}	31.30	3.42	0.71	0.33	0.39	0.88	0.29					
Mv ($kPa^{-1}x10^{-3}$)	0.433	0.611	1.634	1.206	0.404	0.077	0.456					
C_a x 10^{-3}	1.1	2.4	14.6	16.8	11.5	1.4	4.0					
% Consolidation	0.5	2.1	10.1	20.9	27.3	25.6	23.1					

Wet Density (t/m^3):	1.54	Initial Moisture (%):	81.0	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.53	Initial Voids Ratio:	1.982	Initial Degree of Saturation (%):	103.7

Undisturbed sample supplied by the client

Remarks: Tested As Received

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801541-OED

Project: 077692009

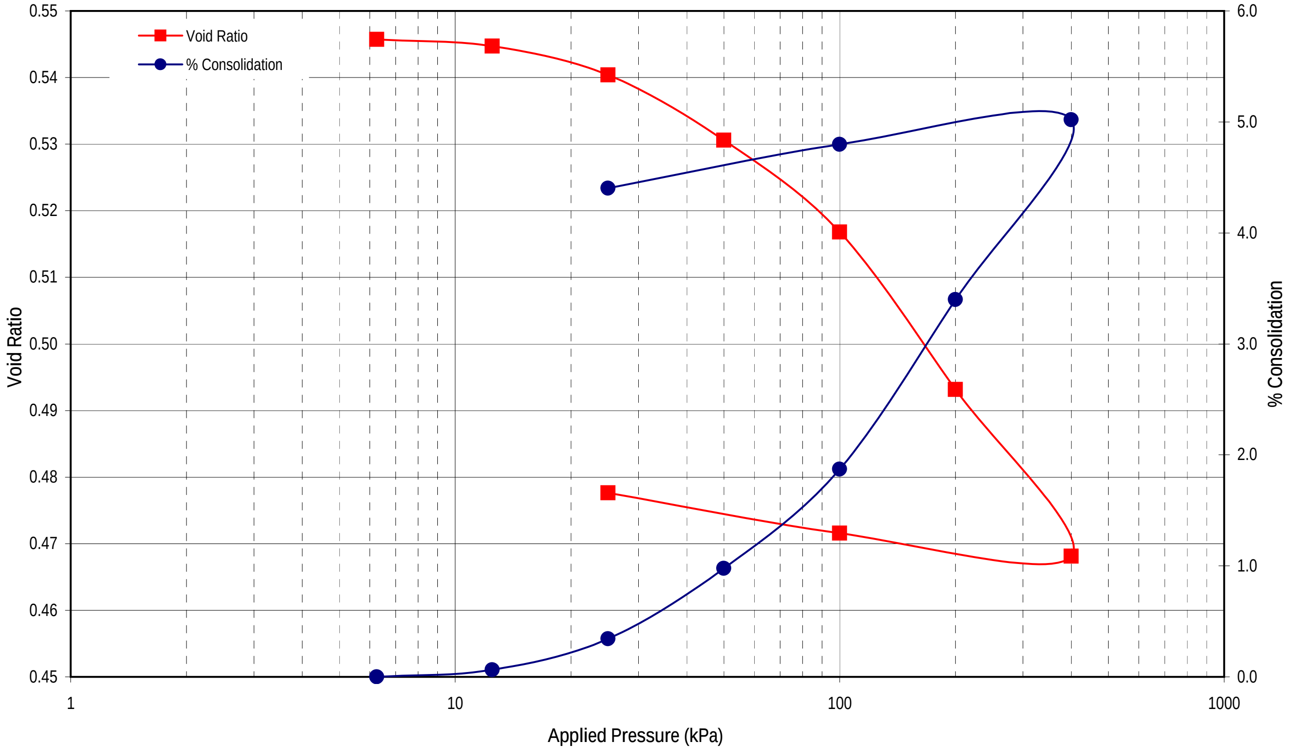
Test Date: 31/01/2008

Report Date: 14/02/2008

Client Id.: TPA6

Depth (m): 5.5-5.9

Description: (CH) GRAVELLY SANDY CLAY-grey brown



Load (kPa)	6.25-12.5	12.5-25	25-50	50-100	100-200	200-400	400-100	100-25				
Cc	0.003	0.014	0.033	0.046	0.079	0.083	0.006	0.010				
Cv (m^2/yr) t_{50}	22.30	15.08	14.38	12.76	10.86	13.49	106.52	4.62				
t_{90}	834.43	89.12	62.86	123.10	39.72	371.50	327.68	11.32				
Mv (kPa^{-1}x10^{-3})	0.101	0.225	0.254	0.180	0.156	0.084	0.008	0.055				
C_a x 10^{-3}	0.2	0.8	1.1	1.4	1.5	2.2	0.6	1.3				
% Consolidation	0.1	0.3	1.0	1.9	3.4	5.0	4.8	4.4				

Wet Density (t/m^3):	2.06	Initial Moisture (%):	20.2	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.64	Initial Voids Ratio:	0.546	Initial Degree of Saturation (%):	98.3

Undisturbed sample supplied by the client

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OEDOMETER TEST REPORT

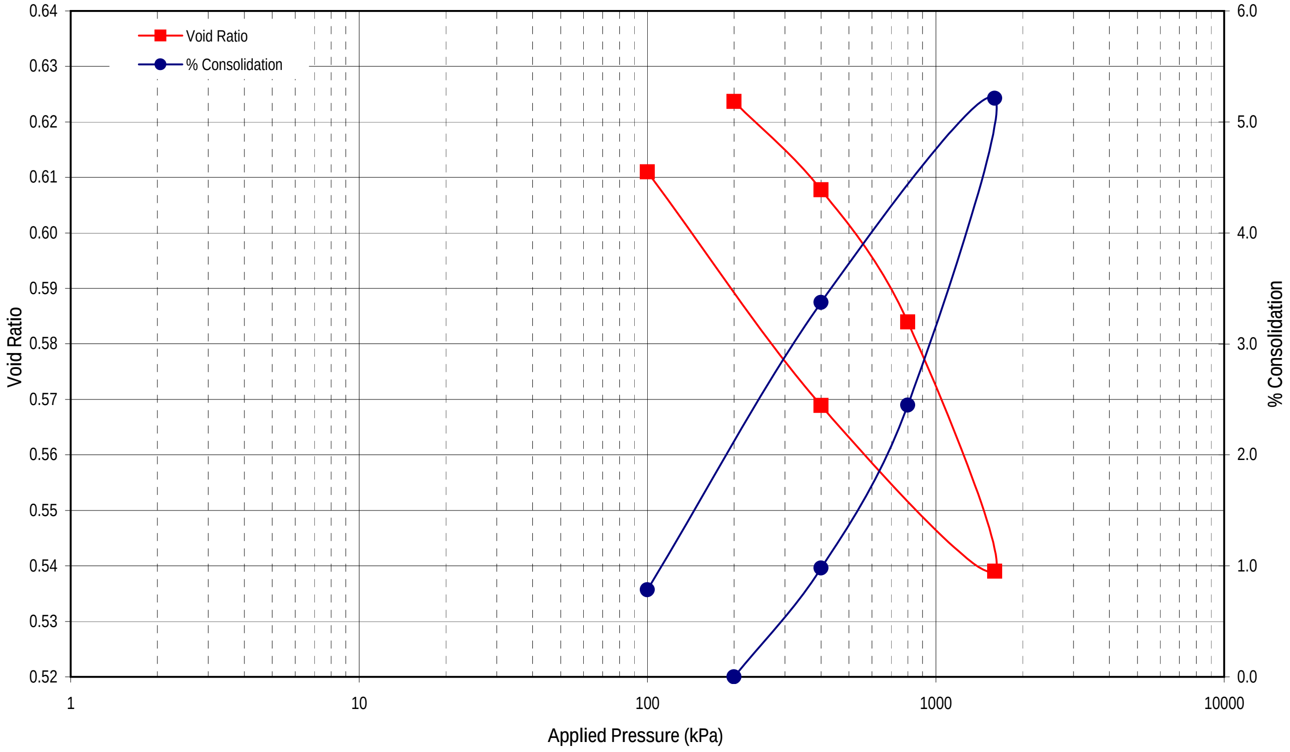
Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd
Report No.: 802321-OED

Project: 077692009
Test Date: 14/02/2008
Report Date: 25/02/2008

Client Id.: TPA7
Depth (m): 2.5-2.8

Description:



Load (kPa)	200-400	400-800	800-1600	1600-400	400-100							
Cc	0.053	0.079	0.149	0.050	0.070							
Cv (m^2/yr) t_{50}	2.94	0.32	0.22	0.27	0.09							
t_{90}	0.67	1.08	0.58	4.79	1.47							
Mv ($kPa^{-1}x10^{-3}$)	0.049	0.037	0.035	0.016	0.089							
C_a x 10^{-3}	0.6	1.9	3.5	1.8	7.7							
% Consolidation	1.0	2.4	5.2	3.4	0.8							

Wet Density (t/m^3): 2.06
Initial Moisture (%): 21.9
Test Condition: Inundated on load

Particle Density (t/m^3): 2.70
Initial Voids Ratio: 0.602
Initial Degree of Saturation (%): 98.4

Undisturbed sample supplied by the client
Remarks: Tested as received

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 802322-OED

Project: 077692009

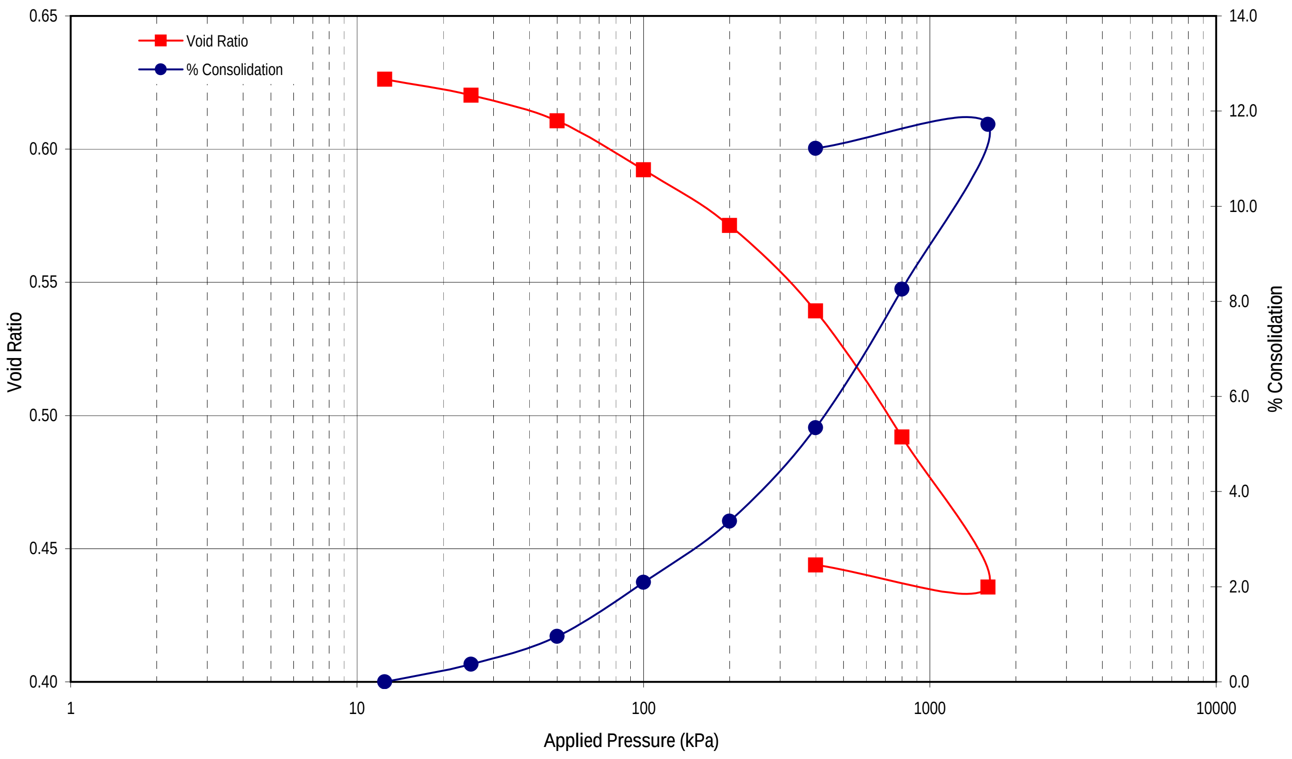
Test Date: 14/02/2008

Report Date: 27/02/2008

Client Id.: TPA7

Depth (m): 4.0-4.4

Description:



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400				
Cc	0.020	0.032	0.061	0.069	0.106	0.157	0.187	0.014				
Cv (m^2/yr) t_{50}	11.17	16.37	15.94	16.40	12.15	10.09	5.30	13.49				
t_{90}	24.33	122.77	50.26	364.28	106.78	127.46	88.15	95.31				
Mv ($kPa^{-1}x10^{-3}$)	0.294	0.237	0.229	0.131	0.102	0.077	0.047	0.005				
C_a x 10^{-3}	0.6	1.1	1.3	1.2	2.0	2.5	3.9	0.2				
% Consolidation	0.4	1.0	2.1	3.4	5.3	8.3	11.7	11.2				

Wet Density (t/m^3): 2.05 — Initial Moisture (%): 23.9 — Test Condition: Inundated on load

Particle Density (t/m^3): 2.70 — Initial Voids Ratio: 0.624 — Initial Degree of Saturation (%): 103.3

Undisturbed sample supplied by the client — Remarks: Tested As Received — Page 1 of 1

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 802323-OED

Project: 077692009

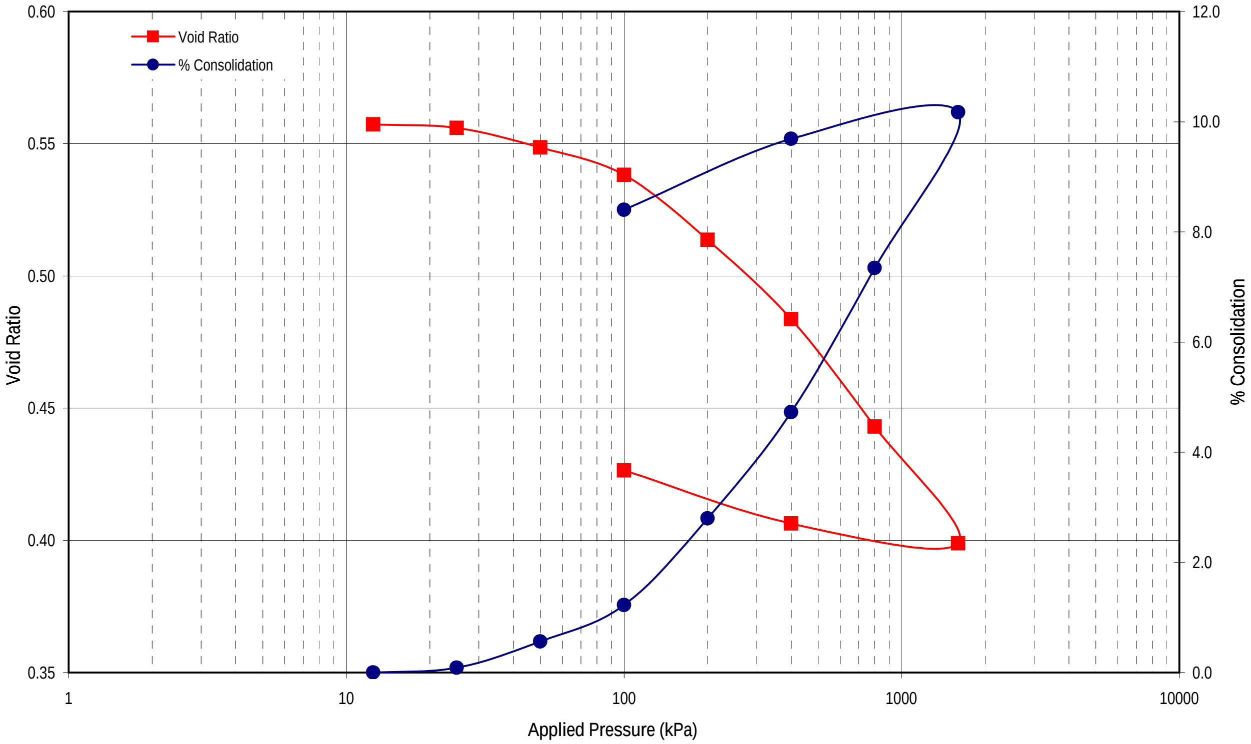
Test Date: 22/02/2008

Report Date: 4/03/2008

Client Id.: TPA7

Depth (m): 5.5-5.95

Description:



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100			
Cc	0.004	0.025	0.034	0.081	0.100	0.135	0.146	0.012	0.033			
Cv (m^2/yr) t_{50}	5.66	2.30	3.50	2.74	1.99	1.27	1.15	6.74	0.46			
t_{90}	69.14	40.76	265.70	129.32	106.18	35.82	20.98	91.30	20.78			
Mv ($kPa^{-1}x10^{-3}$)	0.067	0.191	0.134	0.159	0.099	0.069	0.038	0.004	0.048			
C_a x 10^{-3}	0.6	1.0	1.7	1.9	2.8	3.0	3.9	0.7	1.7			
% Consolidation	0.1	0.6	1.2	2.8	4.7	7.3	10.2	9.7	8.4			

Wet Density (t/m^3):	2.13	Initial Moisture (%):	21.7	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.72	Initial Voids Ratio:	0.557	Initial Degree of Saturation (%):	106.5

Undisturbed sample supplied by the client

Remarks: Tested as received

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801843-OED

Project: 077692009

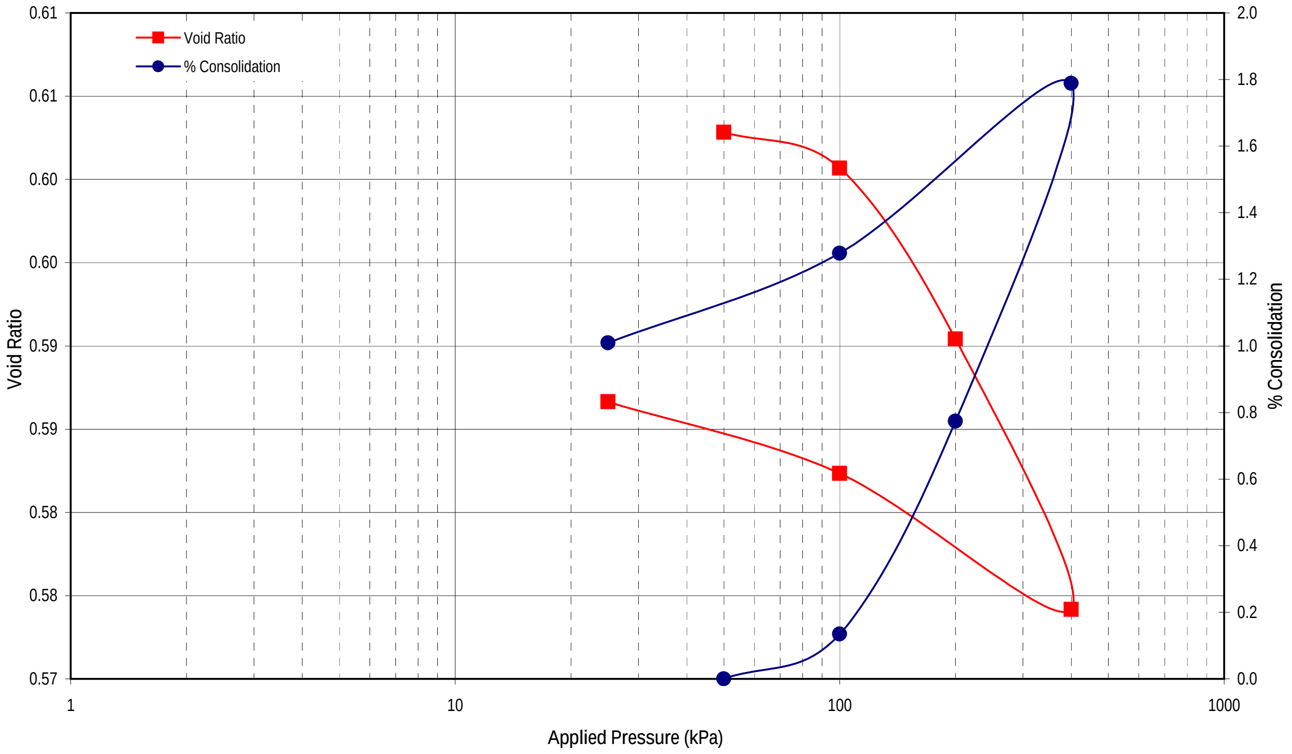
Test Date: 5/02/2008

Report Date: 18/02/2008

Client Id.: TPA9

Depth (m): 2.5-2.9

Description:



Load (kPa)	50-100	100-200	200-400	400-100	100-25							
Cc	0.007	0.034	0.054	0.014	0.007							
Cv (m^2/yr) t_{50}	24.89	18.41	25.19	19.18	4.19							
t_{90}	940.59	145.46	711.60	1391.16	48.48							
Mv ($kPa^{-1}x10^{-3}$)	0.027	0.064	0.051	0.017	0.036							
C_a x 10^{-3}	0.5	0.8	1.1	0.5	1.1							
% Consolidation	0.1	0.8	1.8	1.3	1.0							

Wet Density (t/m^3): 1.99

Initial Moisture (%): 21.4

Test Condition: Inundated on load

Particle Density (t/m^3): 2.62

Initial Voids Ratio: 0.594

Initial Degree of Saturation (%): 94.1

Undisturbed sample supplied by the client

Remarks:

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pt Ltd

Project: 077692009

Report No.: 801844-OED

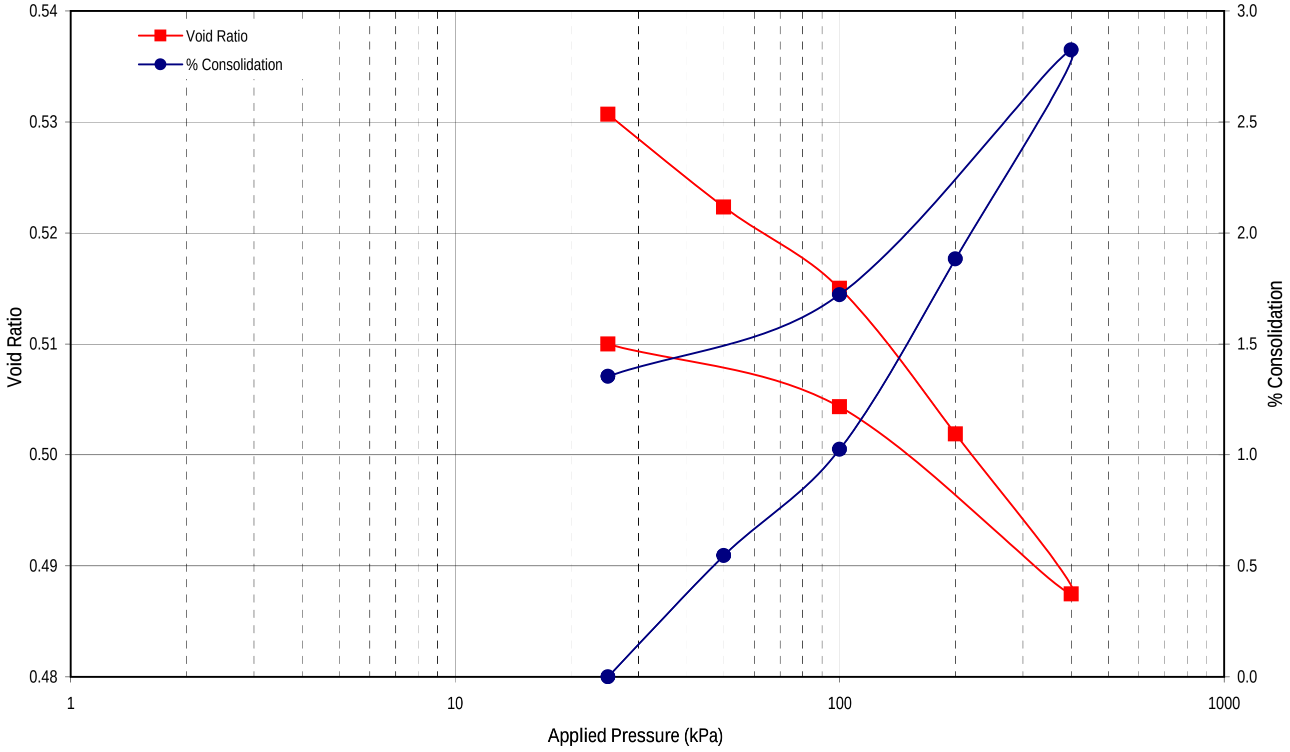
Test Date: 5/02/2008

Report Date: 18/02/2008

Client Id.: TPA9

Depth (m): 4.0-4.40

Description:



Load (kPa)	25-50	50-100	100-200	200-400	400-100	100-25					
Cc	0.028	0.024	0.044	0.048	0.028	0.009					
Cv (m^2/yr) t_{50}	204.00	199.69	185.64	117.38	195.59	138.75					
t_{90}	661.89	396.25	441.59	373.85	640.24	268.07					
Mv ($kPa^{-1}x10^{-3}$)	0.219	0.096	0.087	0.048	0.038	0.050					
C_a x 10^{-3}	0.6	0.8	0.9	1.1	0.4	1.0					
% Consolidation	0.5	1.0	1.9	2.8	1.7	1.4					

Wet Density (t/m^3): 2.04 | Initial Moisture (%): 18.9 | Test Condition: Inundated on load

Particle Density (t/m^3): 2.62 | Initial Voids Ratio: 0.530 | Initial Degree of Saturation (%): 93.8

Undisturbed sample supplied by the client | Remarks: | Page 1 of 1

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801847-OED

Project: 077692009

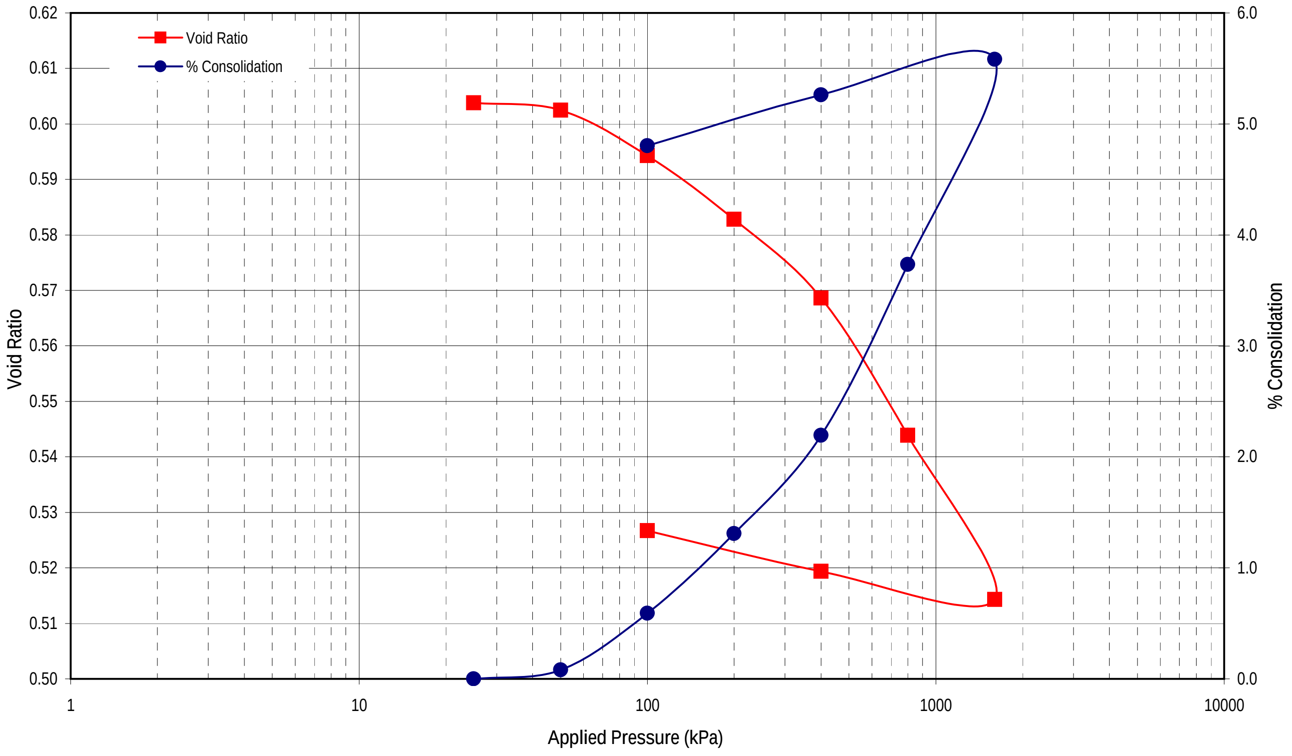
Test Date: 11/02/2008

Report Date: 20/02/2008

Client Id.: TPA 17

Depth (m): 5.0-5.4

Description:



Load (kPa)	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100				
Cc	0.004	0.027	0.038	0.047	0.082	0.098	0.008	0.012				
Cv (m^2/yr) t_{50}	342.28	75.67	308.03	324.67	303.18	247.43	299.12	9.91				
t_{90}	800.66	1020.46	515.60	1405.55	586.92	581.78	489.47	348.95				
Mv ($kPa^{-1}x10^{-3}$)	0.033	0.102	0.072	0.045	0.039	0.024	0.003	0.016				
C_a x 10^{-3}	0.5	0.7	1.0	1.9	2.3	2.7	0.4	0.6				
% Consolidation	0.1	0.6	1.3	2.2	3.7	5.6	5.3	4.8				

Wet Density (t/m^3): 1.98 | Initial Moisture (%): 17.1 | Test Condition: Inundated on load

Particle Density (t/m^3): 2.70 | Initial Voids Ratio: 0.599 | Initial Degree of Saturation (%): 77.0

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801848-OED

Project: 077692009

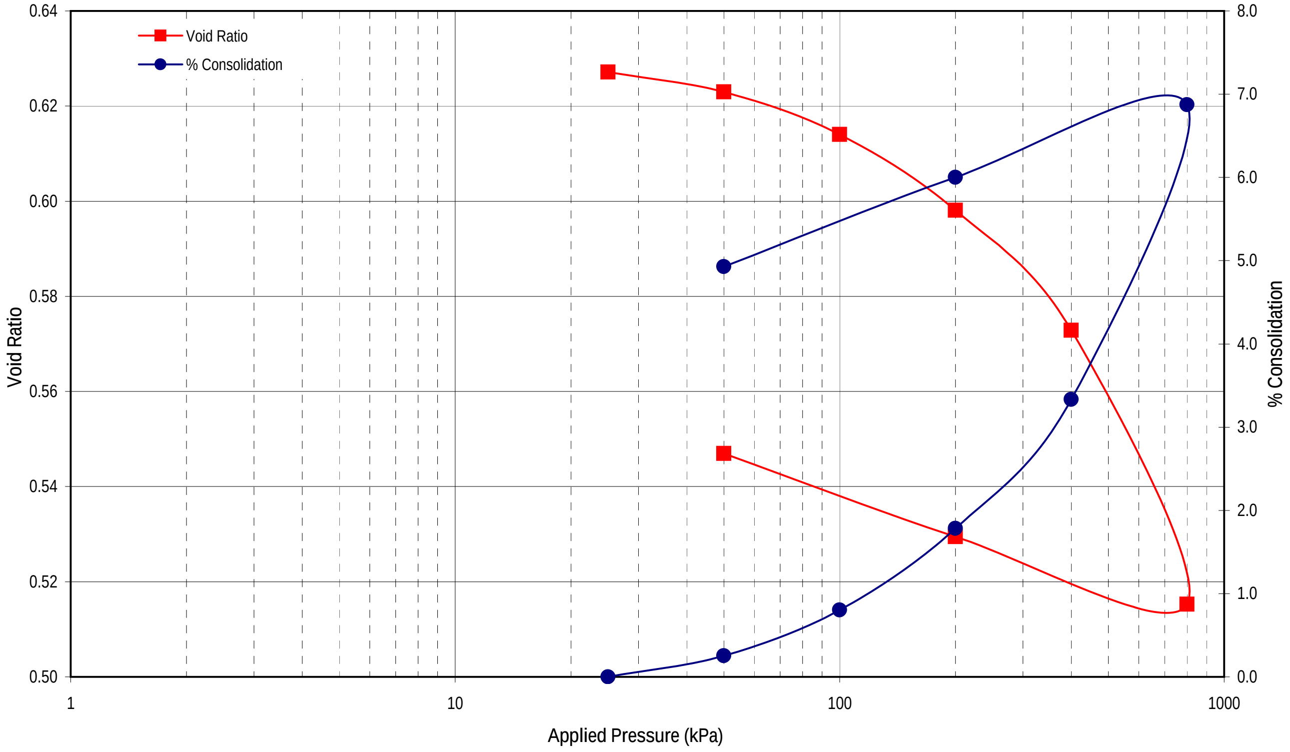
Test Date: 8/02/2008

Report Date: 18/02/2008

Client Id.: TPA 17

Depth (m): 6.2-6.6

Description:



Load (kPa)	25-50	50-100	100-200	200-400	400-800	800-200	200-50					
Cc	0.014	0.030	0.053	0.084	0.191	0.024	0.029					
Cv (m^2/yr) t_{50}	97.90	50.02	189.60	114.97	169.81	67.64	6.66					
t_{90}	614.67	630.84	611.96	248.19	391.19	755.37	111.74					
Mv ($kPa^{-1}x10^{-3}$)	0.102	0.110	0.099	0.079	0.092	0.016	0.076					
C_a x 10^{-3}	0.6	0.7	1.1	1.9	5.2	0.8	1.2					
% Consolidation	0.3	0.8	1.8	3.3	6.9	6.0	4.9					

Wet Density (t/m^3): 1.97

Initial Moisture (%): 22.1

Test Condition: Inundated on load

Particle Density (t/m^3): 2.61

Initial Voids Ratio: 0.620

Initial Degree of Saturation (%): 93.2

Undisturbed sample supplied by the client

Remarks: Tested As Received

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801849-OED

Project: 077692009

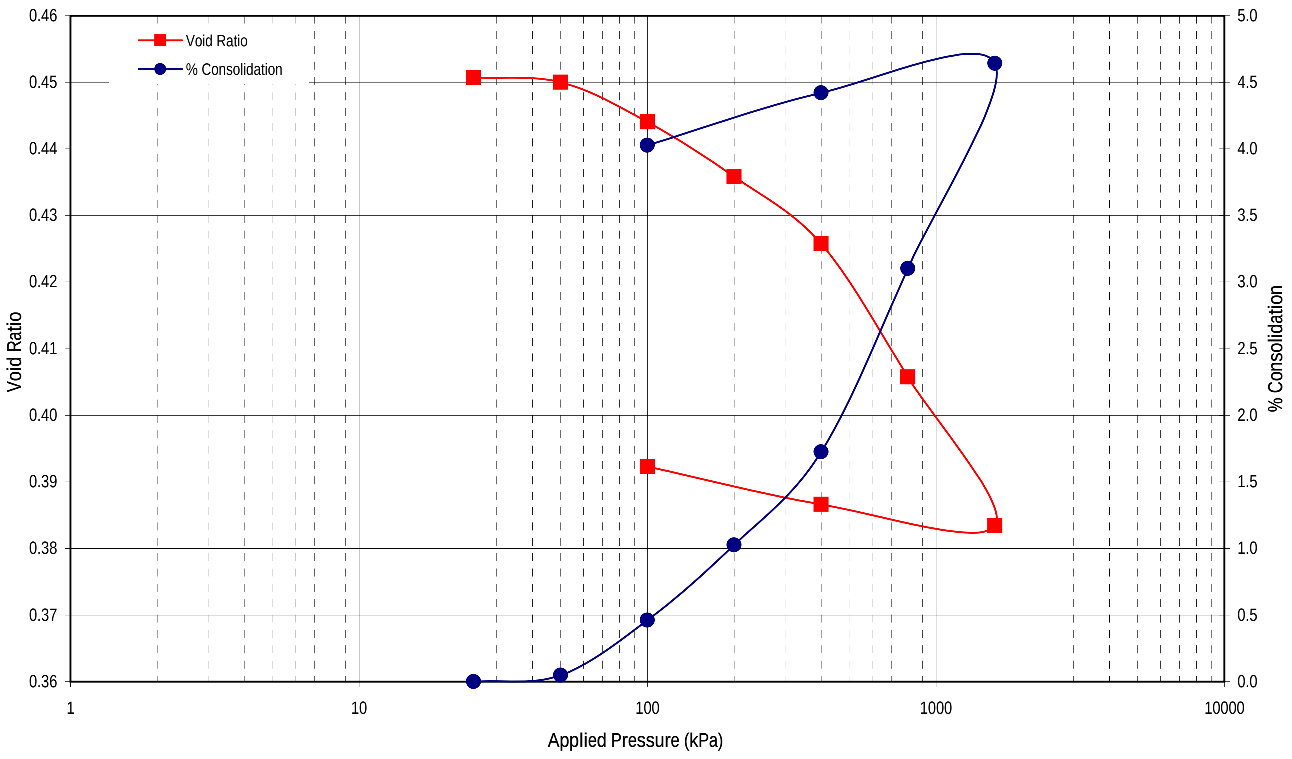
Test Date: 11/02/2008

Report Date: 20/02/2008

Client Id.: TPA 17

Depth (m): 7.5-7.9

Description:



Load (kPa)	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100				
Cc	0.002	0.020	0.027	0.034	0.066	0.074	0.005	0.009				
Cv (m^2/yr) t_{50}	61.02	45.08	187.78	108.91	268.15	118.08	34.51	4.30				
t_{90}	366.55	443.28	256.65	632.28	163.49	239.26	779.62	108.89				
Mv ($kPa^{-1}x10^{-3}$)	0.020	0.082	0.057	0.035	0.035	0.020	0.002	0.014				
C_a x 10^{-3}	0.5	0.8	1.0	1.5	1.9	2.3	0.2	0.5				
% Consolidation	0.0	0.5	1.0	1.7	3.1	4.6	4.4	4.0				

Wet Density (t/m^3):	2.11	Initial Moisture (%):	13.9	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.68	Initial Voids Ratio:	0.446	Initial Degree of Saturation (%):	83.8

Undisturbed sample supplied by the client

Remarks: Tested As Received

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd

Report No.: 801861-OED

Project: 077692009

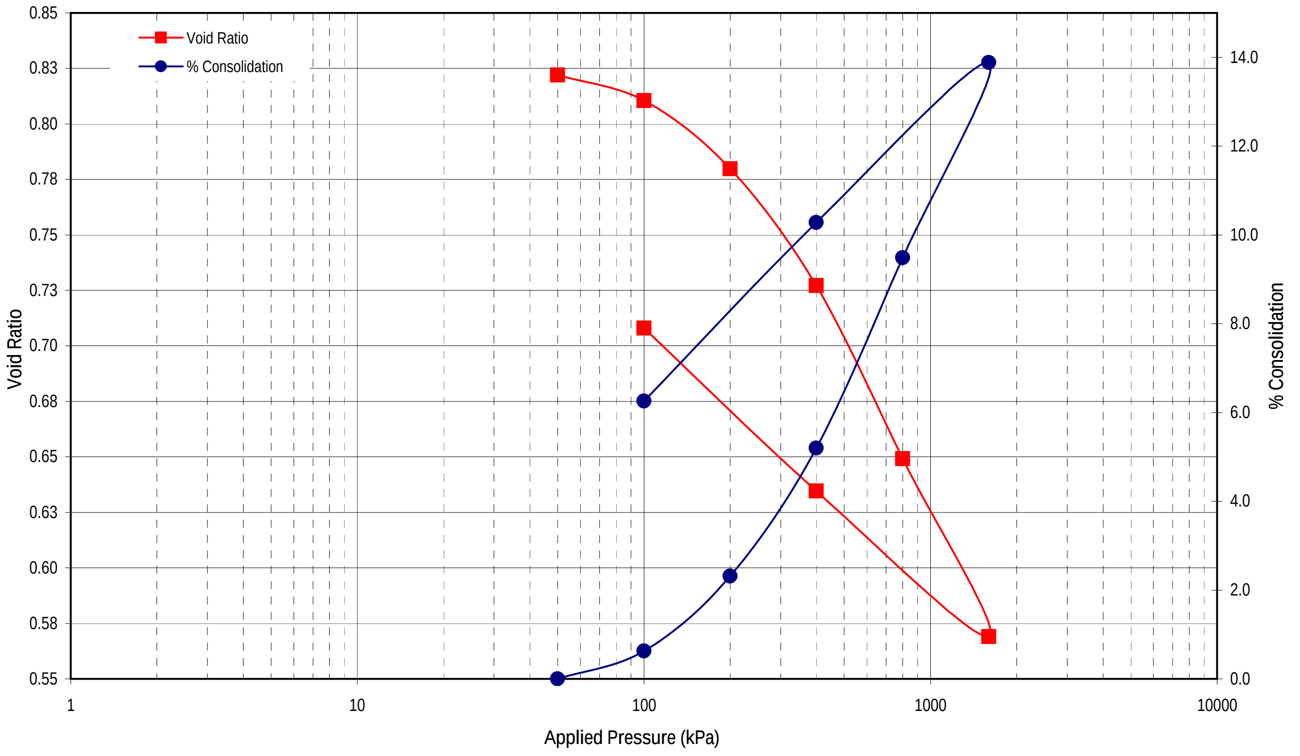
Test Date: 11/02/2008

Report Date: 26/02/2008

Client Id.: TPA 22

Depth (m): 1.5-1.9

Description:



Load (kPa)	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100					
Cc	0.038	0.102	0.174	0.259	0.266	0.109	0.122					
Cv (m^2/yr) t_{50}	1.65	0.42	0.23	0.13	0.09	0.12	0.04					
t_{90}	251.75	15.08	1.12	0.31	0.21	7.95	0.14					
Mv ($kPa^{-1}x10^{-3}$)	0.126	0.170	0.148	0.113	0.061	0.035	0.150					
C_a x 10^{-3}	1.5	1.7	4.0	2.2	5.3	3.6	2.9					
% Consolidation	0.6	2.3	5.2	9.5	13.9	10.3	6.3					

Wet Density (t/m^3): 1.95

Initial Moisture (%): 30.5

Test Condition: Inundated on load

Particle Density (t/m^3): 2.76

Initial Voids Ratio: 0.822

Initial Degree of Saturation (%): 101.1

Undisturbed sample supplied by the client

Remarks: Tested As Received

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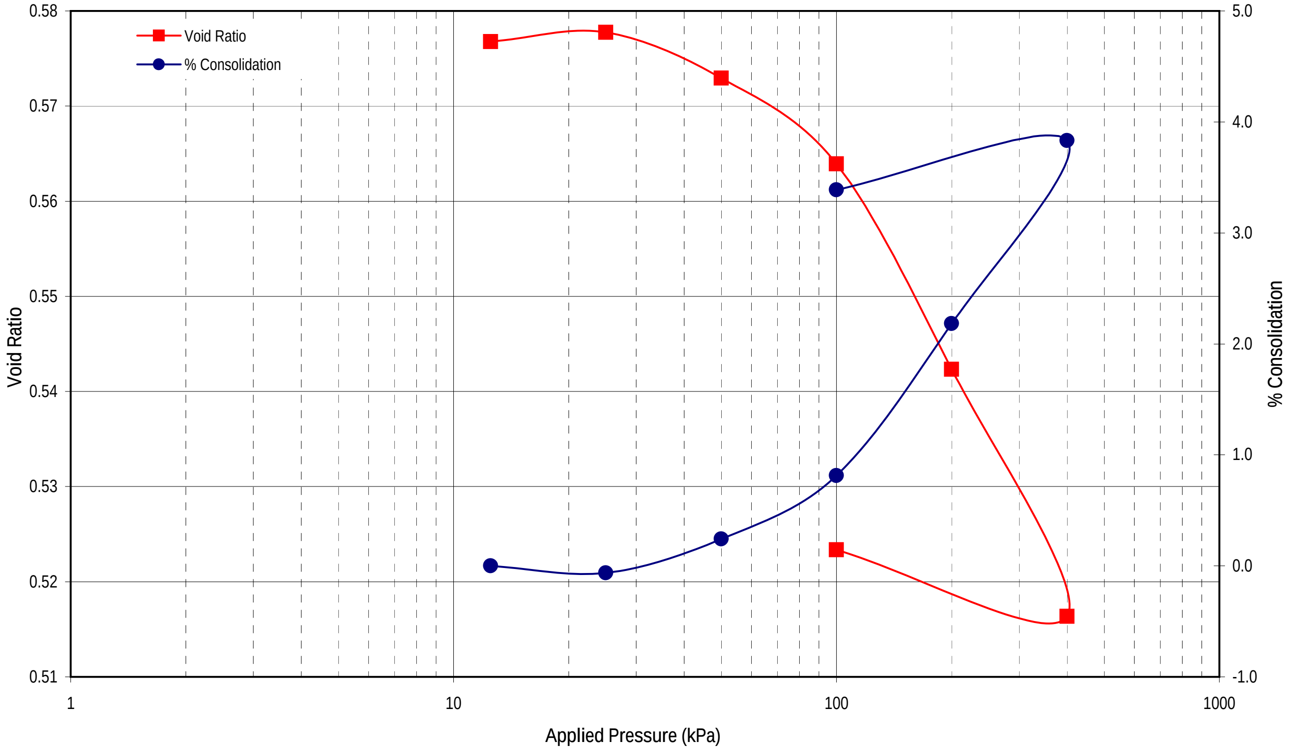
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd
Report No.: 801862-OED
Project: 077692009
Test Date: 9/02/2008
Report Date: 18/02/2008
Client Id.: TPA 22
Depth (m): 3.3-3.7
Description:



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-100						
Cc	-0.003	0.016	0.030	0.072	0.086	0.012						
Cv (m^2/yr) t_{50}	4.76	4.81	4.52	3.26	3.37	6.89						
t_{90}	54.53	52.41	27.16	4.46	4.82	43.21						
Mv (kPa^{-1}x10^{-3})	-0.049	0.122	0.115	0.138	0.084	0.015						
C_a x 10^{-3}	0.3	0.6	1.1	1.6	1.9	0.4						
% Consolidation	-0.1	0.2	0.8	2.2	3.8	3.4						

Wet Density (t/m^3): 2.06
Initial Moisture (%): 21.5
Test Condition: Inundated on load
Particle Density (t/m^3): 2.66
Initial Voids Ratio: 0.575
Initial Degree of Saturation (%): 100.3
Undisturbed sample supplied by the client
Remarks: Tested As Received
Page 1 of 1

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OEDOMETER TEST REPORT

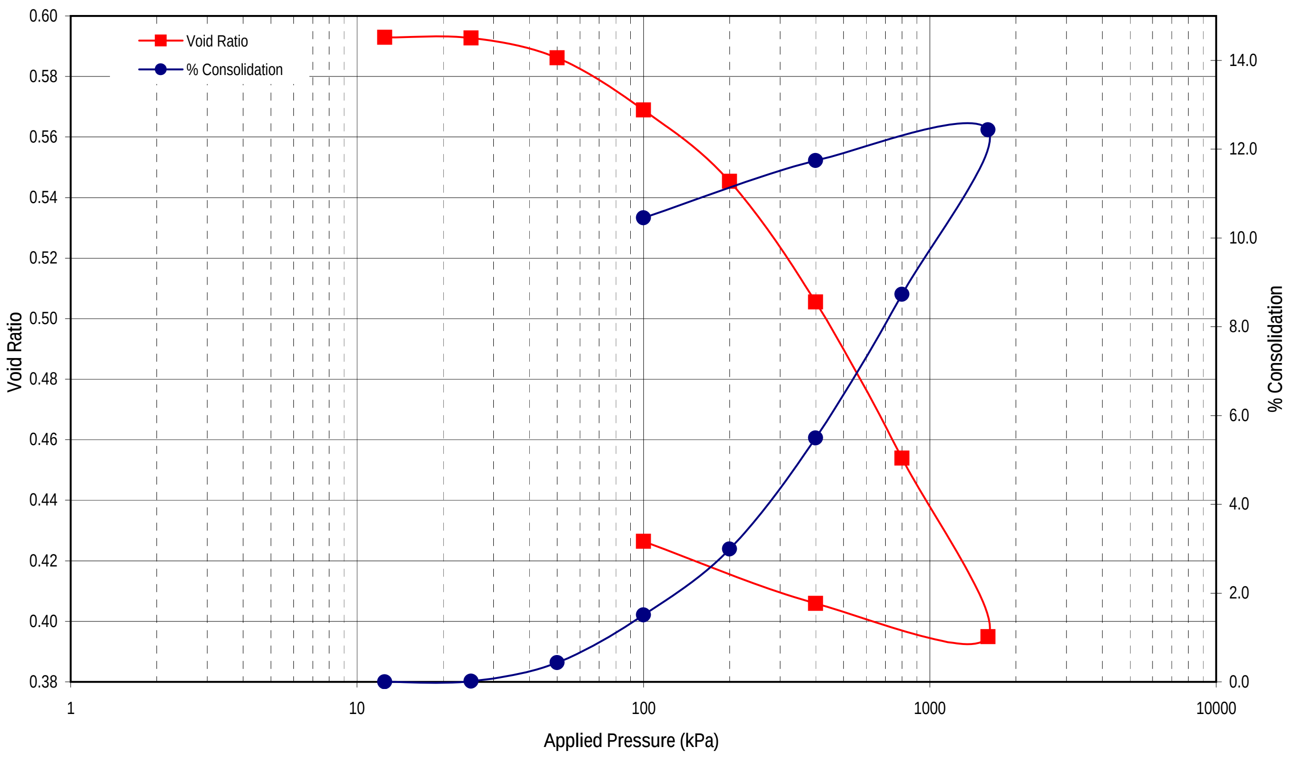
Test Method: AS1289.6.6.1, 3.5.1

Client: Golder Associates Pty Ltd
Report No.: 801863-OED

Project: 077692009
Test Date: 9/02/2008
Report Date: 25/02/2008

Client Id.: TPA 22
Depth (m): 4.5-4.9

Description:



Load (kPa)	12.5-25	25-50	50-100	100-200	200-400	400-800	800-1600	1600-400	400-100			
Cc	0.001	0.022	0.057	0.079	0.132	0.171	0.196	0.018	0.034			
Cv (m^2/yr) t_{50}	6.65	5.39	4.81	3.35	2.71	2.09	1.45	16.49	0.63			
t_{90}	44.51	236.22	45.45	46.74	22.16	31.99	3.27	166.41	61.56			
Mv ($kPa^{-1}x10^{-3}$)	0.012	0.166	0.216	0.151	0.129	0.086	0.051	0.007	0.049			
C_a x 10^{-3}	0.6	1.0	1.4	2.2	3.3	4.2	4.0	0.8	1.3			
% Consolidation	0.0	0.4	1.5	3.0	5.5	8.7	12.4	11.7	10.5			

Wet Density (t/m^3):	2.07	Initial Moisture (%):	24.8	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.64	Initial Voids Ratio:	0.592	Initial Degree of Saturation (%):	110.8
Undisturbed sample supplied by the client		Remarks:	Tested As Received		Page 1 of 1

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client: Golder Associates Pty Ltd
Report No. 801523-G

Project: 077692009
Test Date: 8/2/08
Report Date: 14/2/08

Sample No.	801523	801526	801528	801531	801532
Client ID:	TPA 1	TPA 1	TPA 2	TPA 3	TPA 3
Depth (m):	1.25-1.65	5.5-5.95	10.5-1.95	1.5-1.78	3.0-3.4
Moisture (%)	22.5	16.0	21.2	14.3	25.6

AS SIEVE SIZE (mm)	**PERCENT PASSING**				
26.5					
19					
9.5	100				
4.75	99	100			
2.36	99	99	100	100	100
1.18	97	97	99	99	99
0.600	95	91	98	97	99
0.425	93	89	97	96	99
0.300	90	88	96	96	98
0.150	77	80	95	94	98
0.075	60	39	78	93	91

Sample/s supplied by the client

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Form Number: GT005-5/5

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client: Golder Associates Pty Ltd
Project: 077692009

Report No. 801533-G
Test Date: 11/2/08
Report Date: 14/2/08

Sample No.	801533	801537	801538	801542
Client ID:	TPA 3	TPA 4	TPA 4	TPA 6
Depth (m):	6.0-6.4	4.5-4.95	9.0-9.45	7.0-7.3
Moisture (%)	16.0	12.9	14.4	23.1

AS SIEVE SIZE (mm)	**PERCENT PASSING**			
37.5				
26.5				
19				
9.5		100	100	
4.75		93	93	
2.36	100	81	78	
1.18	99	68	61	100
0.600	98	48	40	99
0.425	98	38	33	99
0.300	98	30	28	99
0.150	95	20	22	98
0.075	40	16	18	96

Sample/s supplied by the client

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N ATA Accredited Laboratory Number 9926
Form Number: GT005-5/4

Authorised Signatory
James Russell
J. Russell
Manager

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client:	Golder Associates Pty Ltd	Report No.	802319-G
Project:	077692009	Test Date:	14/02/08 – 22/02/08
		Report Date:	04/03/08

Sample No.	802319	802320	802321	802324
Client ID:	TPA 1	TPA 5	TPA 7	TPA 7
Depth (m):	10.0 – 10.45	11.0 – 11.45	2.5 – 2.8	7.0 – 7.45
Moisture (%)	19.5	10.9	22.6	19.7

AS SIEVE SIZE (mm)	**PERCENT PASSING**			
37.5				
26.5				
19		100		100
9.5		99		96
4.75	100	93		95
2.36	99	69	100	93
1.18	98	39	99	91
0.600	95	24	99	90
0.425	92	20	99	90
0.300	86	16	99	90
0.150	69	10	99	88
0.075	40	7	97	57

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client:	Golder Associates Pty Ltd	Report No.	802326-G
Project:	077692009	Test Date:	14/02/08 – 22/02/08
		Report Date:	04/03/08

Sample No.	802326	802328	802330	802333
Client ID:	TPA 7	TPA 8	TPA 8	TPA 12
Depth (m):	11.5 – 11.95	1.0 – 1.4	8.5 – 8.95	2.5 – 2.95
Moisture (%)	24.8	18.1	12.9	20.2

AS SIEVE SIZE (mm)	**PERCENT PASSING**			
37.5				
26.5				
19			100	
9.5			99	
4.75			95	
2.36	100		74	
1.18	99	100	50	
0.600	99	99	38	100
0.425	99	99	34	99
0.300	90	96	31	99
0.150	97	88	26	98
0.075	65	76	24	92

Sample/s supplied by the client

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Form Number: GT005-5/4

PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client: Golder Associates Pty Ltd
Project: 077692009

Report No. 802337-G
Test Date: 14/02/08 – 22/02/08
Report Date: 04/03/08

Sample No.	802337	802338	802339	802340
Client ID:	TPA 12	TPA 12	TPA 12	TPA 12
Depth (m):	8.5 – 8.95	10.0 – 10.45	11.5 – 11.95	13.0 – 13.45
Moisture (%)	19.0	20.2	18.6	20.8

AS SIEVE SIZE (mm)	**PERCENT PASSING**			
37.5				
26.5				
19				100
9.5		100	100	99
4.75	100	98	99	99
2.36	99	93	95	98
1.18	95	81	84	88
0.600	80	54	52	50
0.425	66	36	38	32
0.300	42	24	30	24
0.150	21	16	24	20
0.075	15	11	21	19

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client: Golder Associates Pty Ltd

Project: 077692009

Report No. 802341-G

Test Date: 14/02/08 – 22/02/08
Report Date: 04/03/08

Sample No.	802341	802344	802345	802346
Client ID:	TPA 13	TPA 13	TPA 13	TPA 13
Depth (m):	4.0 – 4.4	9.5 – 9.95	11.0 – 11.45	12.5 – 12.95
Moisture (%)	46.3	18.1	11.9	22.6

AS SIEVE SIZE (mm)	**PERCENT PASSING**			
37.5				
26.5			100	
19		100	98	
9.5		93	83	
4.75		81	70	
2.36		68	57	100
1.18		60	42	99
0.600		47	30	95
0.425		37	25	85
0.300	100	26	20	60
0.150	99	15	15	15
0.075	95	12	11	9

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client: Golder Associates Pty Ltd
Project: 077692009

Report No. 801848-G
Test Date: 12/02/08 – 14/02/08
Report Date: 26/02/08

Sample No.	801848	801850	801851	801852	801853
Client ID:	TPA 17	TPA 17	TPA 17	TPA 16	TPA 16
Depth (m):	6.2 – 6.6	11.5 – 11.95	14.5 – 14.95	8.5 – 8.95	11.5 – 11.95
Moisture (%)	22.3	15.4	21.0	22.0	19.5

AS SIEVE SIZE (mm)	**PERCENT PASSING**				
26.5					
19					
9.5					
4.75		100		100	100
2.36		99		98	99
1.18		96	100	94	99
0.600	100	89	98	88	94
0.425	99	74	97	85	84
0.300	99	54	93	84	62
0.150	97	32	82	80	24
0.075	82	25	71	74	14

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client:	Golder Associates Pty Ltd	Report No.	801855-G
Project:	077692009	Test Date:	12/02/08 – 14/02/08
		Report Date:	26/02/08

Sample No.	801855	801856	801857	801858	801860
Client ID:	TPA 20	TPA 20	TPA 20	TPA 20	TPA 21
Depth (m):	6.0 – 6.45	9.0 – 9.42	12.0 – 12.5	15.0 – 15.43	13.0 – 13.45
Moisture (%)	17.9	16.4	16.1	16.2	27.6

AS SIEVE SIZE (mm)	**PERCENT PASSING**				
26.5					
19					
9.5	100			100	
4.75	99			96	100
2.36	99		100	95	99
1.18	99		99	91	98
0.600	98		96	74	96
0.425	98	100	93	60	96
0.300	97	99	88	44	95
0.150	89	85	69	19	94
0.075	75	44	51	12	85

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS1289 3.6.1, 2.1.1

Client: Golder Associates Pty Ltd

Project: 077692009

Report No. 801864-G

Test Date: 12/02/08 – 14/02/08
Report Date: 26/02/08

Sample No.	801864	801865	801869	801870	801871
Client ID:	TPA 22	TPA 22	TPA 23	TPA 23	TPA 23
Depth (m):	7.5 – 7.95	10.5 – 10.95	7.5 – 7.95	9.0 – 9.45	10.5 – 10.95
Moisture (%)	13.3	21.5	22.8	15.9	18.3

AS SIEVE SIZE (mm)	**PERCENT PASSING**				
26.5					
19					100
9.5	100			100	99
4.75	97			99	98
2.36	89			97	94
1.18	57			92	90
0.600	23			77	87
0.425	19	100		66	87
0.300	16	99	100	58	86
0.150	12	99	99	50	85
0.075	10	74	87	35	60

Sample/s supplied by the client

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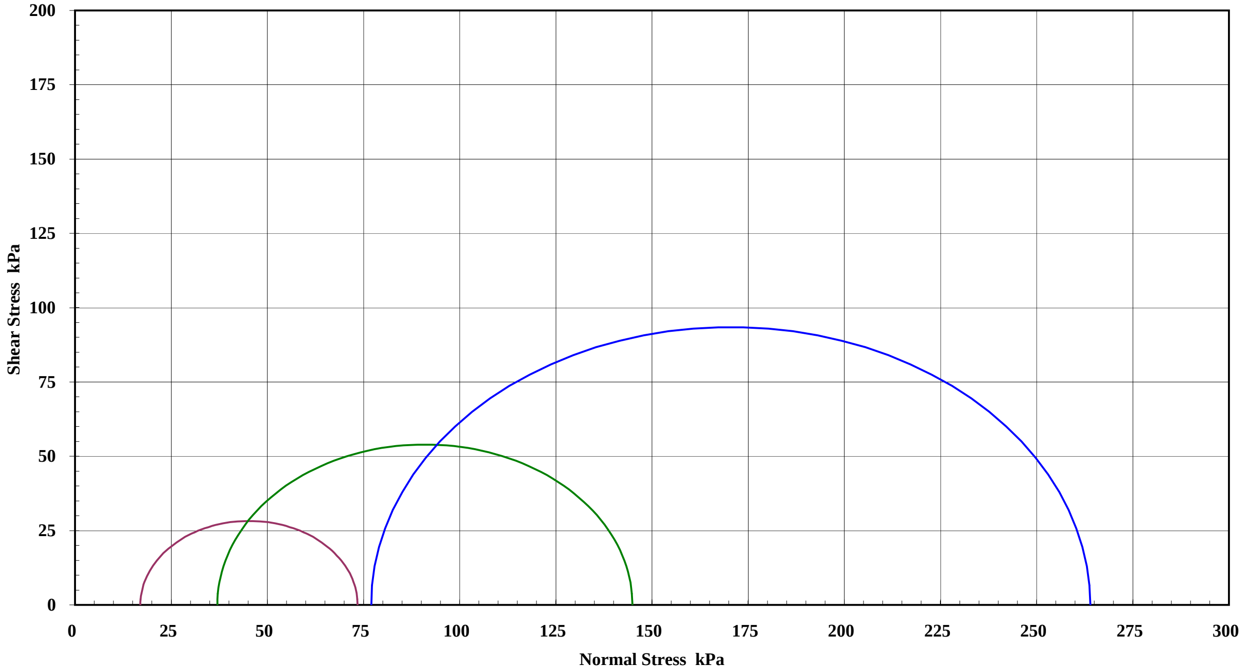
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801523-CU
Project:	077692009	**Test Date:**	18/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 1	**Depth (m):**	1.25-1.65
Description:	(CH) SILTY CLAY- grey		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	3.4	10.1	6.5
Angle of Shear Resistance Φ' (Degrees) :	34.2	29.8	31.2

Cell Pressures (kPa):		30-60-120	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			Moisture Contents
Initial Height :	96.3	mm	Initial Moisture
Initial Diameter :	46.3	mm	22.2 %
Wet Density :	2.09	t/m^3	Final Moisture
Dry Density :	1.71	t/m^3	
Rate of Strain:	0.009	%/min	20.3 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		Deviator Stress	Strain
σ'$_1$	σ'$_3$		
73 kPa	17 kPa	56 kPa	1.03 %
145 kPa	37 kPa	108 kPa	2.37 %
264 kPa	77 kPa	187 kPa	5.45 %

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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Authorised Signatory
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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801523-CU

Project: 077692009

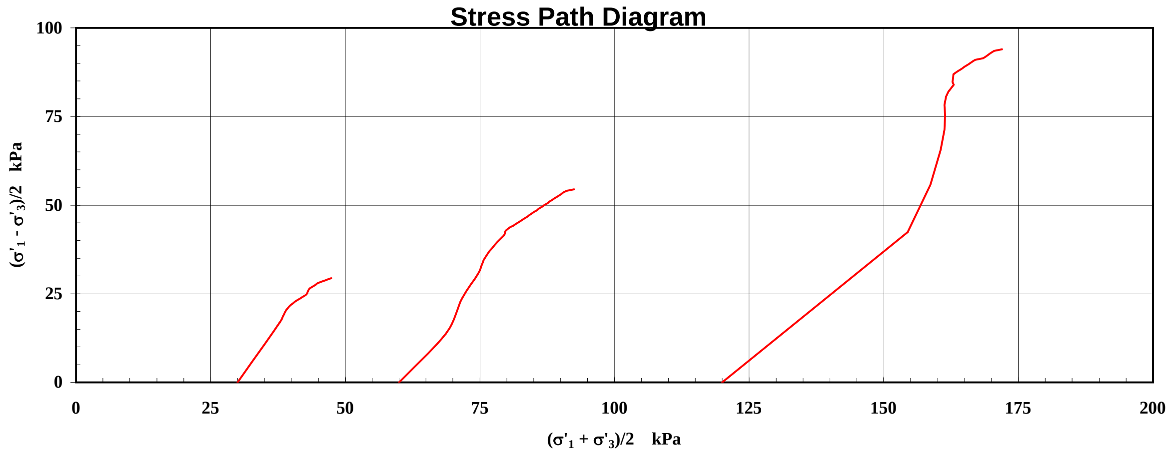
Test Date: 18/01/2008

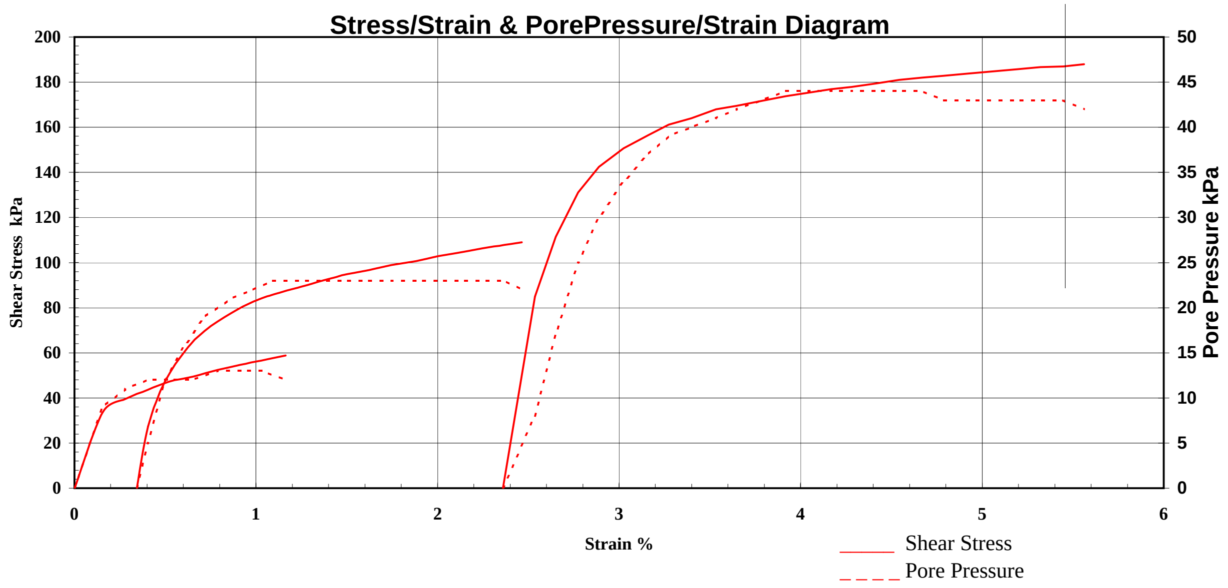
Report Date: 5/02/2008

Client Id.: TPA 1

Depth (m): 1.25-1.65

Description (CH) SILTY CLAY- grey





Sample Type: Single Individual Undisturbed Sample

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801523-CU
Project:	077692009	**Test Date:**	18/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 1	**Depth (m):**	1.25-1.65

Description (CH) SILTY CLAY- grey

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009 | AFTER TEST
LAB SAMPLE No. 801009 | DATE: 22/1/08
BH: TPA 1 | DEPTH: 1.25-1.65

Sample Type: Single Individual Undisturbed Sample | Remarks: Tested as Received

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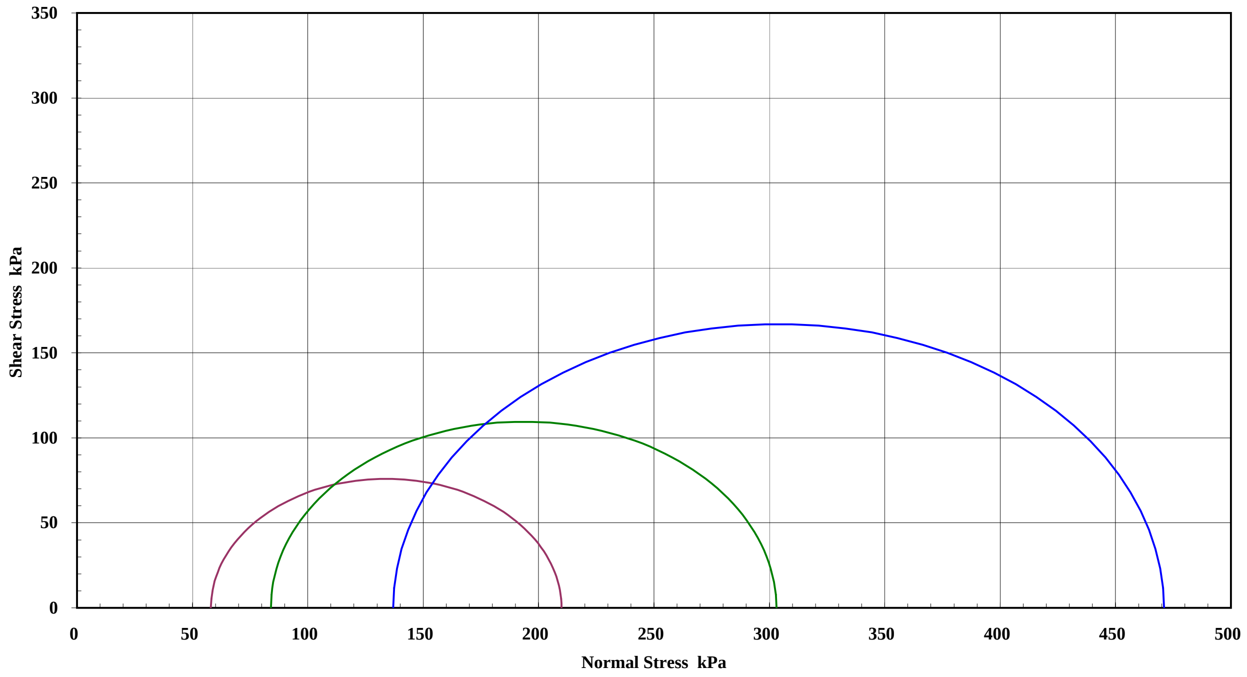
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801524-CU
Project:	077692009	**Test Date:**	24/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 1	**Depth (m):**	2.5-2.9

Description: (ML) SANDY SILT- grey brown

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	0.6	10.4	6.2
Angle of Shear Resistance **Φ'** (Degrees) :	34.3	31.3	32.2

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				***FAILURE DETAILS***			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
				σ'_1	σ'_3		
Initial Height :	96.1	mm	Initial Moisture				
Initial Diameter :	47.8	mm	22.4 %	210 kPa	58 kPa	152 kPa	1.91 %
Wet Density :	2.01	t/m^3	Final Moisture	303 kPa	84 kPa	219 kPa	3.01 %
Dry Density :	1.64	t/m^3		471 kPa	137 kPa	334 kPa	5.24 %
Rate of Strain:	0.009	%/min	22.4 %				
B Response:	98	%					

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801524-CU

Project: 077692009

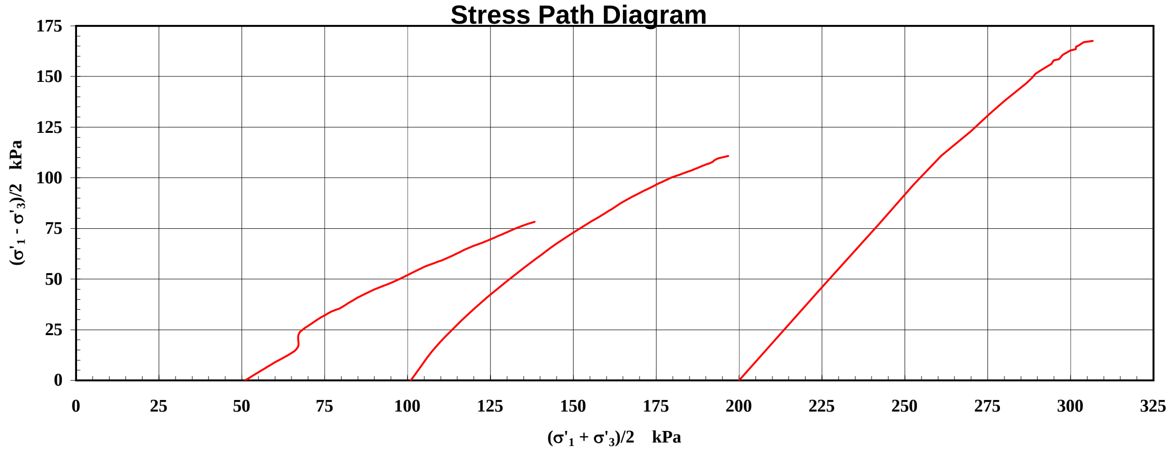
Test Date: 24/01/2008

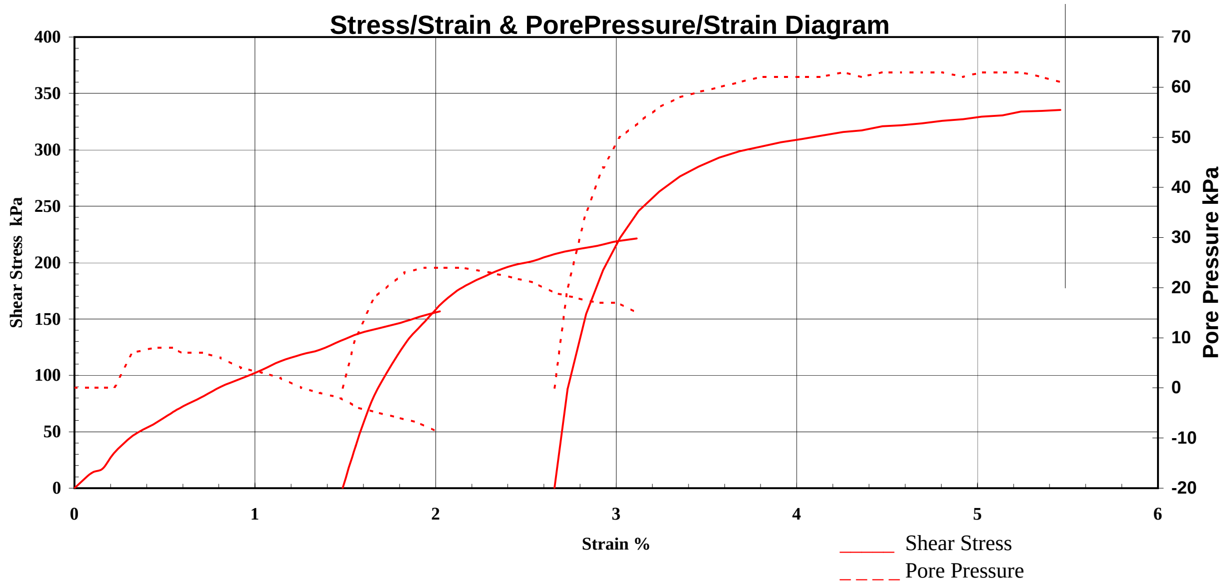
Report Date: 5/02/2008

Client Id.: TPA 1

Depth (m): 2.5-2.9

Description (ML) SANDY SILT- grey brown





Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801524-CU
Project:	077692009	**Test Date:**	24/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 1	**Depth (m):**	2.5-2.9

Description (ML) SANDY SILT- grey brown

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 801524
BH: TPA 1
AFTER TEST
DATE: 29/1/08
DEPTH: 2.5-2.9

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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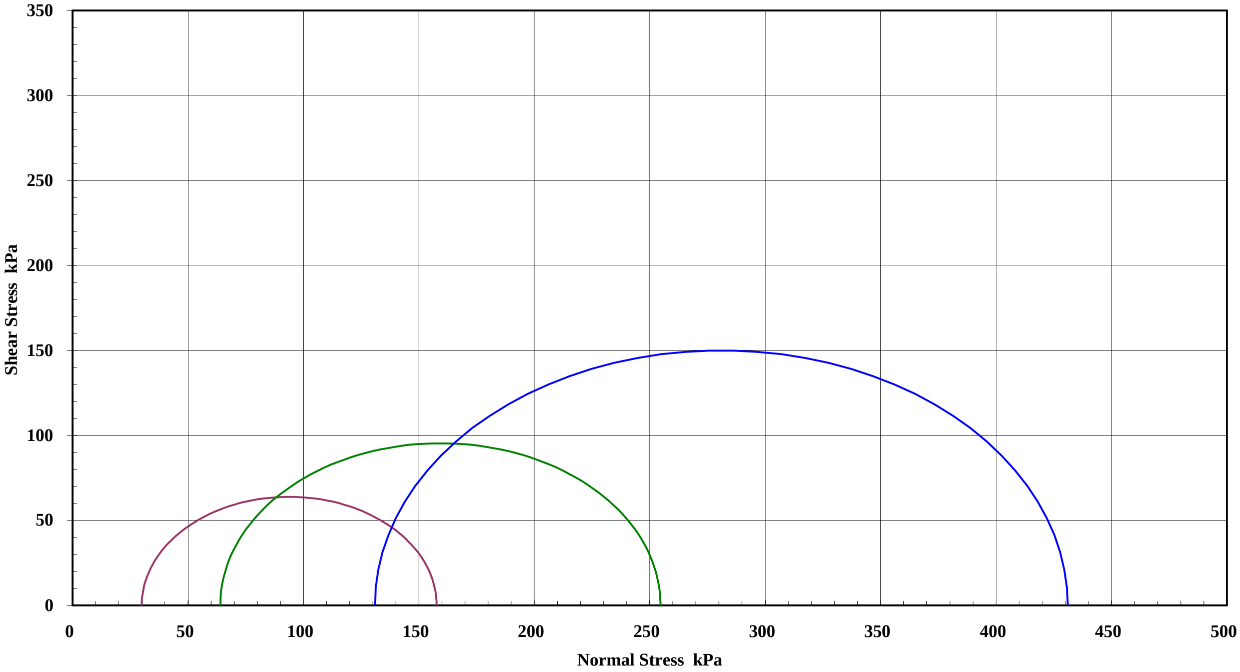
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801525-CU
Project:	77692009	**Test Date:**	29/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA1	**Depth (m):**	4.0-4.32

Description: (CH) GARVELLY SANDY CLAY-grey orange brown

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	21.3	26.6	24.0
Angle of Shear Resistance **Φ'** (Degrees) :	28.7	26.7	27.3

Cell Pressures (kPa):	60-120-240	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.2	mm	Initial Moisture
Initial Diameter :	47.9	mm	19.3 %
Wet Density :	2.03	t/m^3	Final Moisture
Dry Density :	1.70	t/m^3	
Rate of Strain:	0.008	%/min	24.3 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
158 kPa	30 kPa	128 kPa	1.64 %
255 kPa	64 kPa	191 kPa	2.83 %
431 kPa	131 kPa	300 kPa	5.13 %

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801525-CU

Project: 77692009

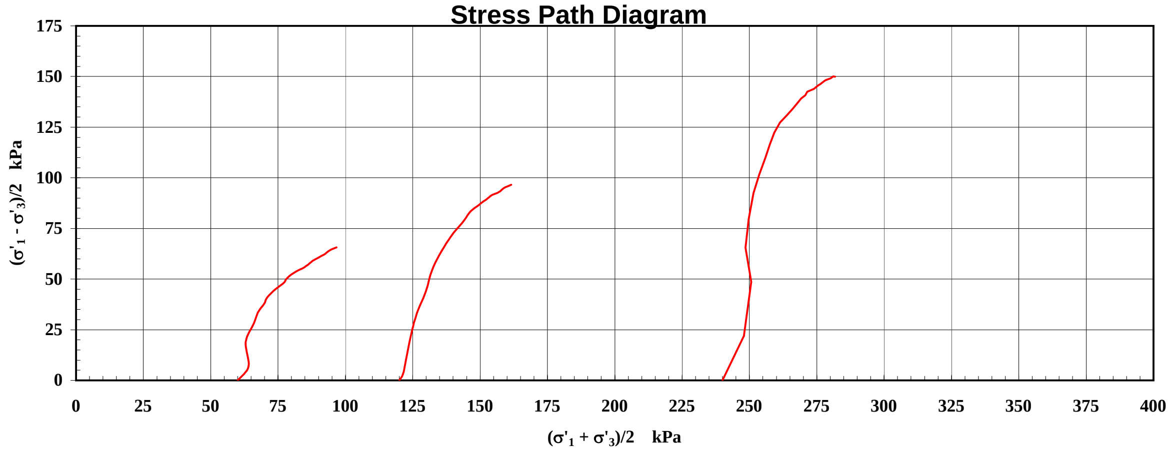
Test Date: 29/01/2008

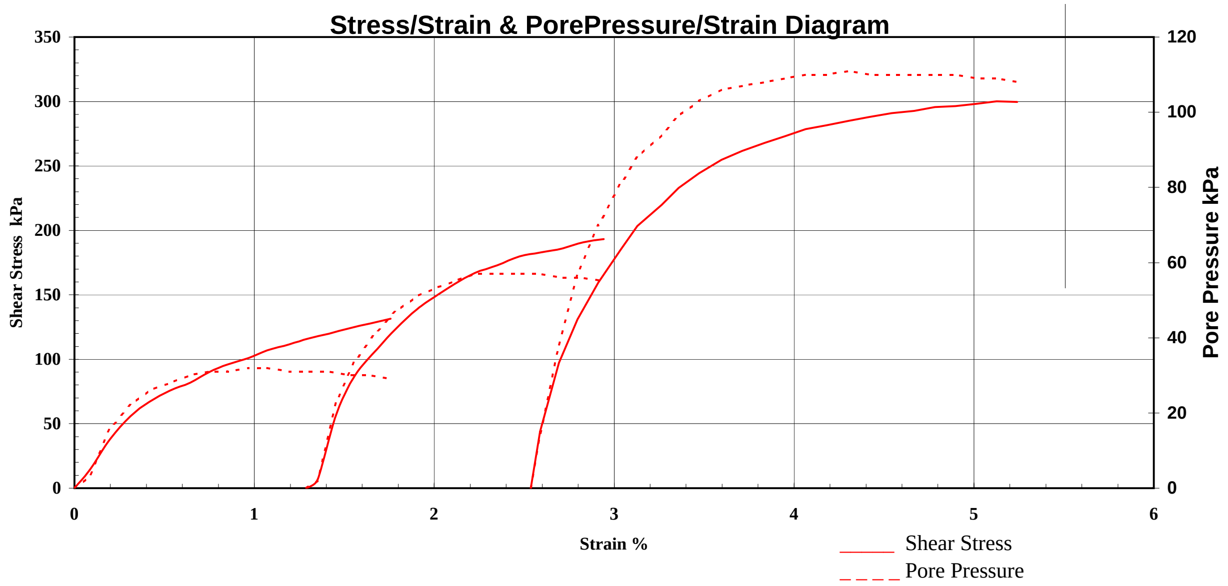
Report Date: 5/02/2008

Client Id.: TPA1

Depth (m): 4.0-4.32

Description (CH) GARVELLY SANDY CLAY-grey orange brown





Sample Type: Single Individual Undisturbed Sample

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801525-CU
Project:	77692009	**Test Date:**	29/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA1	**Depth (m):**	4.0-4.32

Description (CH) GARVELLY SANDY CLAY-grey orange brown

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd

Report No.: 801529-UU

Project: 77692009

Test Date: 23/02/2008

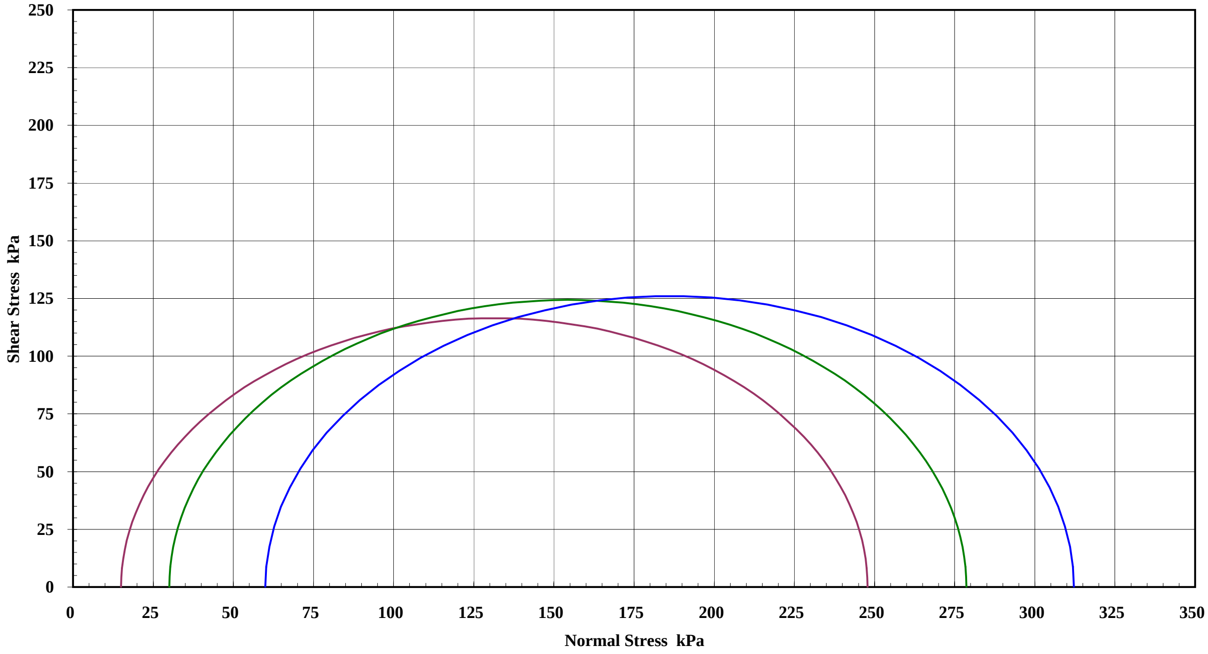
Report Date: 6/02/2008

Client Id.: TPA2

Depth (m): 1.5-1.8

Description: (CH) CLAY-grey brown

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	75.7	116.0	97.1
Angle of Shear Resistance Φ (Degrees) :	20.2	3.2	9.7

Cell Pressures (kPa): 15-30-60

Failure Criteria: Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details			Moisture Contents
Initial Height :	96.2	mm	Initial Moisture
Initial Diameter :	47.8	mm	24.5 %
Wet Density :	2.06	t/m^3	Final Moisture
Dry Density :	1.66	t/m^3	
Rate of Strain:	1.040	%/min	24.5 %

FAILURE DETAILS

Principal Stresses		Deviator Stress	Strain
σ_1	σ_3		
248 kPa	15 kPa	233 kPa	4.16 %
279 kPa	30 kPa	249 kPa	6.68 %
312 kPa	60 kPa	252 kPa	9.09 %

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as received

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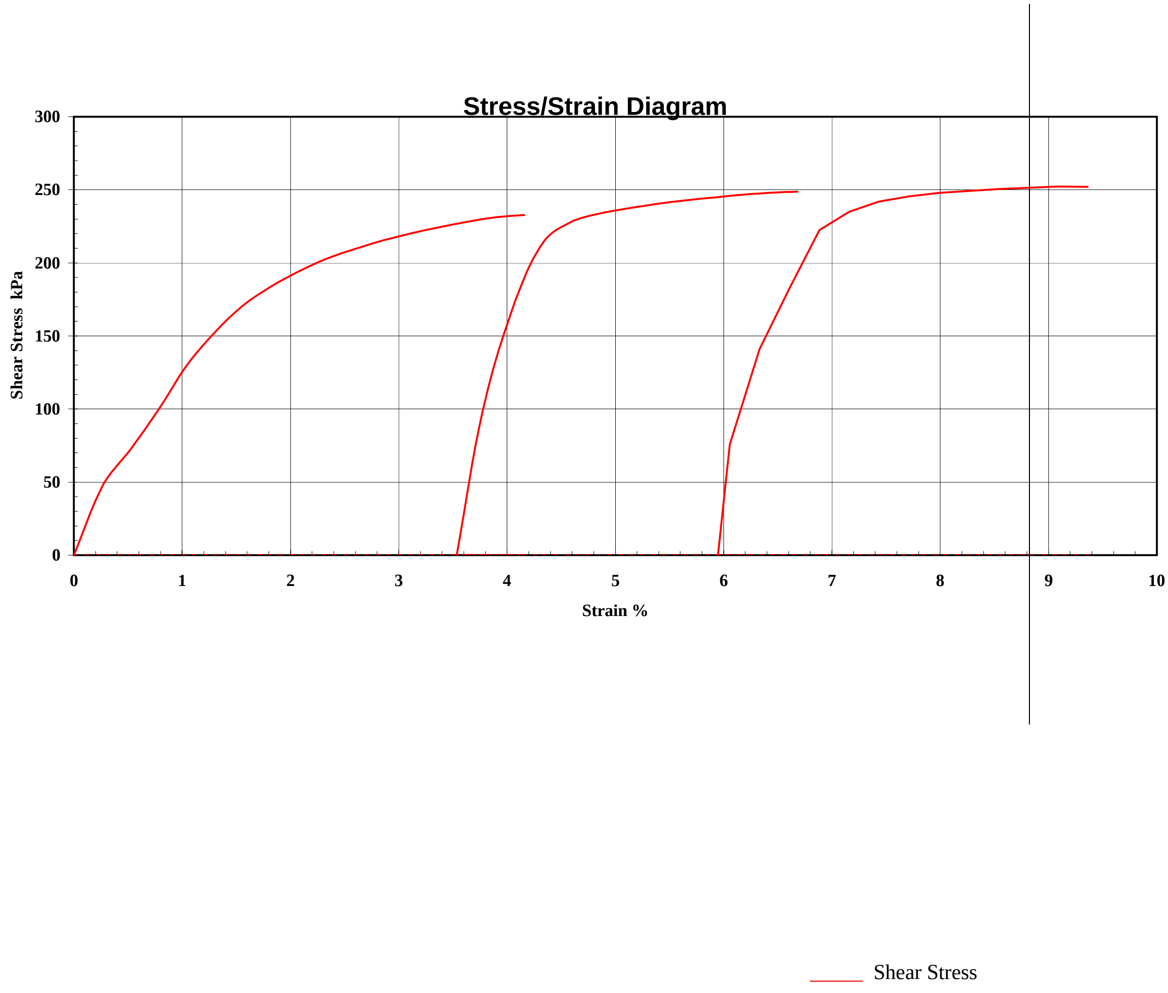
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801529-UU
Project:	77692009	**Test Date:**	23/02/2008
		Report Date:	6/02/2008
Client Id.:	TPA2	**Depth (m):**	1.5-1.8
Description:	(CH) CLAY-grey brown		



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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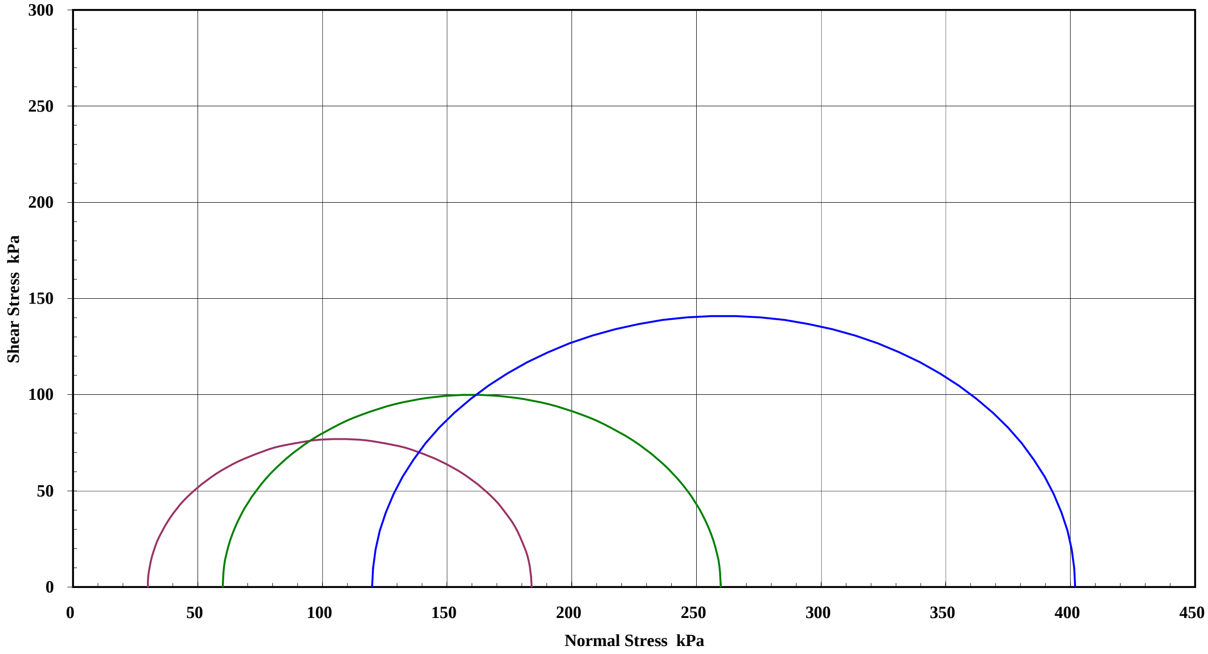
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd
Report No.: 801530-UU
Project: 77692009
Test Date: 23/01/2008
Report Date: 6/02/2008
Client Id.: TPA2
Depth (m): 3.0-3.4
Description: (MH) SANDY SILT-brown

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	34.0	38.3	36.3
Angle of Shear Resistance Φ (Degrees) :	25.7	24.0	24.5

Cell Pressures (kPa): 30-60-120
Failure Criteria: Peak Shear Stress

SAMPLE & TEST DETAILS				FAILURE DETAILS			
Sample Details			Moisture Contents	Principal Stresses		Deviator Stress	Strain
				σ_1	σ_3		
Initial Height :	96.2	mm	Initial Moisture				
Initial Diameter :	47.6	mm	19.6 %	184 kPa	30 kPa	154 kPa	4.57 %
Wet Density :	2.01	t/m^3	Final Moisture	260 kPa	60 kPa	200 kPa	7.48 %
Dry Density :	1.68	t/m^3		402 kPa	120 kPa	282 kPa	12.51 %
Rate of Strain:	1.040	%/min	19.6 %				

Sample Type: Single Individual Undisturbed Specimen
Remarks: Tested as received

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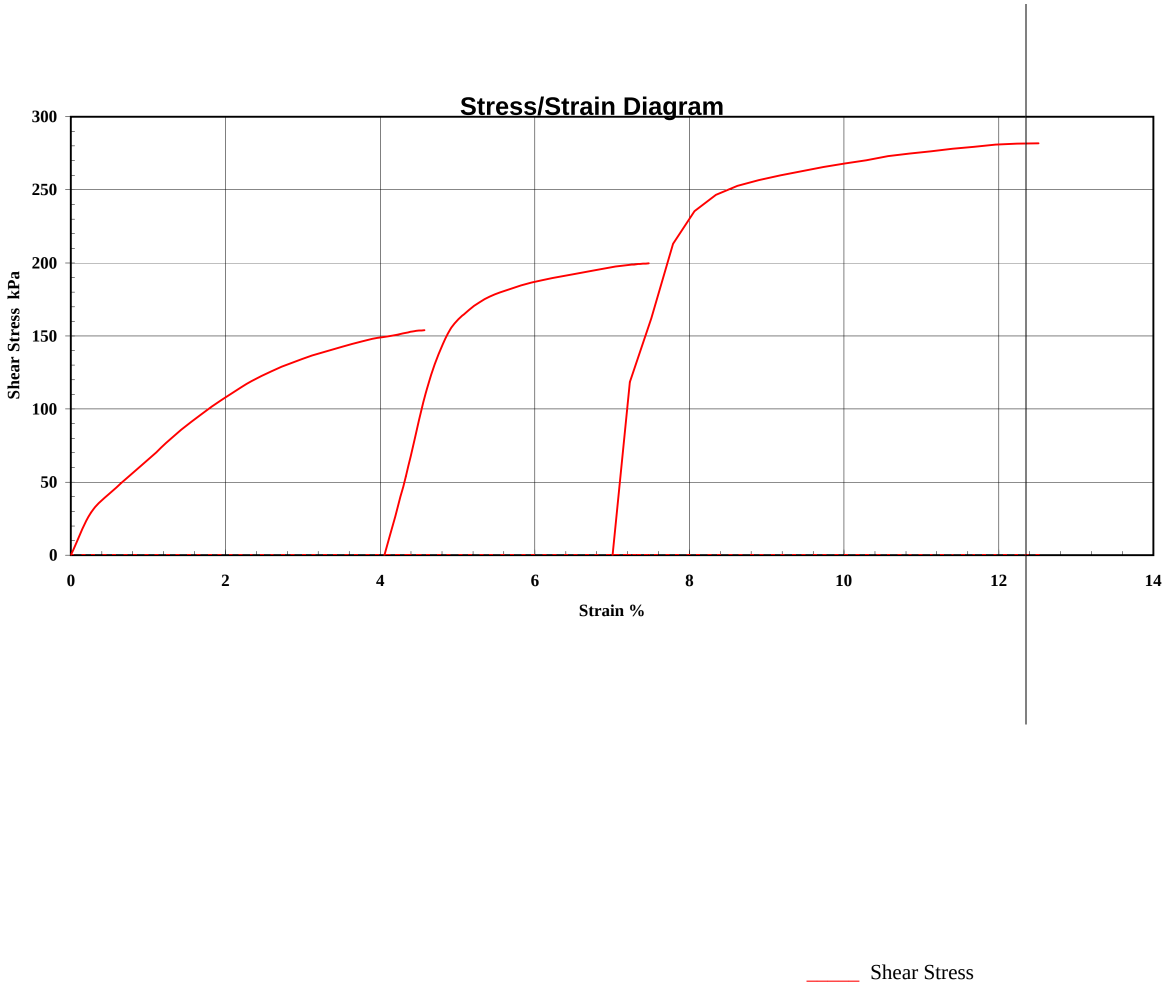
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801530-UU
Project:	77692009	**Test Date:**	23/01/2008
		Report Date:	6/02/2008
Client Id.:	TPA2	**Depth (m):**	3.0-3.4
Description:	(MH) SANDY SILT-brown		



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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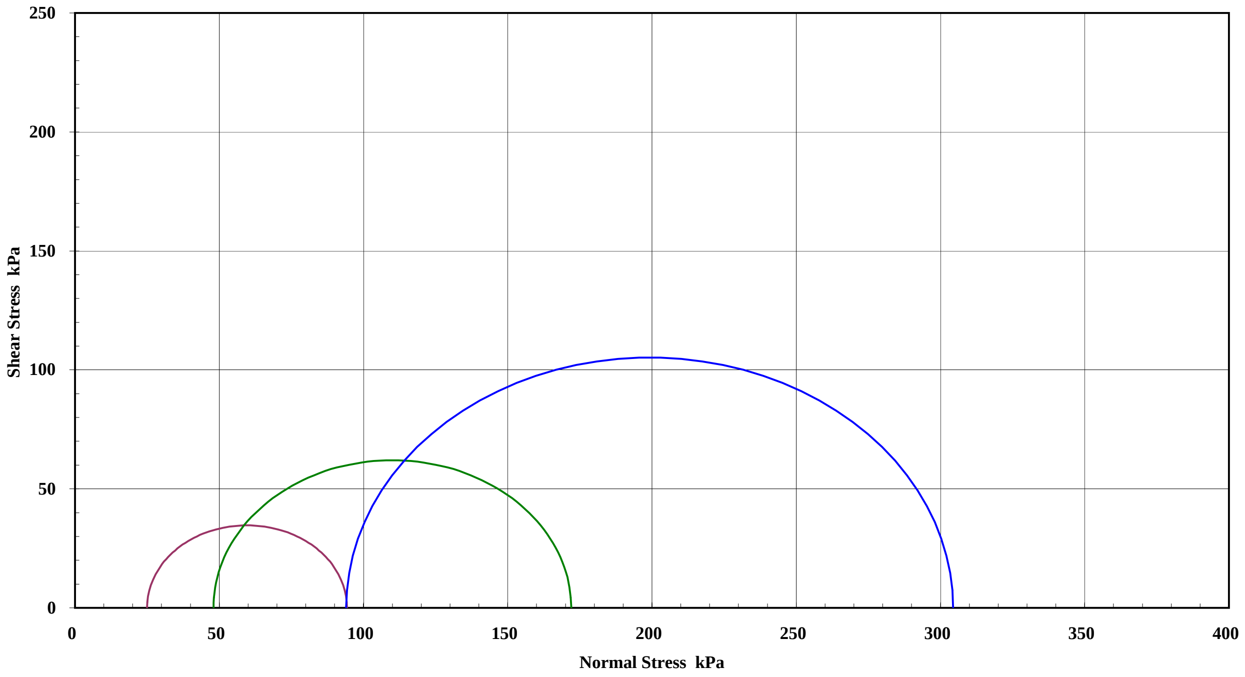
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801531-CU
Project:	077692009	**Test Date:**	2/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA 3	**Depth (m):**	1.5-1.78

Description: (CH) CLAY-grey green brown

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	2.8	10.0	6.3
Angle of Shear Resistance Φ' (Degrees) :	32.9	29.0	30.2

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				*FAILURE DETAILS*			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
			Initial Moisture	σ'_1	σ'_3		
Initial Height :	96.3	mm	23.8 %	94 kPa	25 kPa	69 kPa	2.75 %
Initial Diameter :	46.4	mm	Final Moisture	172 kPa	48 kPa	124 kPa	5.13 %
Wet Density :	1.96	t/m^3		304 kPa	94 kPa	210 kPa	7.91 %
Dry Density :	1.58	t/m^3					
Rate of Strain:	0.008	%/min	23.7 %				
B Response:	99	%					

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801531-CU

Project: 077692009

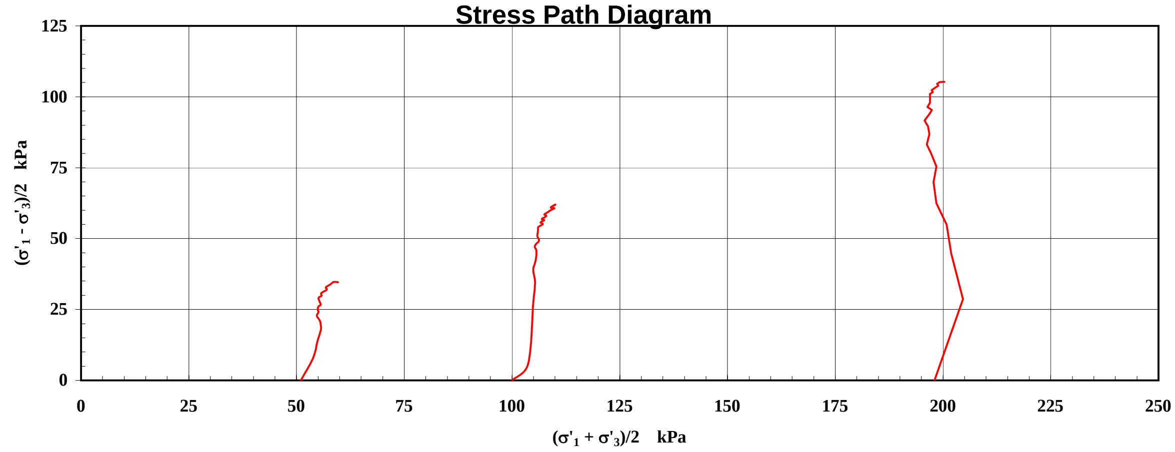
Test Date: 2/02/2008

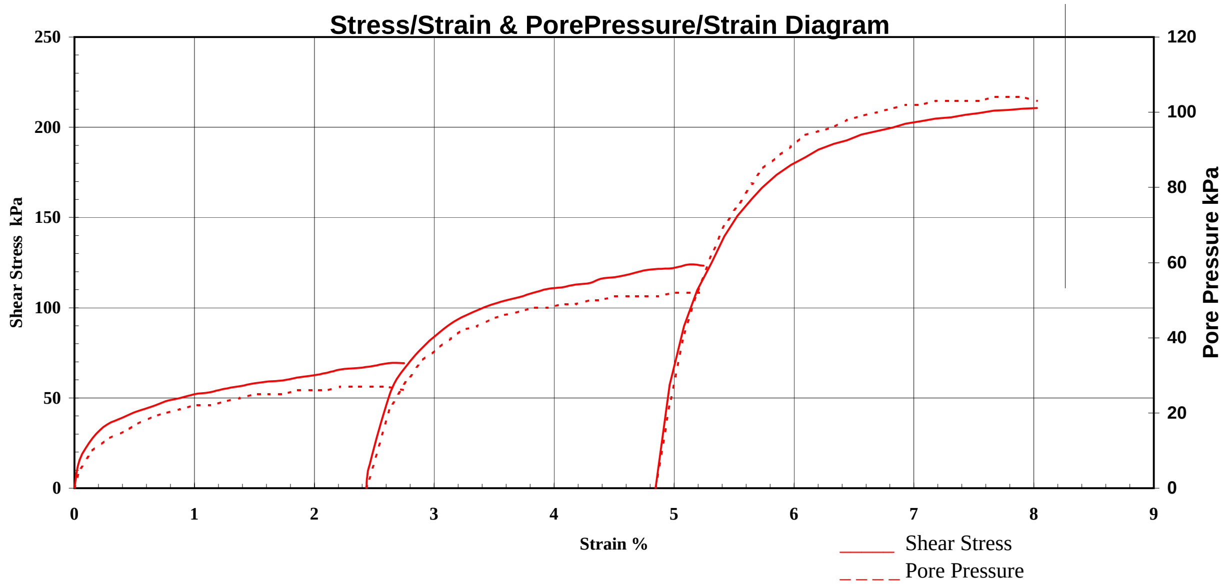
Report Date: 7/02/2008

Client Id.: TPA 3

Depth (m): 1.5-1.78

Description (CH) CLAY-grey green brown





Sample Type: Single Individual Undisturbed Sample

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801531-CU
Project:	077692009	**Test Date:**	2/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA 3	**Depth (m):**	1.5-1.78

Description (CH) CLAY-grey green brown

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 801531
BH: TPA 3
AFTER TEST
DATE: 5/2/08
DEPTH: 1.5-1.78

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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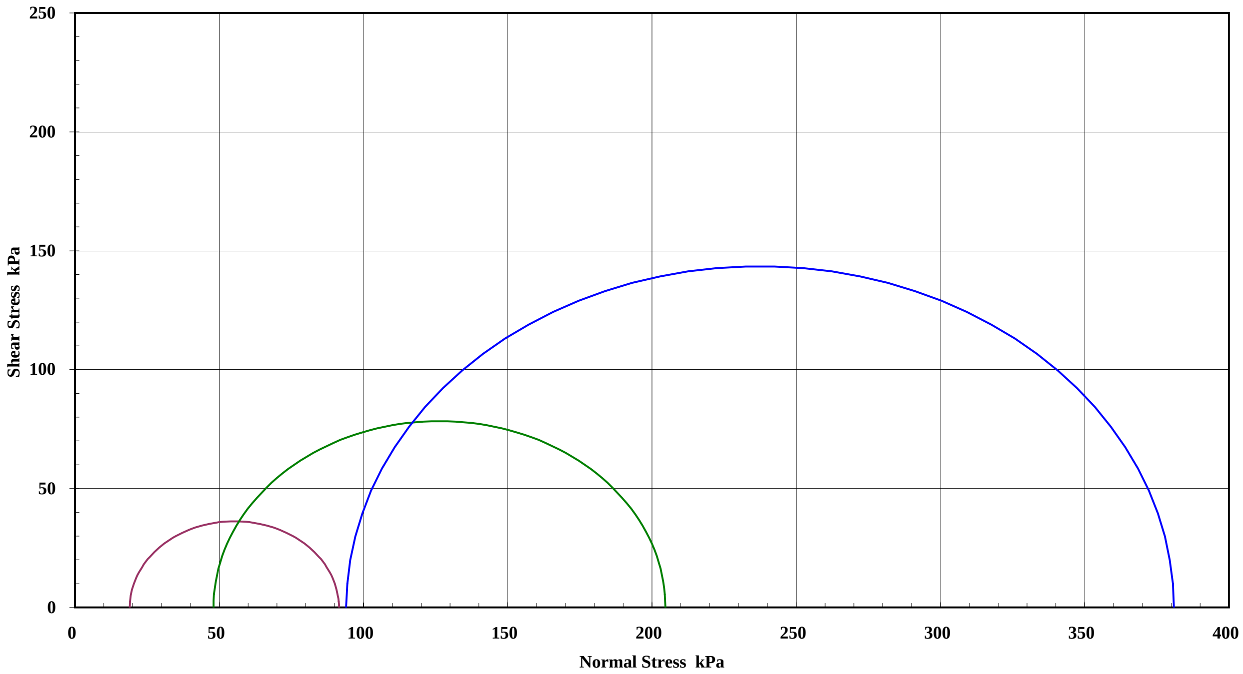
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801532-CU
Project:	077692009	**Test Date:**	22/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 3	**Depth (m):**	3.0-3.4

Description: (MH) SANDY SILT-grey brown

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	4.4	5.3	4.8
Angle of Shear Resistance Φ' (Degrees) :	36.3	35.9	36.0

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.2	mm	Initial Moisture
Initial Diameter :	47.2	mm	24.1 %
Wet Density :	2.03	t/m^3	Final Moisture
Dry Density :	1.64	t/m^3	
Rate of Strain:	0.009	%/min	22.1 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
91 kPa	19 kPa	72 kPa	2.14 %
205 kPa	48 kPa	157 kPa	4.32 %
381 kPa	94 kPa	287 kPa	7.69 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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Authorised Signatory

James Russell

J. Russell

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801532-CU

Project: 077692009

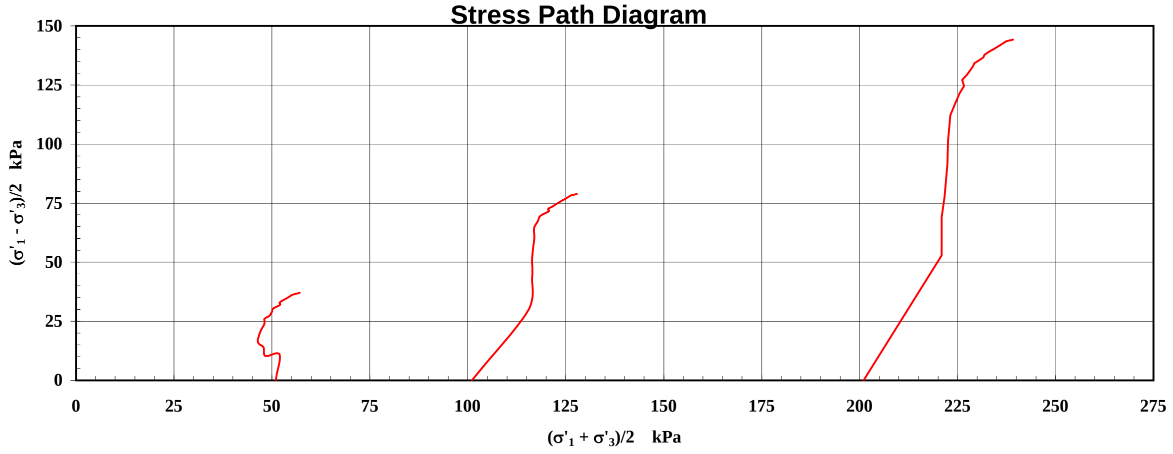
Test Date: 22/01/2008

Report Date: 5/02/2008

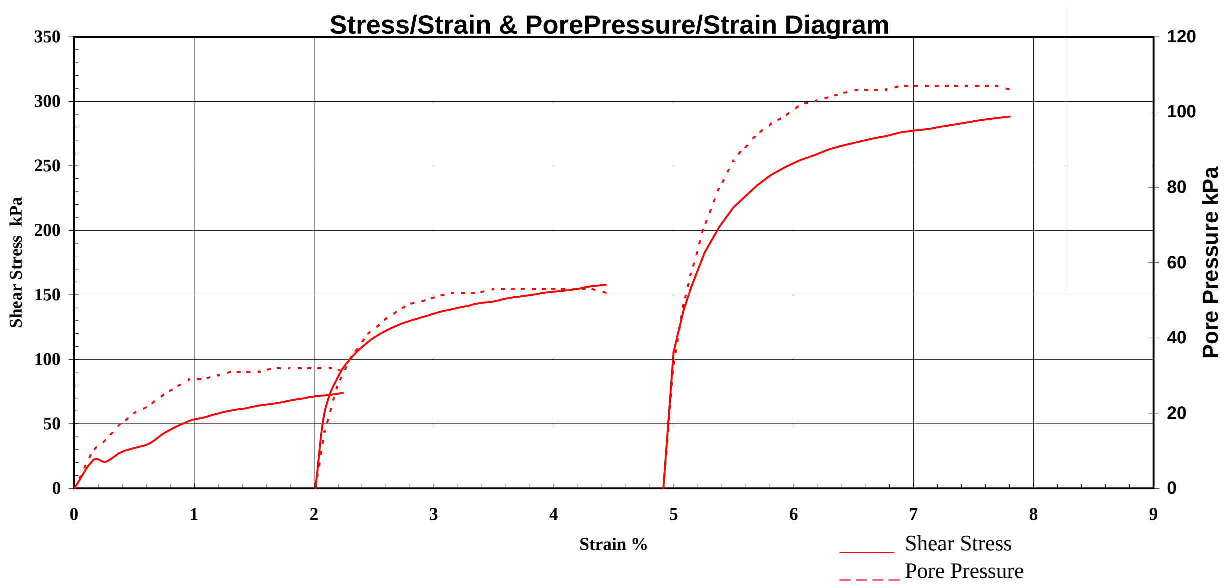
Client Id.: TPA 3

Depth (m): 3.0-3.4

Description (MH) SANDY SILT-grey brown



Stress Path Diagram



Stress/Strain & PorePressure/Strain Diagram

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801532-CU
Project:	077692009	**Test Date:**	22/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 3	**Depth (m):**	3.0-3.4

Description (MH) SANDY SILT-grey brown

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 801532
BH: TPA 3
AFTER TEST
DATE: 25/1/08
DEPTH: 3.0-3.4

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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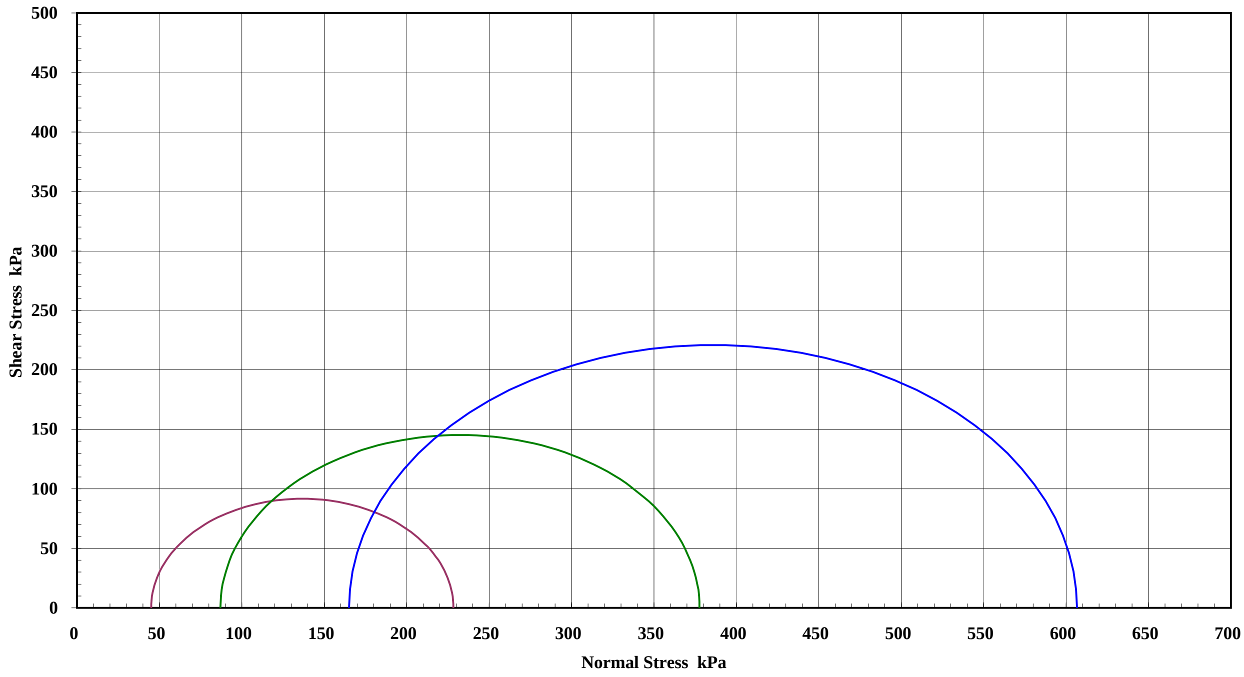
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801533-CU
Project:	077692009	**Test Date:**	2/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA 3	**Depth (m):**	6.0-6.4
Description:	(CI) CLAY-red brown		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	18.1	35.7	26.6
Angle of Shear Resistance Φ' (Degrees) :	34.1	29.5	31.1

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.4	mm	Initial Moisture
Initial Diameter :	47.9	mm	15.4 %
Wet Density :	2.10	t/m^3	Final Moisture
Dry Density :	1.82	t/m^3	
Rate of Strain:	0.008	%/min	17.5 %
B Response:	98	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
228 kPa	45 kPa	183 kPa	1.42 %
378 kPa	87 kPa	291 kPa	2.01 %
607 kPa	165 kPa	442 kPa	2.63 %

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801533-CU

Project: 077692009

Test Date: 2/02/2008

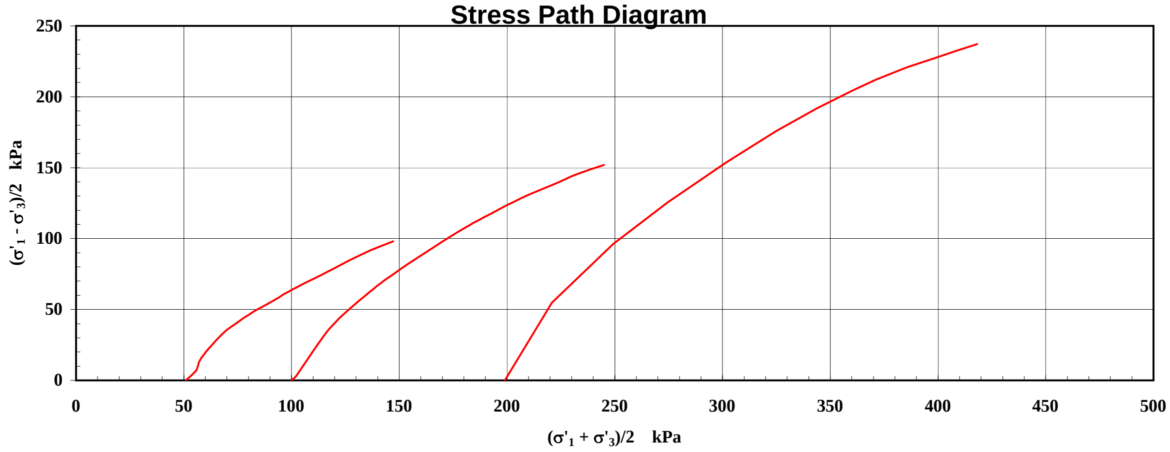
Report Date: 7/02/2008

Client Id.: TPA 3

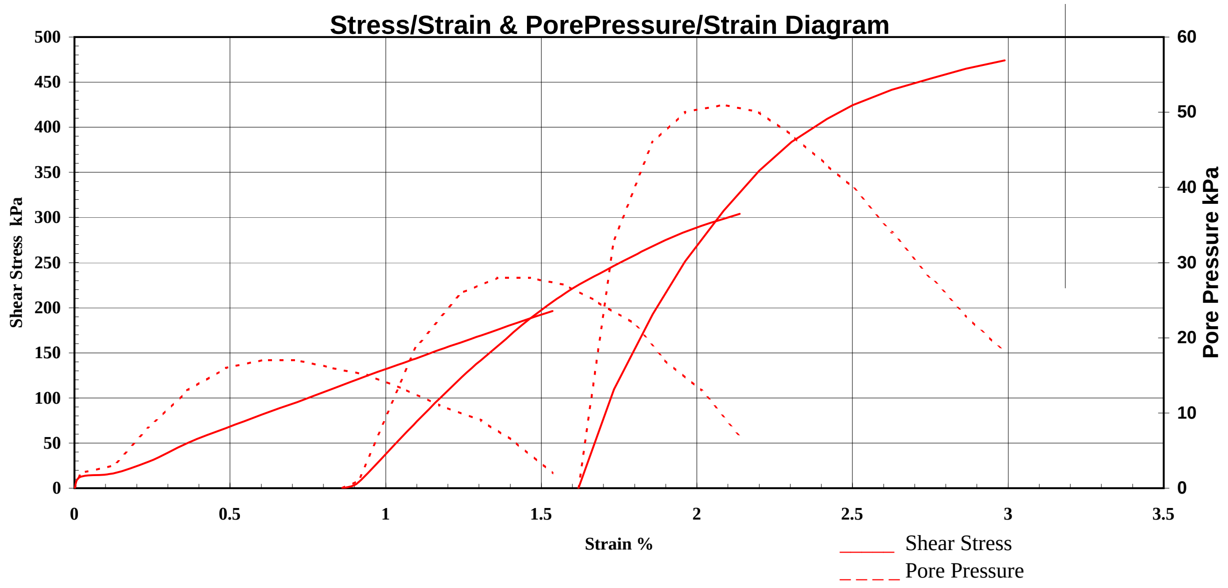
Depth (m): 6.0-6.4

Description (CI) CLAY-red brown

Stress Path Diagram



Stress/Strain & PorePressure/Strain Diagram



Sample Type: Single Individual Undisturbed Sample

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801533-CU
Project:	077692009	**Test Date:**	2/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA 3	**Depth (m):**	6.0-6.4

Description (CI) CLAY-red brown

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 801533
BH: TPA 3
AFTER TEST
DATE: 5/2/08
DEPTH: 6.0-6.4

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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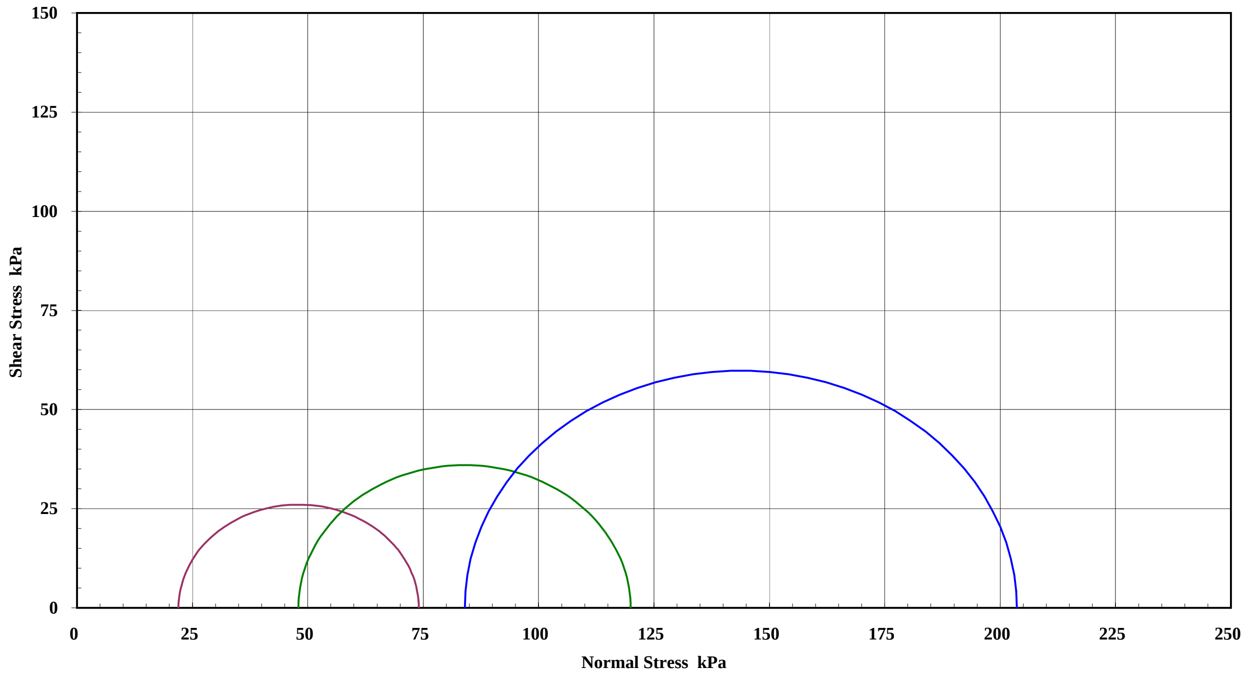
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801540-CU
Project:	077692009	**Test Date:**	18/01/2008
		Report Date:	5/02/2008
Client Id.:	TPA 3	**Depth (m):**	4.0-4.4

Description: (CH) SILTY CLAY- brown, trace fine gravel

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	13.2	2.8	8.3
Angle of Shear Resistance **Φ'** (Degrees) :	16.1	23.4	20.9

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				*FAILURE DETAILS*			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
			Initial Moisture	σ'_1	σ'_3		
Initial Height :	96.1	mm	78.5 %	74 kPa	22 kPa	52 kPa	1.86 %
Initial Diameter :	47.0	mm	Final Moisture	120 kPa	48 kPa	72 kPa	5.05 %
Wet Density :	1.62	t/m^3		204 kPa	84 kPa	120 kPa	11.47 %
Dry Density :	0.91	t/m^3					
Rate of Strain:	0.009	%/min	42.2 %				
B Response:	100	%					

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801540-CU

Project: 077692009

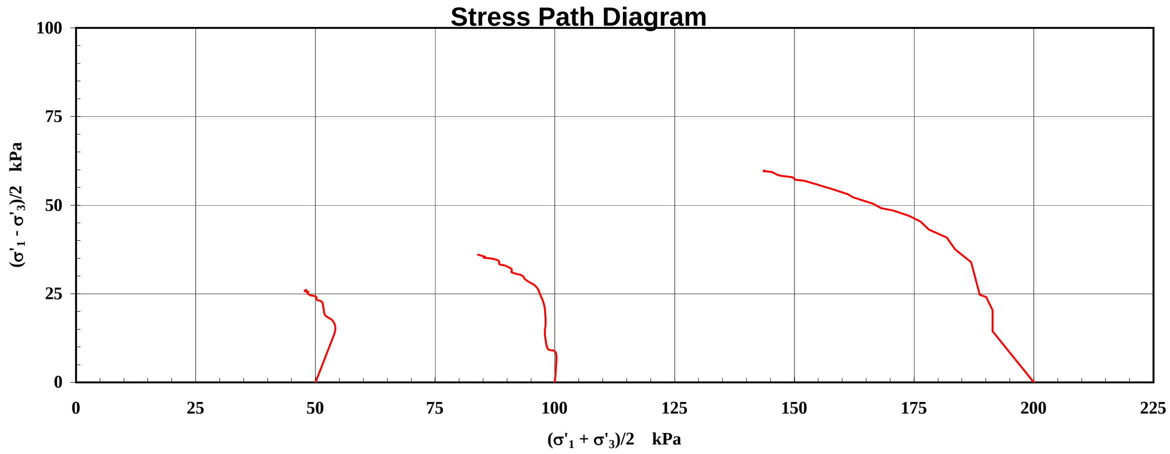
Test Date: 18/01/2008

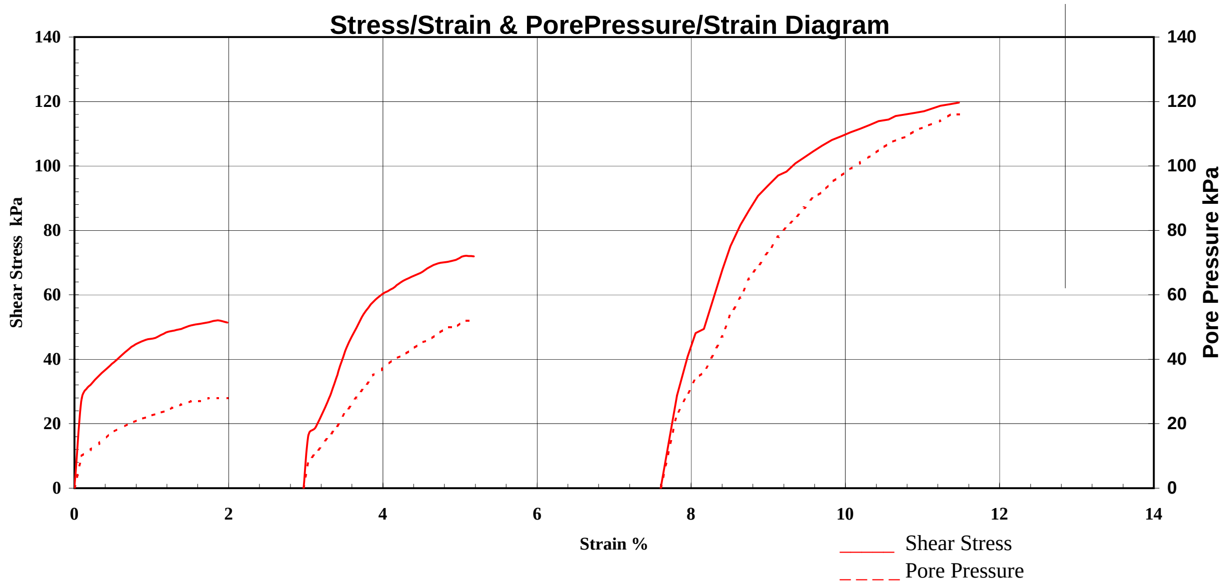
Report Date: 5/02/2008

Client Id.: TPA 3

Depth (m): 4.0-4.4

Description (CH) SILTY CLAY- brown, trace fine gravel





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801540-CU

Project: 077692009

Test Date: 18/01/2008

Report Date: 5/02/2008

Client Id.: TPA 3

Depth (m): 4.0-4.4

Description (CH) SILTY CLAY- brown, trace fine gravel

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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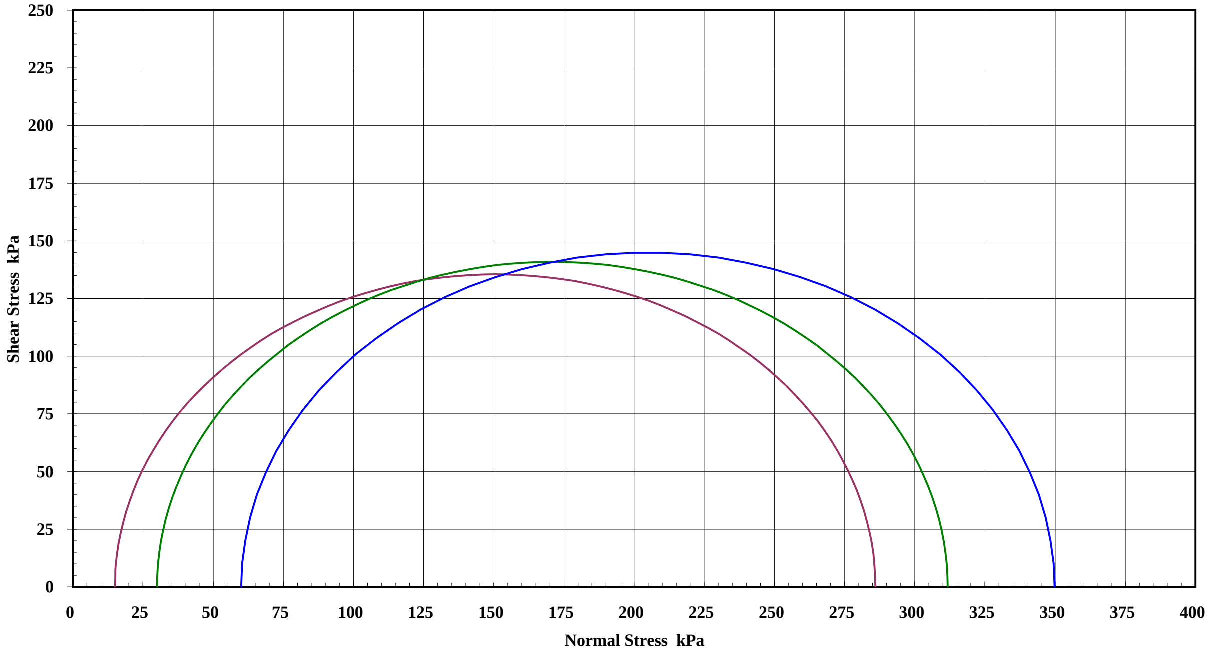
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801536-UU
Project:	77692009	**Test Date:**	23/01/2008
		Report Date:	6/02/2008
Client Id.:	TPA4	**Depth (m):**	1.5-1.75
Description:	(CH) CLAY-grey brown		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	99.4	121.4	112.6
Angle of Shear Resistance Φ (Degrees) :	15.3	6.8	9.6

Cell Pressures (kPa):	15-30-60	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS				FAILURE DETAILS			
Sample Details			*Moisture Contents*	*Principal Stresses*		*Deviator Stress*	*Strain*
			Initial Moisture	σ_1	σ_3		
Initial Height :	96.4	mm	20.2 %	286 kPa	15 kPa	271 kPa	7.57 %
Initial Diameter :	44.5	mm	Final Moisture	312 kPa	30 kPa	282 kPa	11.36 %
Wet Density :	2.18	t/m^3		350 kPa	60 kPa	290 kPa	14.94 %
Dry Density :	1.82	t/m^3					
Rate of Strain:	1.037	%/min	20.2 %				

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd

Report No.: 801536-UU

Project: 77692009

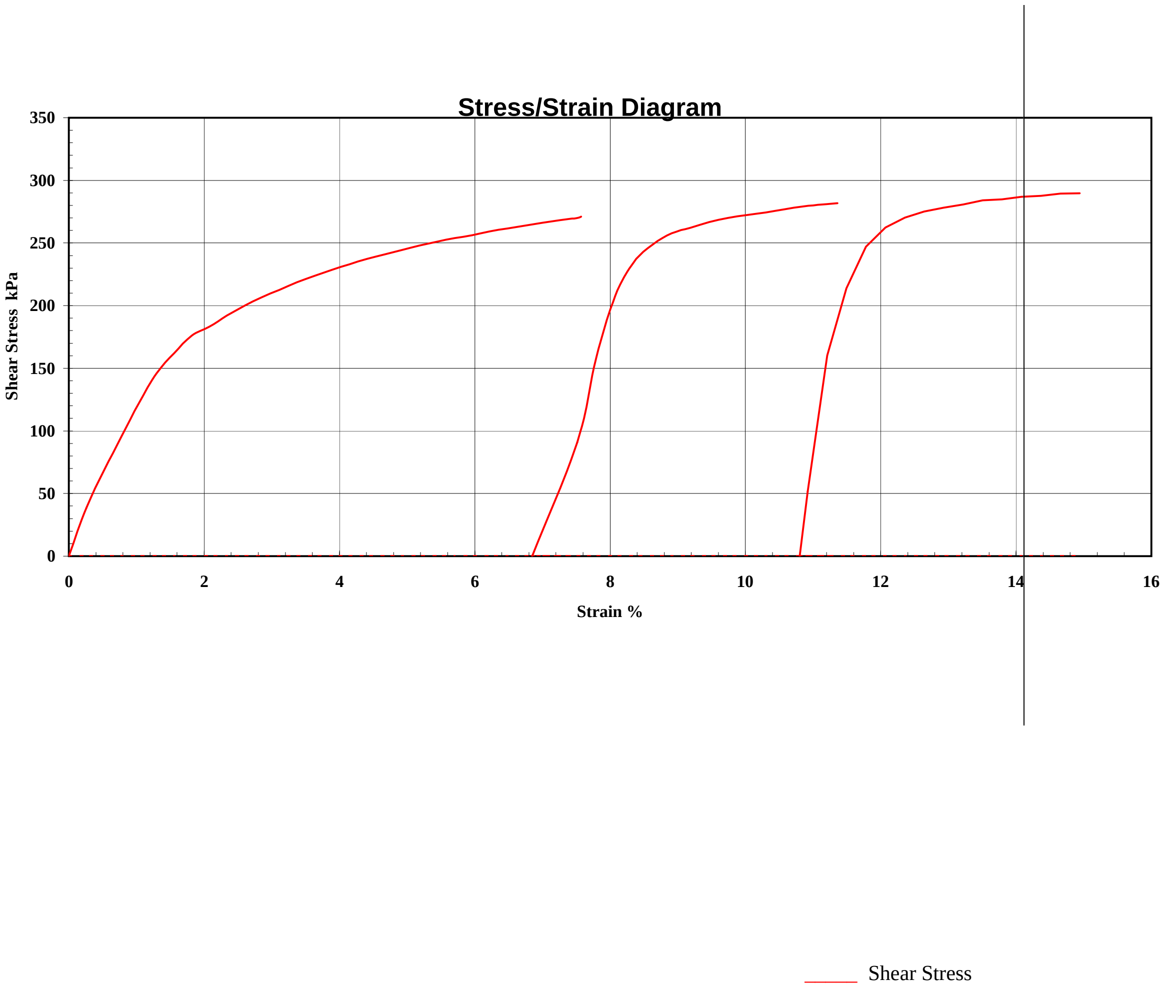
Test Date: 23/01/2008

Report Date: 6/02/2008

Client Id.: TPA4

Depth (m): 1.5-1.75

Description: (CH) CLAY-grey brown



Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as received

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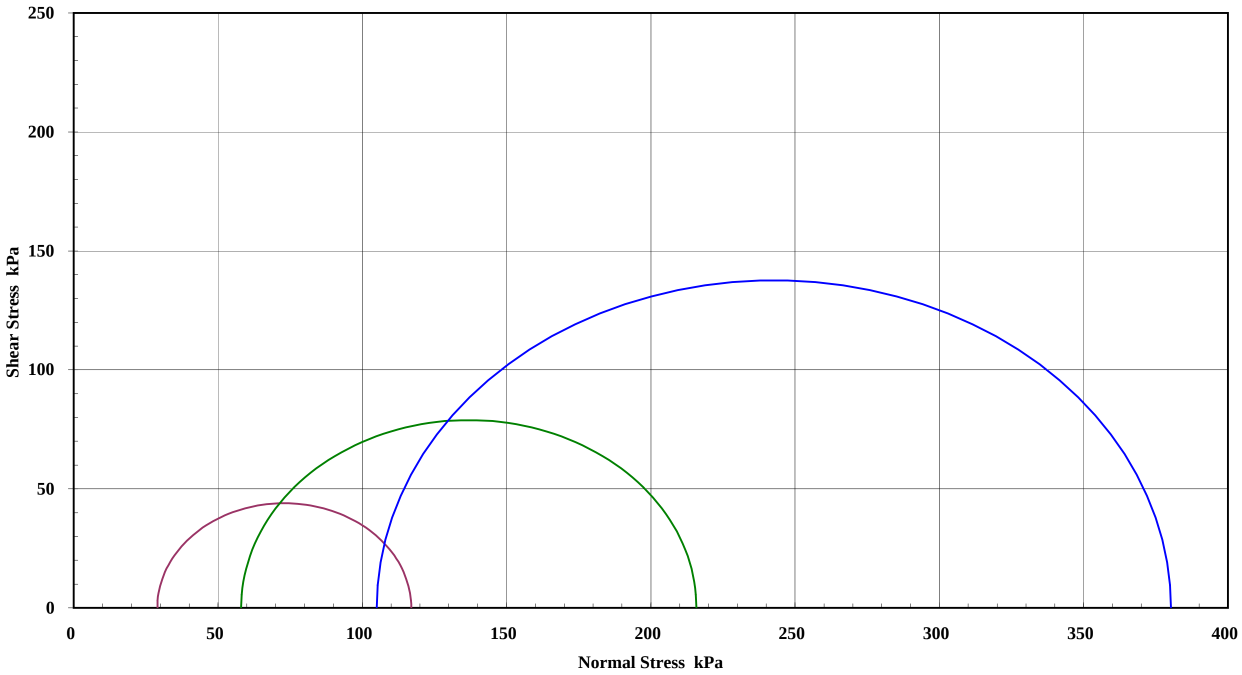
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801541-CU
Project:	077692009	**Test Date:**	2/02/2009
		Report Date:	7/02/2008
Client Id.:	TPA 6	**Depth (m):**	5.5-5.9
Description:	(CH) CLAY-dark brown		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	4.9	3.4	4.2
Angle of Shear Resistance Φ' (Degrees) :	33.1	33.7	33.5

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	92.8	mm	Initial Moisture
Initial Diameter :	47.6	mm	18.8 %
Wet Density :	2.08	t/m^3	Final Moisture
Dry Density :	1.75	t/m^3	
Rate of Strain:	0.009	%/min	20.7 %
B Response:	98	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'$_1$	σ'$_3$		
117 kPa	29 kPa	88 kPa	1.78 %
216 kPa	58 kPa	158 kPa	3.35 %
380 kPa	105 kPa	275 kPa	6.36 %

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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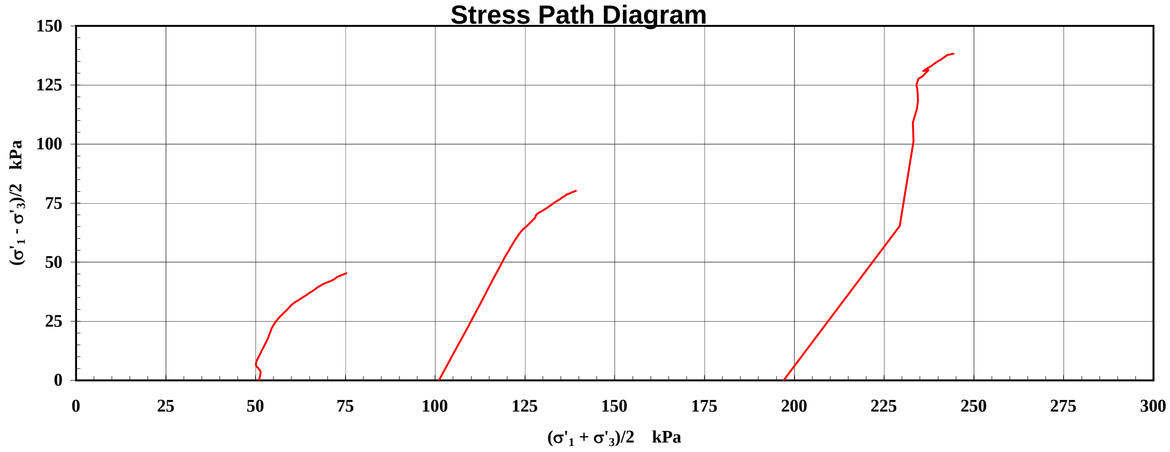
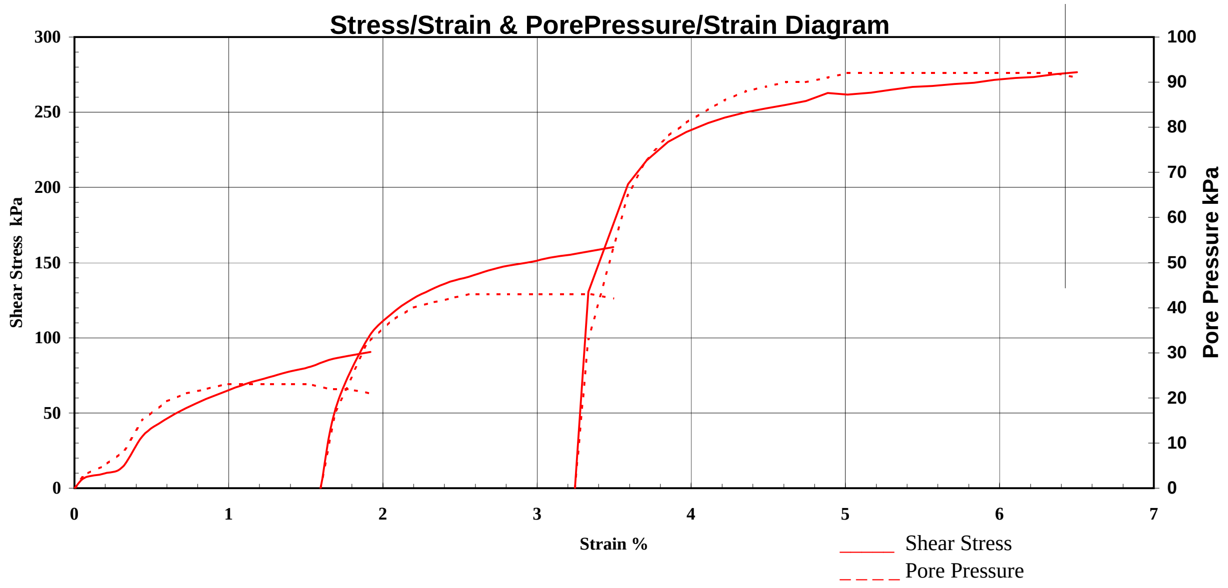
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801541-CU
Project:	077692009	**Test Date:**	2/02/2009
		Report Date:	7/02/2008
Client Id.:	TPA 6	**Depth (m):**	5.5-5.9

Description (CH) CLAY-dark brown





Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801541-CU
Project:	077692009	**Test Date:**	2/02/2009
		Report Date:	7/02/2008
Client Id.:	TPA 6	**Depth (m):**	5.5-5.9
Description	(CH) CLAY-dark brown		

Sample Type:	Single Individual Undisturbed Sample	Remarks:	Tested as Received

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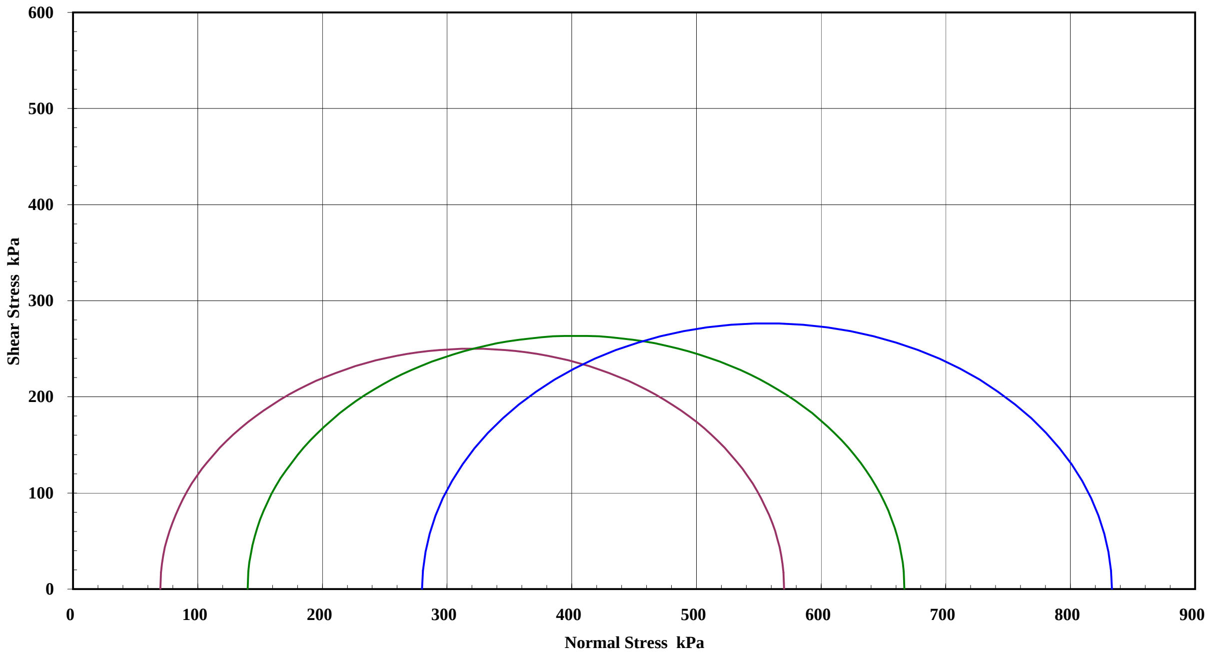
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801542-UU
Project:	77692009	**Test Date:**	6/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA 6	**Depth (m):**	7.0-7.3
Description:	(CH) CLAY-grey brown		

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	201.9	229.4	218.3
Angle of Shear Resistance **Φ** (Degrees) :	9.1	5.0	6.2

Cell Pressures (kPa):	70-140-280	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details		
Initial Height :	96.5	mm
Initial Diameter :	46.6	mm
Wet Density :	2.05	t/m^3
Dry Density :	1.67	t/m^3
Rate of Strain:	1.036	%/min

Moisture Contents	
Initial Moisture	
22.7	%
Final Moisture	
22.7	%

FAILURE DETAILS

Principal Stresses		*Deviator Stress*	*Strain*
σ_1	σ_3		
570 kPa	70 kPa	500 kPa	3.78 %
667 kPa	140 kPa	527 kPa	5.07 %
833 kPa	280 kPa	553 kPa	6.74 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received.

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Authorised Signatory

James Russell

J. Russell

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd

Report No.: 801542-UU

Project: 77692009

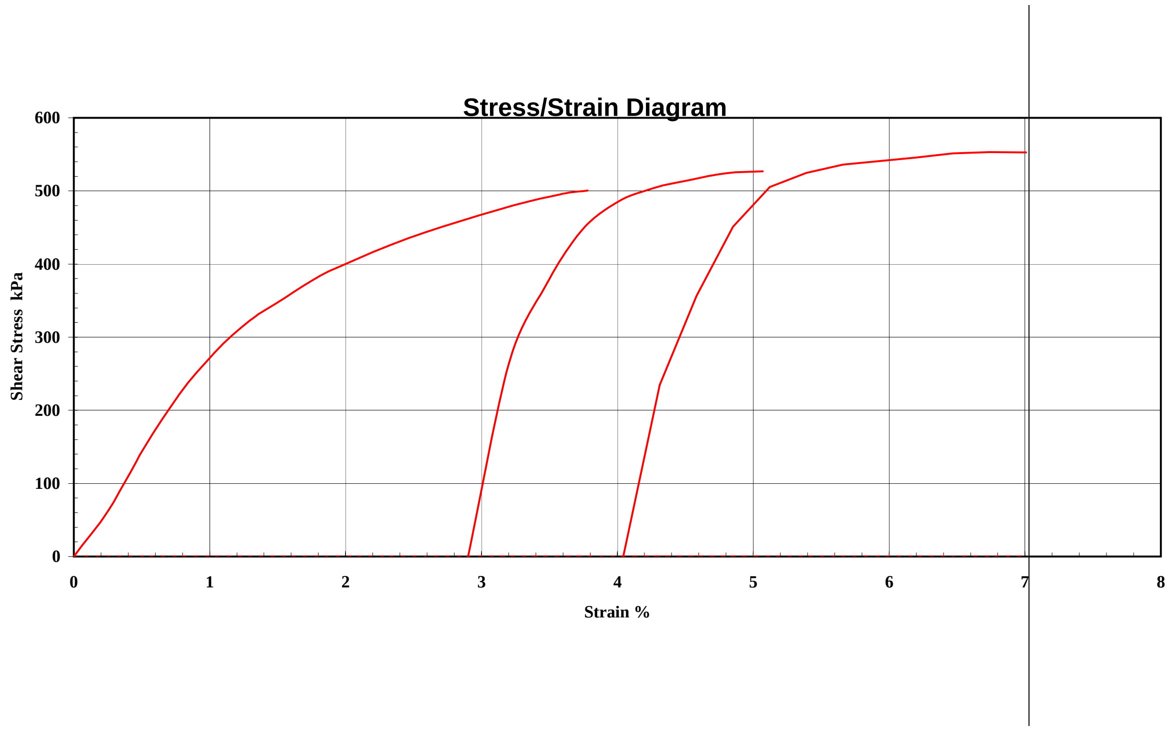
Test Date: 6/02/2008

Report Date: 7/02/2008

Client Id.: TPA 6

Depth (m): 7.0-7.3

Description: (CH) CLAY-grey brown



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received.

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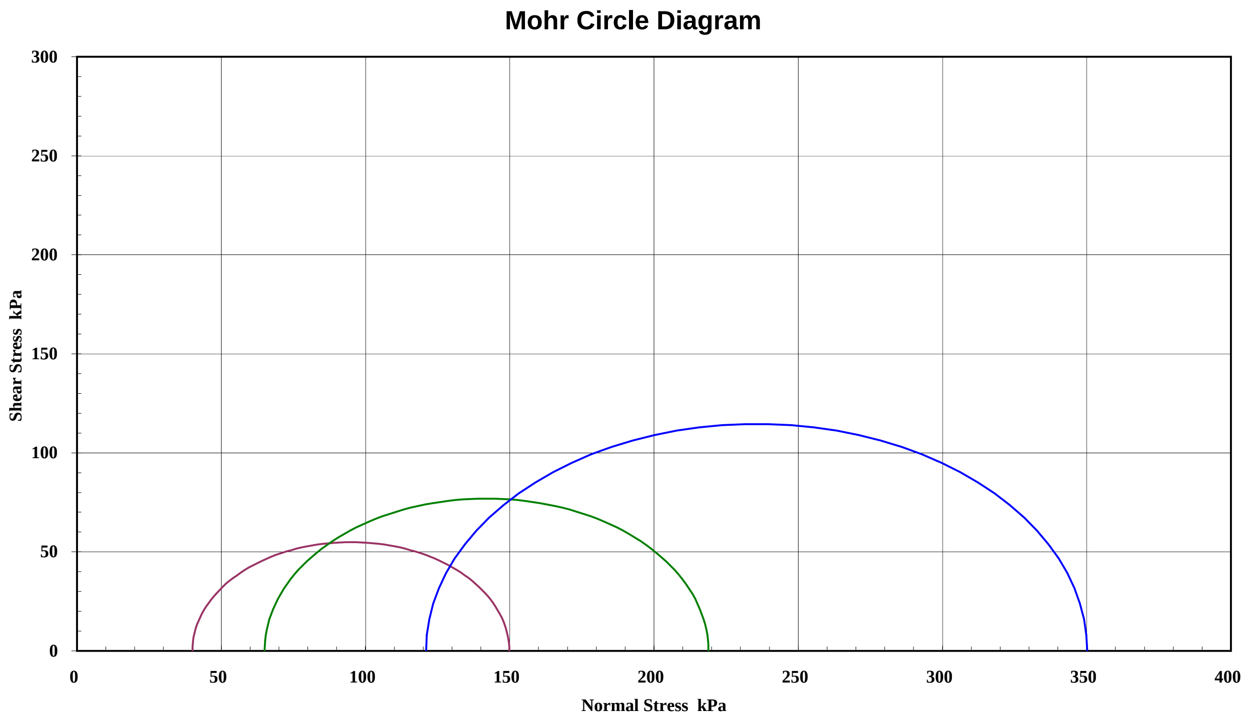
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	802321-CU
Project:	077692009	**Test Date:**	14/02/2008
		Report Date:	25/02/2008
Client Id.:	TPA7	**Depth (m):**	2.5-2.8
Description:			


Mohr Circle Diagram

Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	11.9	21.7	17.5
Angle of Shear Resistance **Φ'** (Degrees) :	27.9	23.7	24.9

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details		
Initial Height :	96.3	mm
Initial Diameter :	47.6	mm
Wet Density :	2.08	t/m^3
Dry Density :	1.73	t/m^3
Rate of Strain:	0.009	%/min
B Response:	98	%

Moisture Contents
Initial Moisture
20.6 %
Final Moisture
22.0 %

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
150 kPa	40 kPa	110 kPa	1.43 %
219 kPa	65 kPa	154 kPa	2.74 %
350 kPa	121 kPa	229 kPa	4.40 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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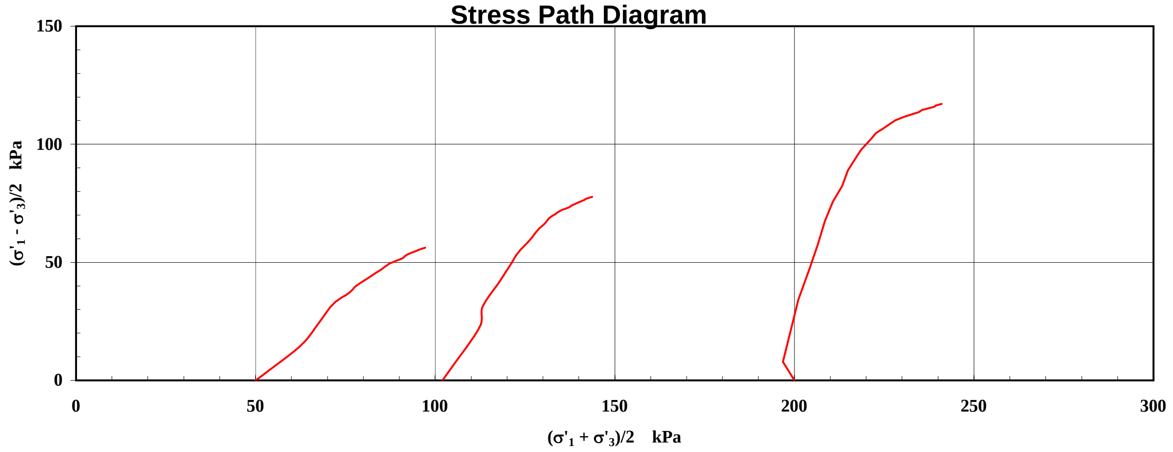
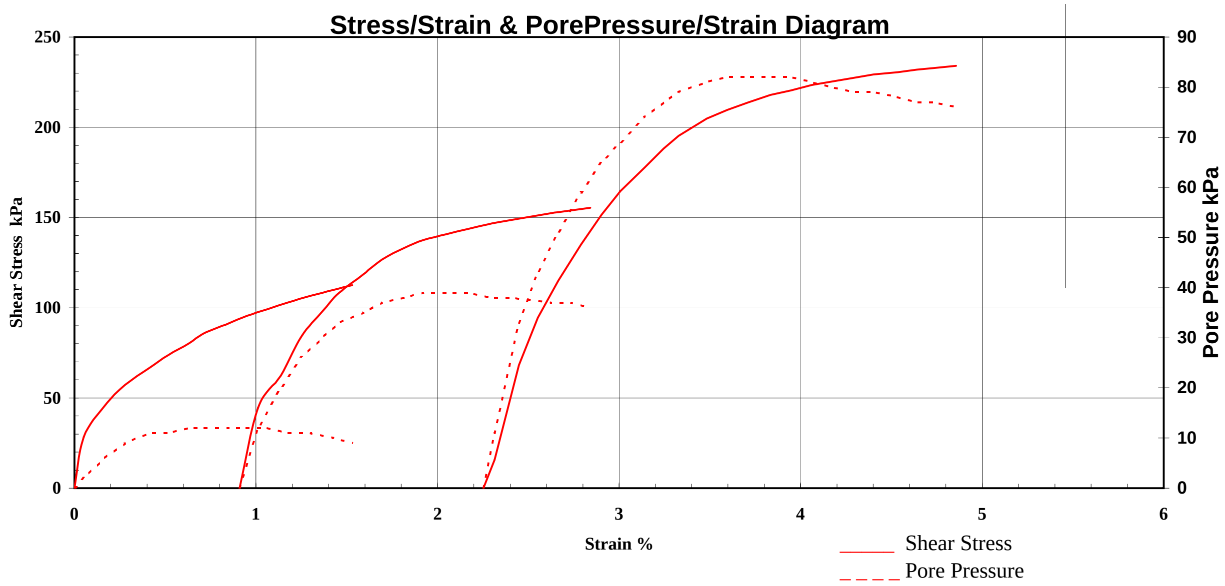
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	802321-CU
Project:	077692009	**Test Date:**	14/02/2008
		Report Date:	25/02/2008
Client Id.:	TPA7	**Depth (m):**	2.5-2.8

Description





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 802321-CU

Project: 077692009

Test Date: 14/02/2008

Report Date: 25/02/2008

Client Id.: TPA7

Depth (m): 2.5-2.8

Description

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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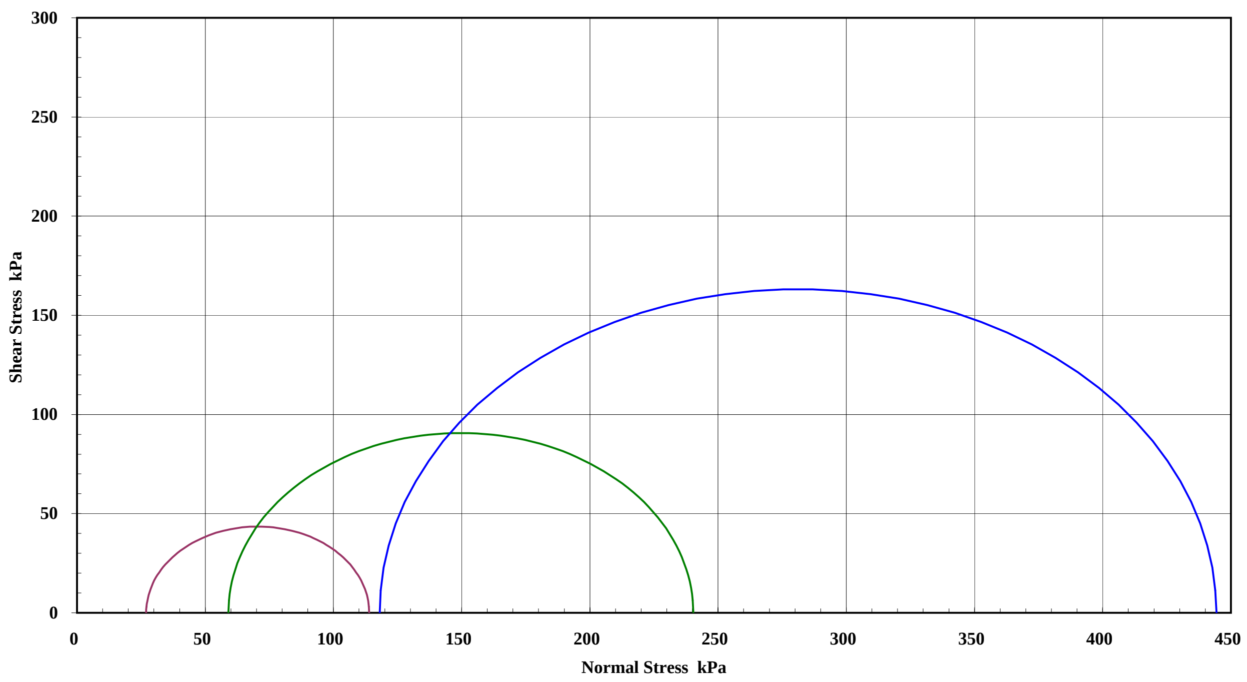
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	802322-CU
Project:	077692009	**Test Date:**	18/02/2008
		Report Date:	25/02/2008
Client Id.:	TPA7	**Depth (m):**	4.0-4.4
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	1.9	9.8	5.4
Angle of Shear Resistance Φ' (Degrees) :	36.6	33.5	34.5

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	97.0	mm	Initial Moisture
Initial Diameter :	47.7	mm	22.0 %
Wet Density :	2.05	t/m^3	Final Moisture
Dry Density :	1.68	t/m^3	
Rate of Strain:	0.009	%/min	20.4 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'$_1$	σ'$_3$		
114 kPa	27 kPa	87 kPa	1.59 %
240 kPa	59 kPa	181 kPa	3.79 %
444 kPa	118 kPa	326 kPa	6.97 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 802322-CU

Project: 077692009

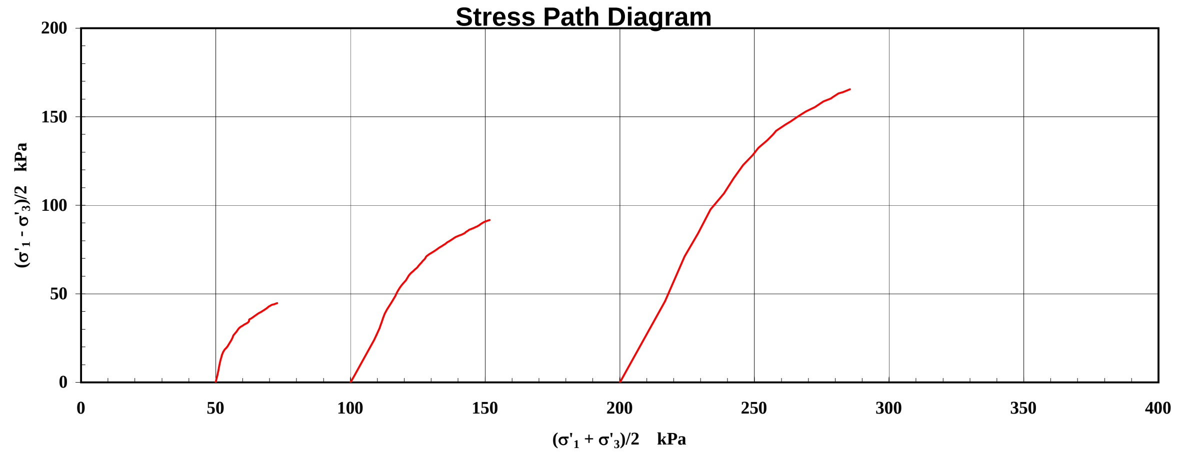
Test Date: 18/02/2008

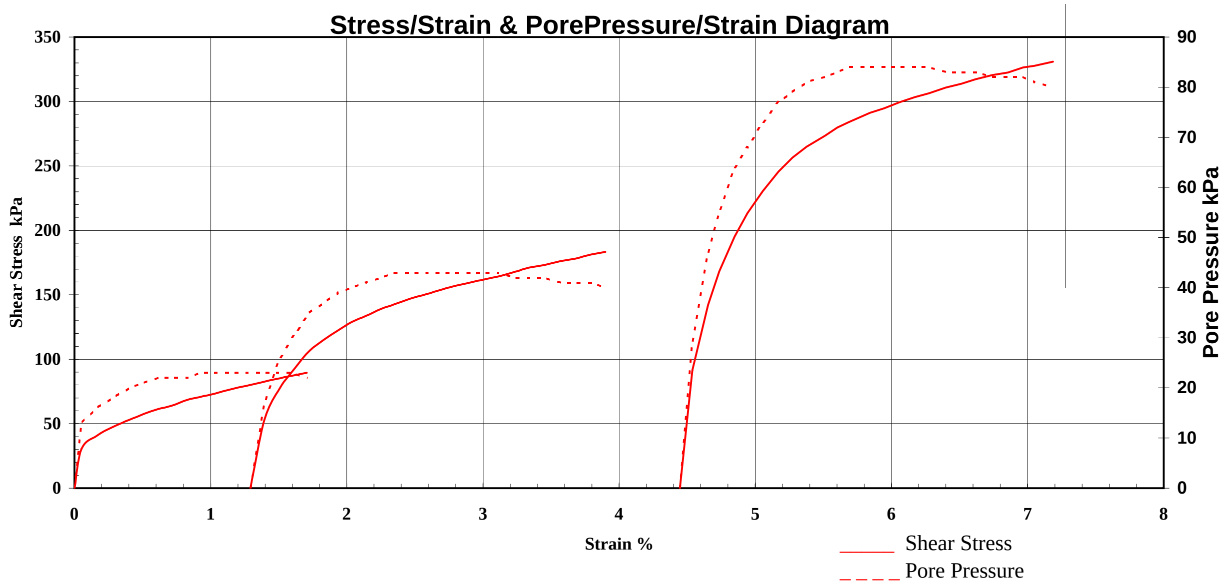
Report Date: 25/02/2008

Client Id.: TPA7

Depth (m): 4.0-4.4

Description





Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	802322-CU
Project:	077692009	**Test Date:**	18/02/2008
		Report Date:	25/02/2008
Client Id.:	TPA7	**Depth (m):**	4.0-4.4

Description

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 802322
BH: TPA 7
AFTER TEST
DATE: 21/2/08
DEPTH: 4.0-4.4

Sample Type: Single Individual Undisturbed Specimen
Remarks: Tested as Received

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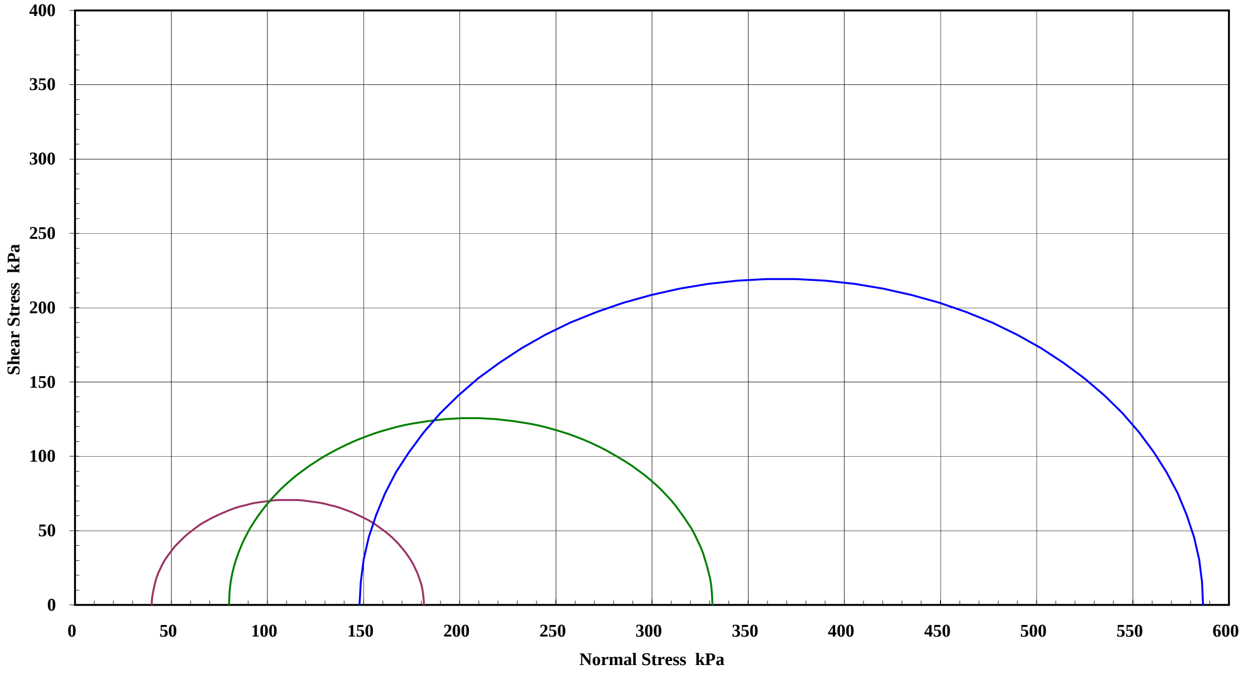
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	802323-CU
Project:	0777692009	**Test Date:**	25/02/2008
		Report Date:	4/03/2008
Client Id.:	TPA7	**Depth (m):**	5.5-5.95
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	8.1	8.1	8.1
Angle of Shear Resistance **Φ'** (Degrees) :	35.4	35.4	35.4

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				***FAILURE DETAILS***			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
Initial Height :	96.4	mm	Initial Moisture	σ'_1	σ'_3		
Initial Diameter :	47.8	mm	15.2 %	181 kPa	40 kPa	141 kPa	1.75 %
Wet Density :	2.14	t/m^3	Final Moisture	331 kPa	80 kPa	251 kPa	2.74 %
Dry Density :	1.86	t/m^3		587 kPa	148 kPa	439 kPa	4.93 %
Rate of Strain:	0.009	%/min	15.6 %				
B Response:	98	%					
Sample Type:	Single Individual Undisturbed Specimen			Remarks:	Tested as Received		

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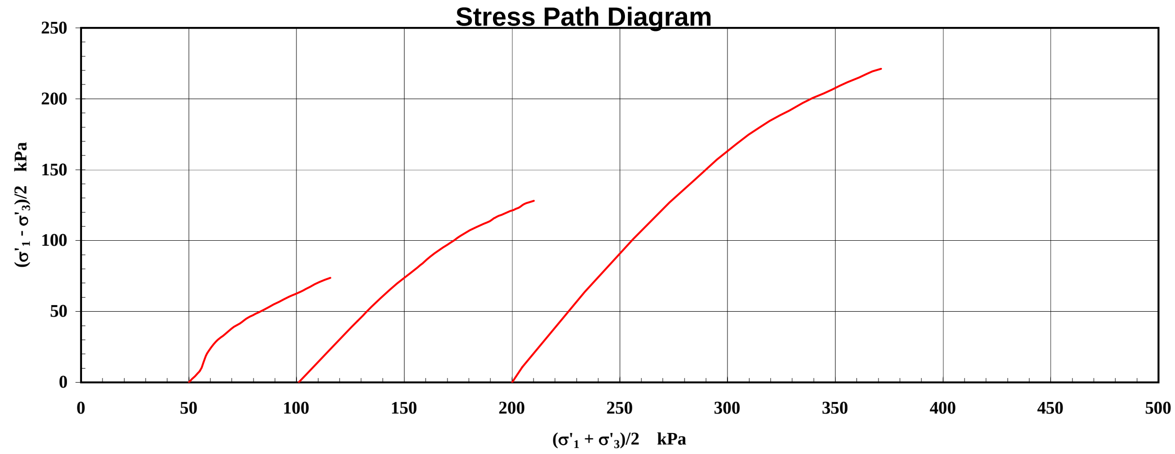
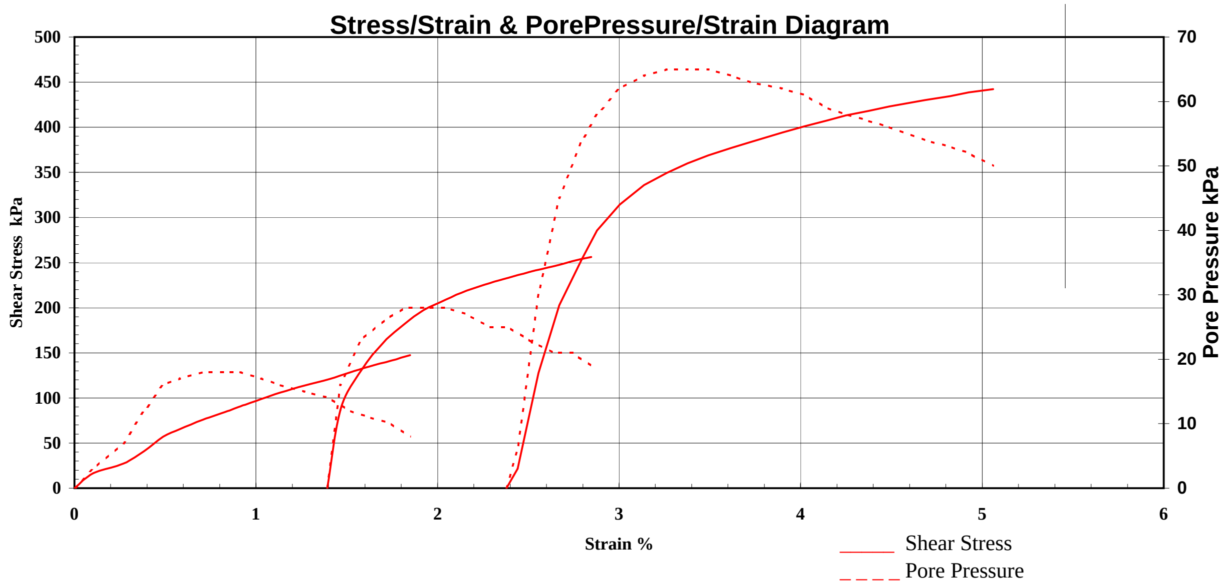
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	802323-CU
Project:	0777692009	**Test Date:**	25/02/2008
		Report Date:	4/03/2008
Client Id.:	TPA7	**Depth (m):**	5.5-5.95

Description





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 802323-CU

Project: 0777692009

Test Date: 25/02/2008

Report Date: 4/03/2008

Client Id.: TPA7

Depth (m): 5.5-5.95

Description

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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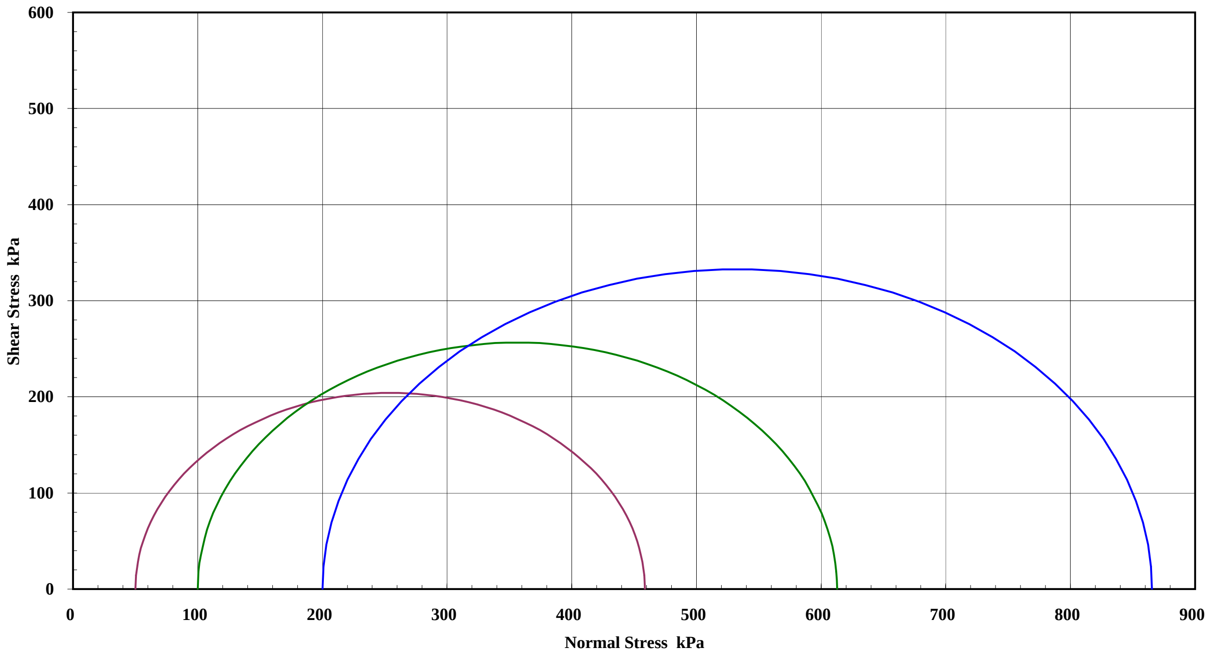
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	802328-UU
Project:	077692009	**Test Date:**	26/02/2008
		Report Date:	4/03/2008
Client Id.:	TPA 8	**Depth (m):**	1.0 - 1.4

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	86.7	113.3	101.1
Angle of Shear Resistance Φ (Degrees) :	30.7	25.6	27.3

Cell Pressures (kPa):	50, 100, 200	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.5	mm	Initial Moisture
Initial Diameter :	48.0	mm	18.1 %
Wet Density :	2.12	t/m^3	Final Moisture
Dry Density :	1.80	t/m^3	
Rate of Strain:	1.036	%/min	18.1 %

FAILURE DETAILS

Principal Stresses		*Deviator Stress*	*Strain*
σ_1	σ_3		
459 kPa	50 kPa	409 kPa	2.69 %
613 kPa	100 kPa	513 kPa	3.80 %
865 kPa	200 kPa	665 kPa	5.87 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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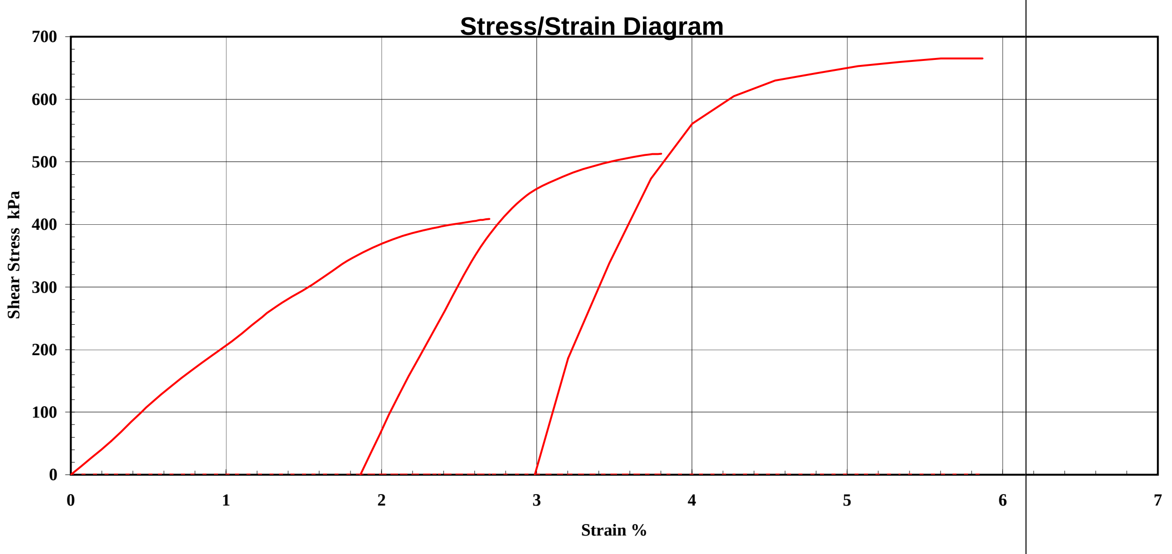
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	802328-UU
Project:	077692009	**Test Date:**	26/02/2008
		Report Date:	4/03/2008
Client Id.:	TPA 8	**Depth (m):**	1.0 - 1.4
Description:			



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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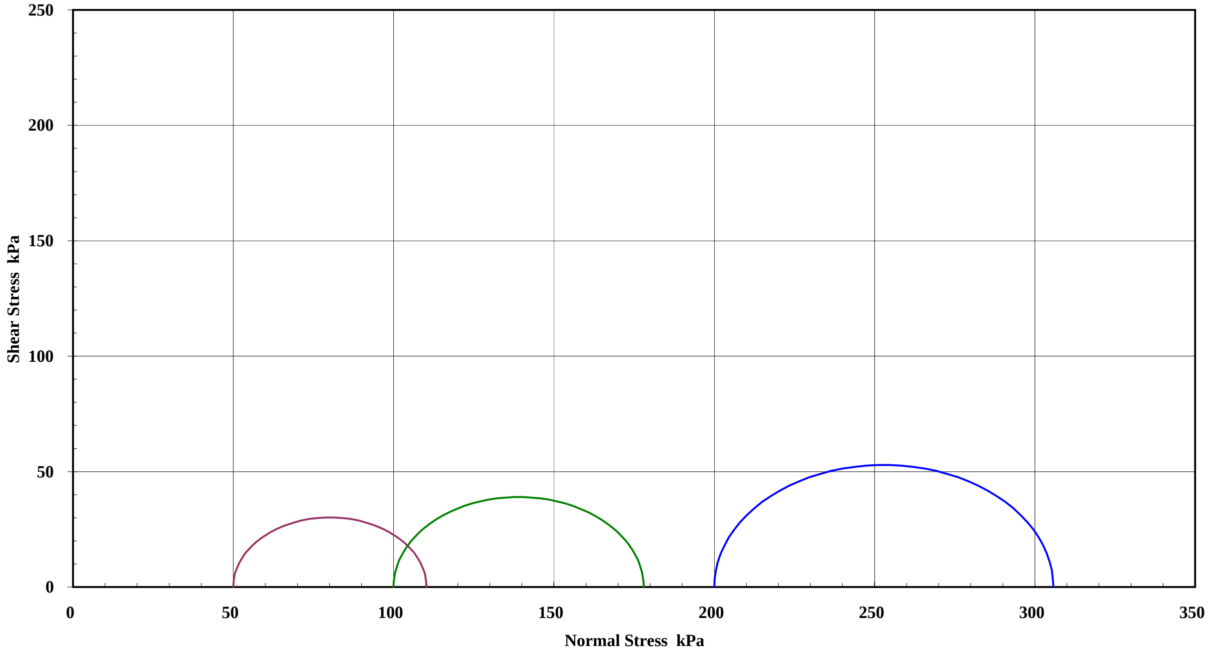
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	802329-UU
Project:	77692009	**Test Date:**	28/02/2008
		Report Date:	4/03/2008
Client Id.:	TPA 8	**Depth (m):**	4.0 - 4.35

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	18.3	22.2	20.3
Angle of Shear Resistance Φ (Degrees) :	8.6	7.0	7.5

Cell Pressures (kPa):	50, 100, 200	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details			Moisture Contents
Initial Height :	96.2	mm	Initial Moisture
Initial Diameter :	47.1	mm	24.3 %
Wet Density :	2.06	t/m^3	Final Moisture
Dry Density :	1.66	t/m^3	
Rate of Strain:	1.040	%/min	24.3 %

FAILURE DETAILS

Principal Stresses		Deviator Stress	Strain
σ_1	σ_3		
110 kPa	50 kPa	60 kPa	1.92 %
178 kPa	100 kPa	78 kPa	3.01 %
306 kPa	200 kPa	106 kPa	6.14 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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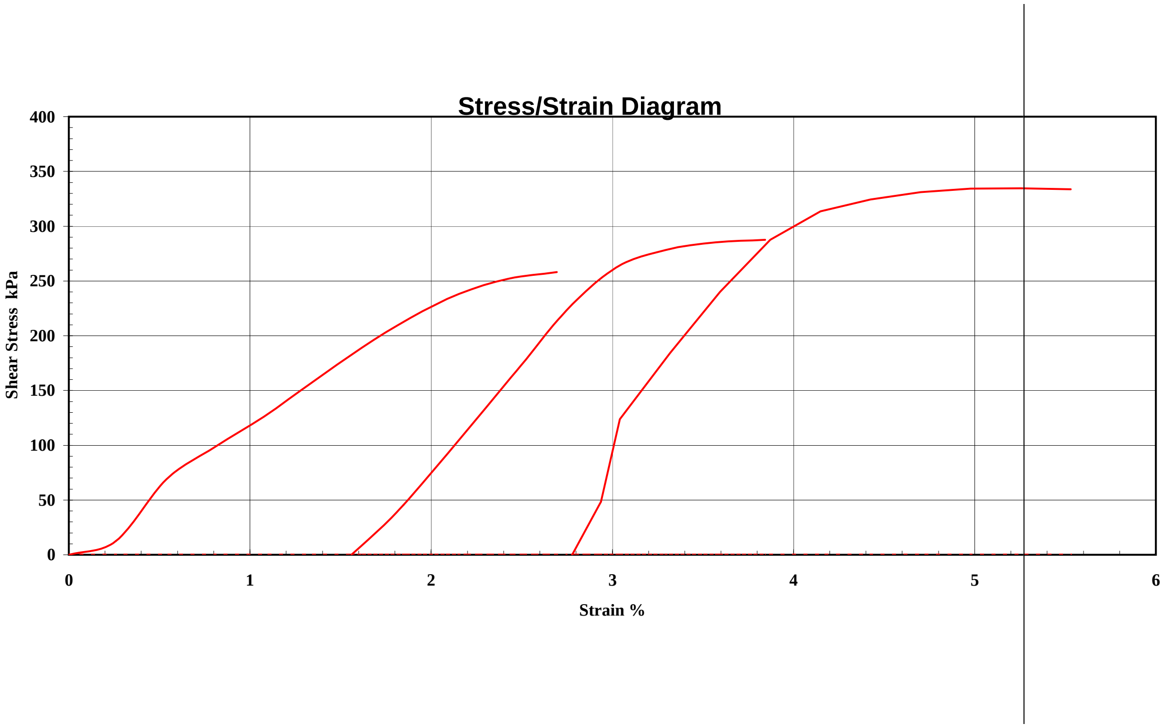
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	802329-UU
Project:	77692009	**Test Date:**	28/02/2008
		Report Date:	4/03/2008
Client Id.:	TPA 8	**Depth (m):**	4.0 - 4.35
Description:			



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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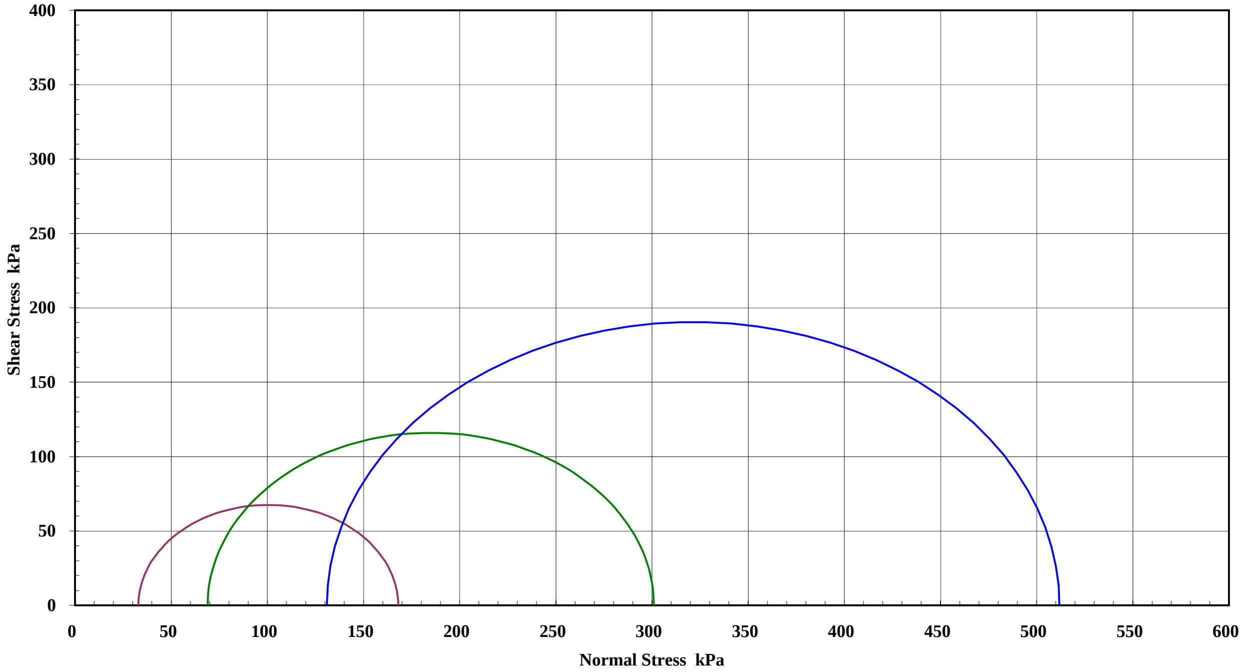
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801843-CU
Project:	077692009	**Test Date:**	5/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 9	**Depth (m):**	2.5-2.9
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	12.0	18.0	14.8
Angle of Shear Resistance Φ' (Degrees) :	35.0	33.1	33.7

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.4	mm	Initial Moisture
Initial Diameter :	47.9	mm	20.5 %
Wet Density :	2.05	t/m^3	Final Moisture
Dry Density :	1.70	t/m^3	
Rate of Strain:	0.008	%/min	22.9 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses σ'_1	*Principal Effective Stresses* σ'_3	*Deviator Stress*	*Strain*
168 kPa	33 kPa	135 kPa	0.99 %
301 kPa	69 kPa	232 kPa	1.82 %
512 kPa	131 kPa	381 kPa	2.93 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801843-CU

Project: 077692009

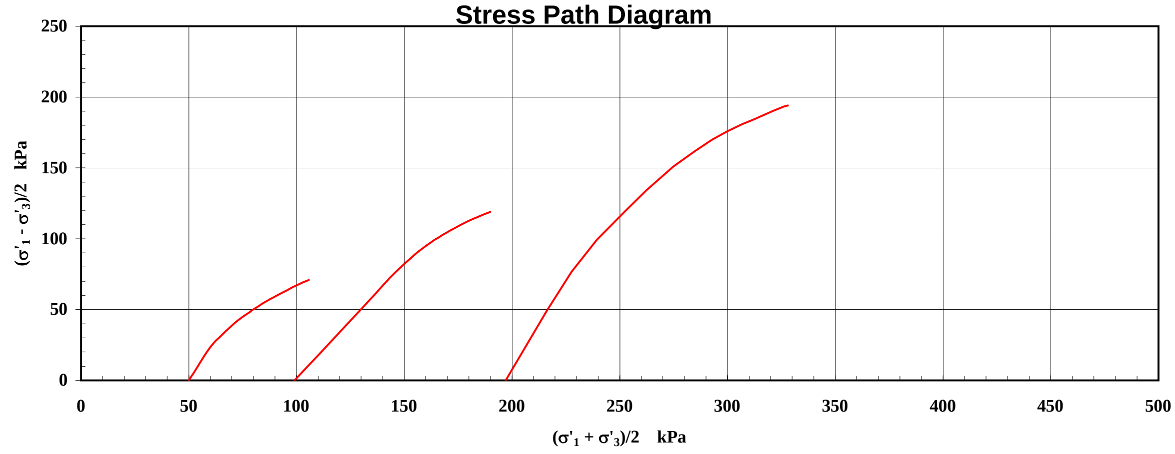
Test Date: 5/02/2008

Report Date: 16/02/2008

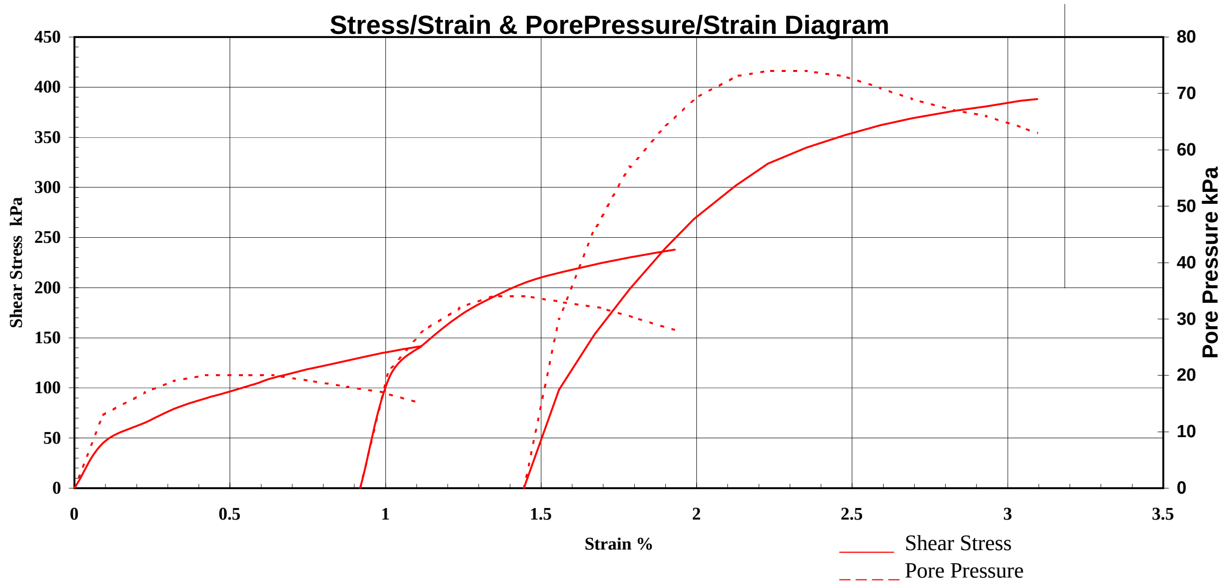
Client Id.: TPA 9

Depth (m): 2.5-2.9

Description



Stress Path Diagram



Stress/Strain & PorePressure/Strain Diagram

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

NATA Accredited Laboratory Number 9926

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Authorised Signatory

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801843-CU
Project:	077692009	**Test Date:**	5/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 9	**Depth (m):**	2.5-2.9

Description

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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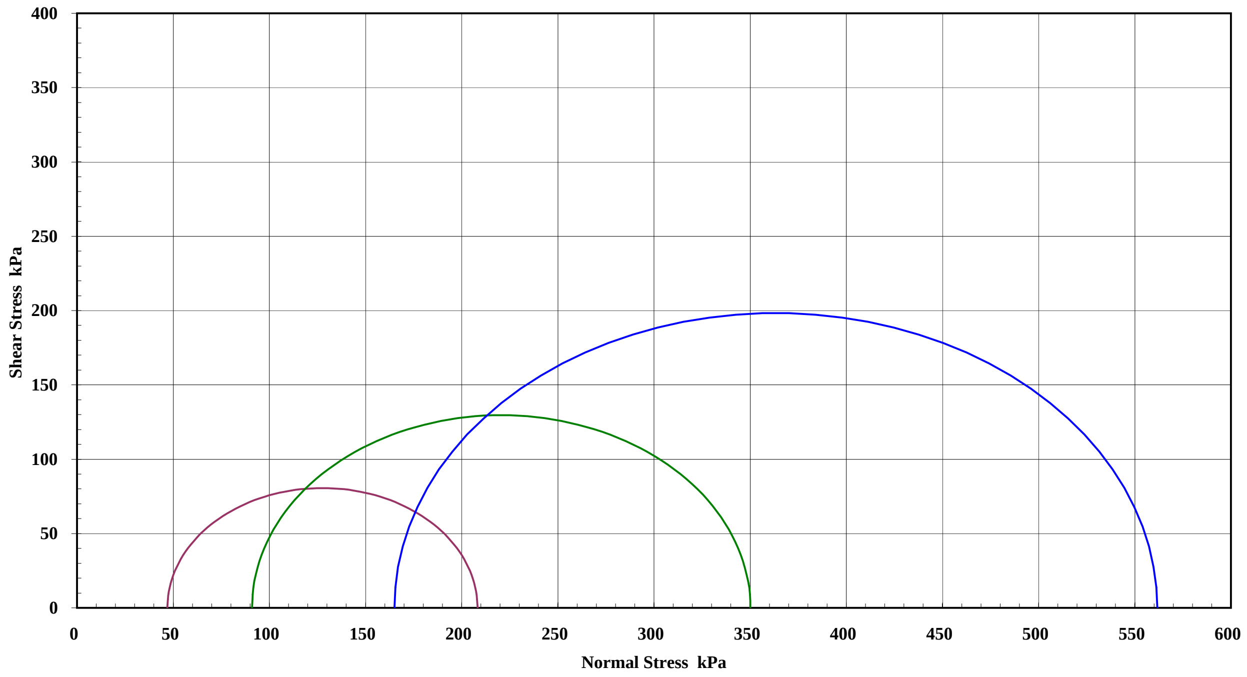
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801844-CU
Project:	077692009	**Test Date:**	5/02/2008
		Report Date:	13/02/2008
Client Id.:	TPA9	**Depth (m):**	4.0-4.4
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	15.8	26.6	20.8
Angle of Shear Resistance Φ' (Degrees) :	31.8	28.8	29.9

Cell Pressures (kPa):	60-120-240	Failure Criteria: Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.2	mm	Initial Moisture
Initial Diameter :	47.5	mm	17.9 %
Wet Density :	2.10	t/m^3	Final Moisture
Dry Density :	1.78	t/m^3	
Rate of Strain:	0.008	%/min	20.7 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
208 kPa	47 kPa	161 kPa	1.91 %
350 kPa	91 kPa	259 kPa	2.91 %
562 kPa	165 kPa	397 kPa	4.41 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801844-CU

Project: 077692009

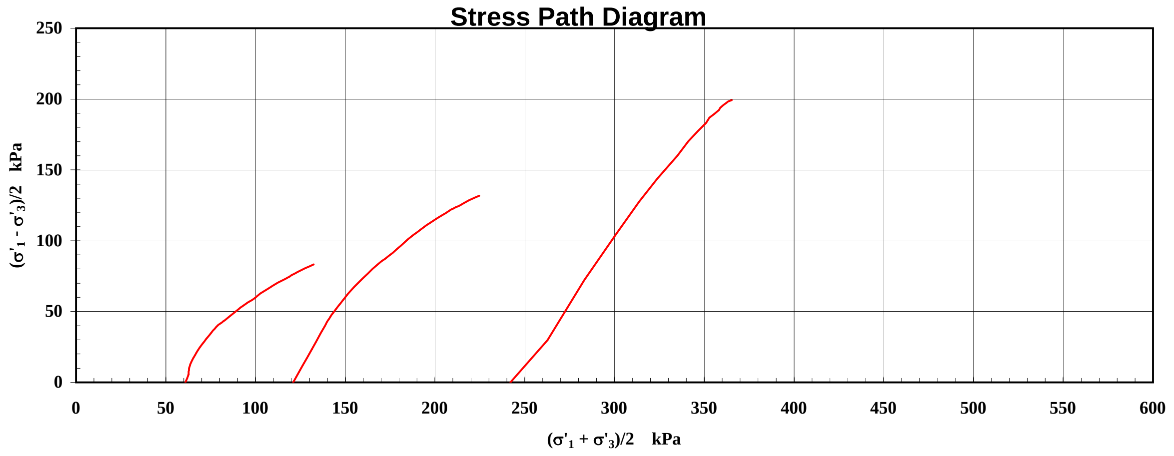
Test Date: 5/02/2008

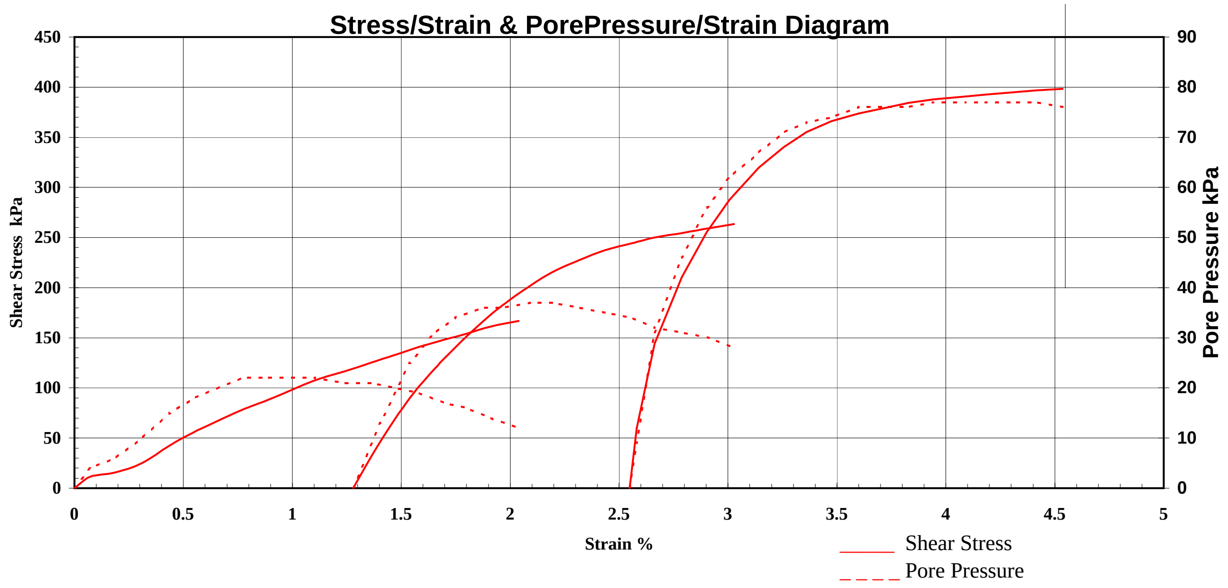
Report Date: 13/02/2008

Client Id.: TPA9

Depth (m): 4.0-4.4

Description





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801844-CU

Project: 077692009

Test Date: 5/02/2008

Report Date: 13/02/2008

Client Id.: TPA9

Depth (m): 4.0-4.4

Description

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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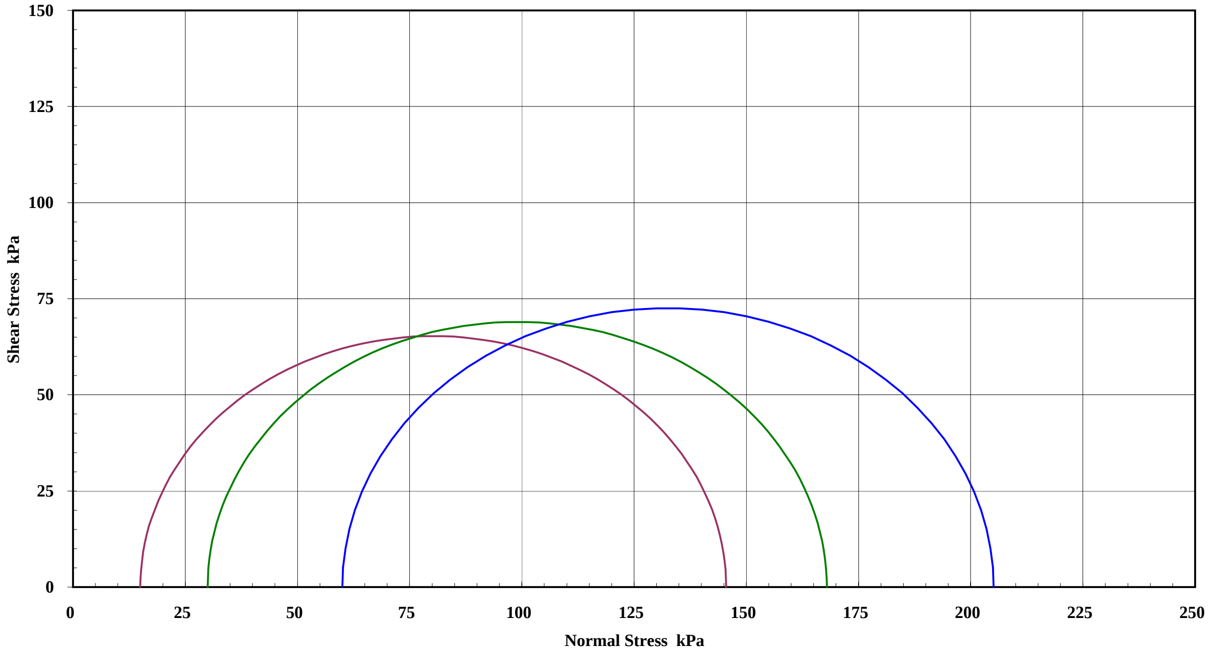
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801845-UU
Project:	77692009	**Test Date:**	6/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA10	**Depth (m):**	1.5-1.9

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	50.4	58.7	55.4
Angle of Shear Resistance Φ (Degrees) :	11.4	6.1	7.8

Cell Pressures (kPa):	15-30-60	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.2	mm	Initial Moisture
Initial Diameter :	47.8	mm	26.4 %
Wet Density :	1.98	t/m^3	Final Moisture
Dry Density :	1.56	t/m^3	
Rate of Strain:	1.040	%/min	26.4 %

FAILURE DETAILS

Principal Stresses		*Deviator Stress*	*Strain*
σ_1	σ_3		
146 kPa	15 kPa	131 kPa	1.98 %
168 kPa	30 kPa	138 kPa	2.58 %
205 kPa	60 kPa	145 kPa	3.98 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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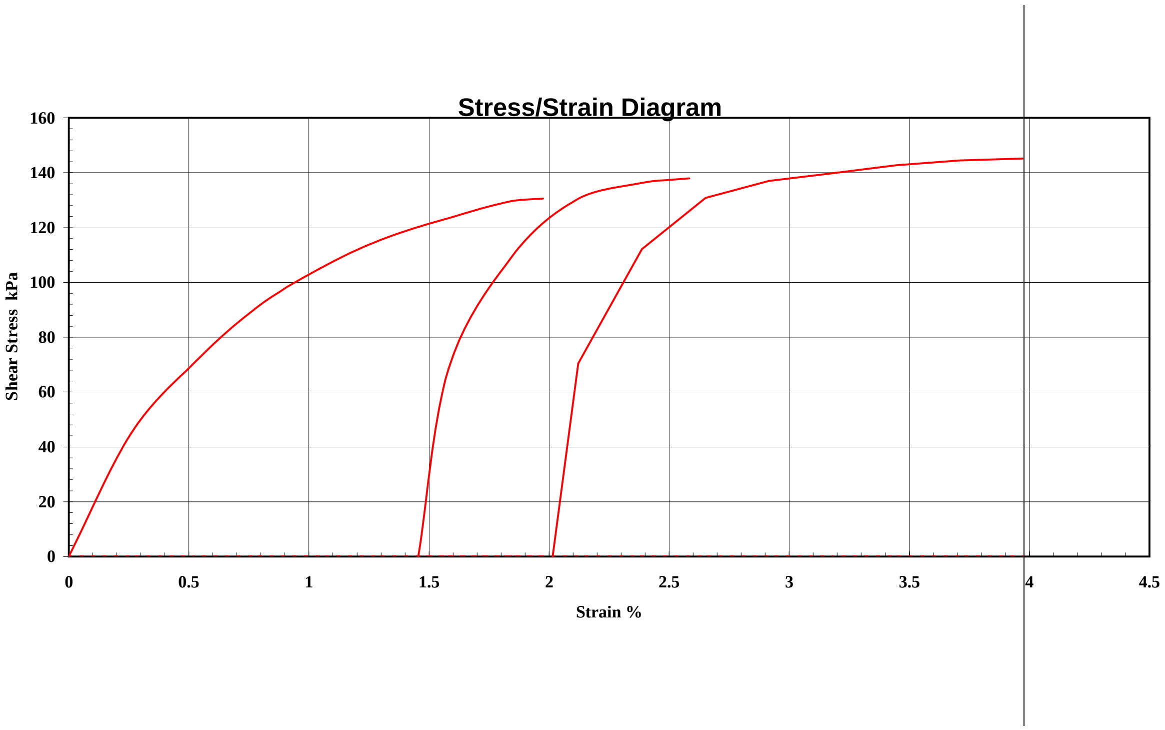
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801845-UU
Project:	77692009	**Test Date:**	6/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA10	**Depth (m):**	1.5-1.9

Description:



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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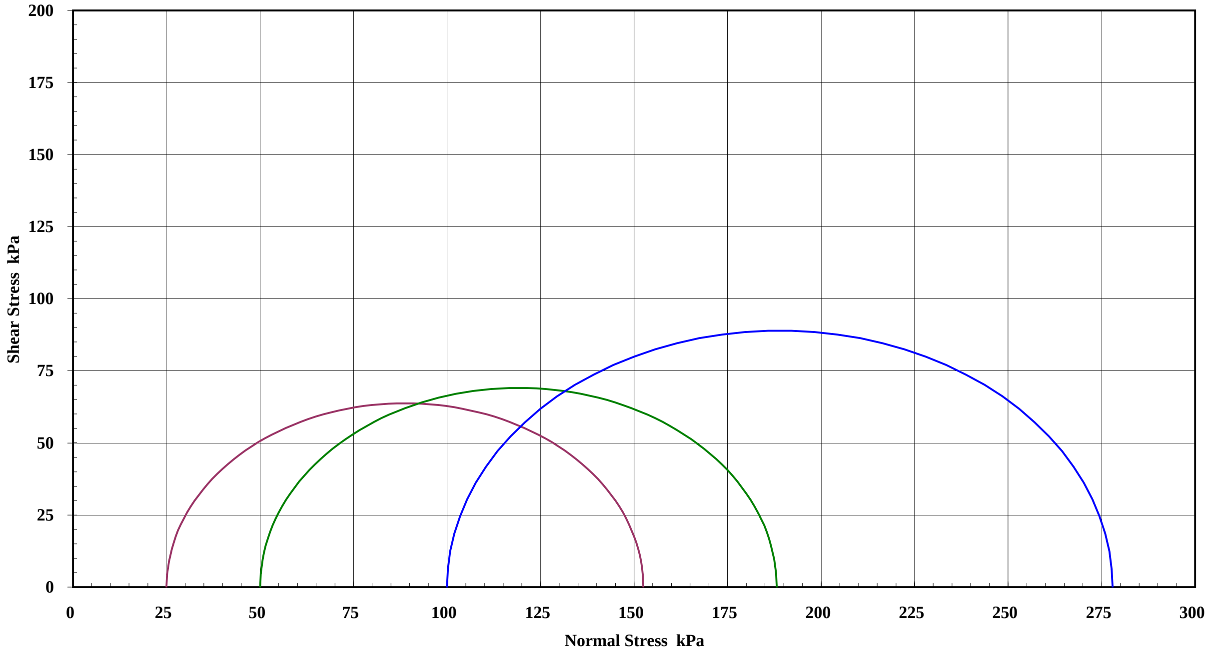
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801846-UU
Project:	7692009	**Test Date:**	6/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA10	**Depth (m):**	2.35-2.75

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	49.0	36.7	41.3
Angle of Shear Resistance Φ (Degrees) :	10.1	16.5	14.9

Cell Pressures (kPa): 25-50-100

Failure Criteria: Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.1	mm	Initial Moisture
Initial Diameter :	47.4	mm	23.8 %
Wet Density :	2.05	t/m^3	Final Moisture
Dry Density :	1.66	t/m^3	
Rate of Strain:	1.041	%/min	23.8 %

FAILURE DETAILS

Principal Stresses		*Deviator Stress*	*Strain*
σ_1	σ_3		
153 kPa	25 kPa	128 kPa	2.60 %
188 kPa	50 kPa	138 kPa	3.35 %
278 kPa	100 kPa	178 kPa	5.88 %

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd

Report No.: 801846-UU

Project: 7692009

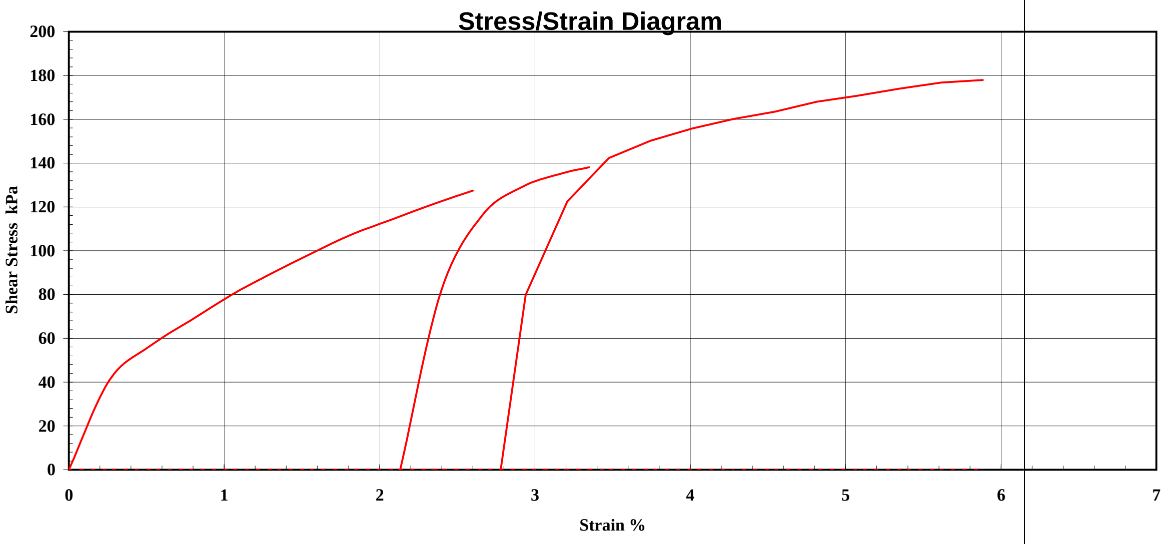
Test Date: 6/02/2008

Report Date: 7/02/2008

Client Id.: TPA10

Depth (m): 2.35-2.75

Description:



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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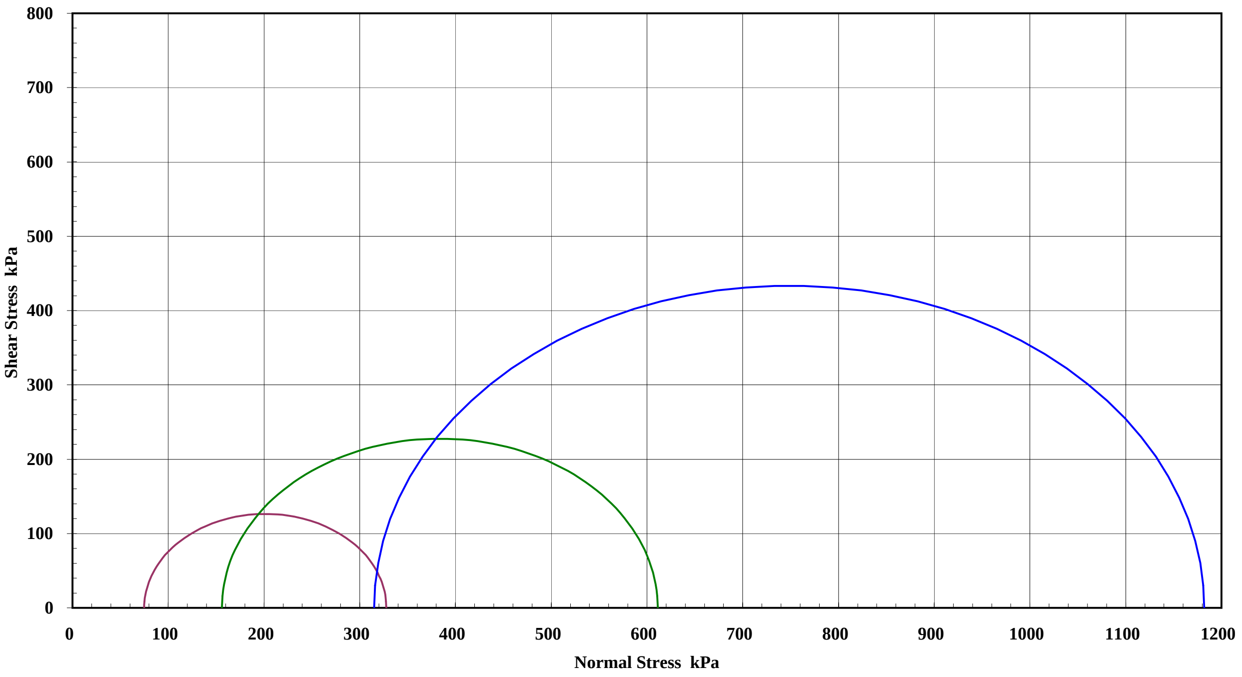
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801847-CU
Project:	077692009	**Test Date:**	13/02/2008
		Report Date:	20/02/2008
Client Id.:	TPA 17	**Depth (m):**	5.0-5.4
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	17.5	13.5	15.5
Angle of Shear Resistance Φ' (Degrees) :	33.7	34.4	34.2

Cell Pressures (kPa):	100-200-400	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	97.2	mm	Initial Moisture
Initial Diameter :	48.0	mm	15.7 %
Wet Density :	2.12	t/m^3	Final Moisture
Dry Density :	1.83	t/m^3	
Rate of Strain:	0.008	%/min	17.2 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
328 kPa	75 kPa	253 kPa	2.21 %
611 kPa	156 kPa	455 kPa	3.47 %
1182 kPa	315 kPa	867 kPa	6.66 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801847-CU

Project: 077692009

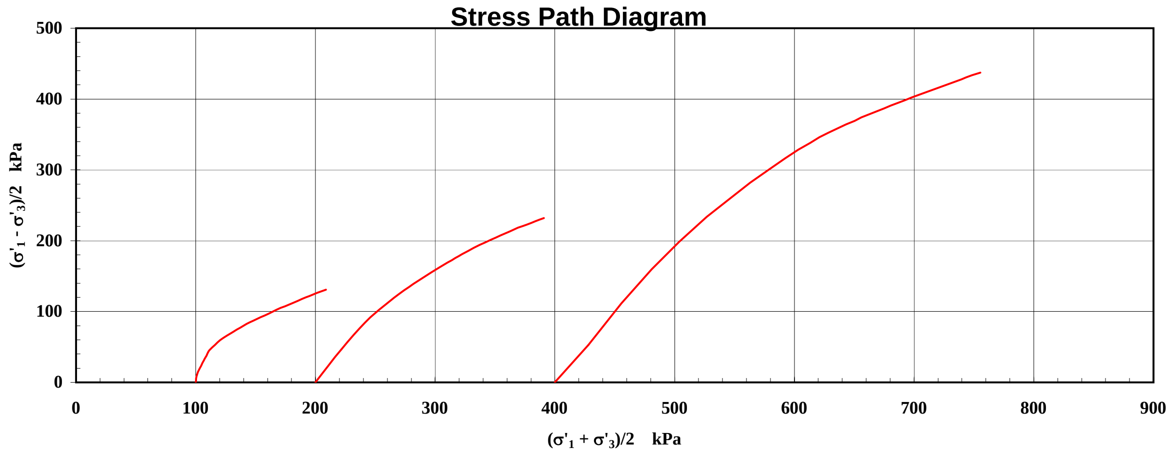
Test Date: 13/02/2008

Report Date: 20/02/2008

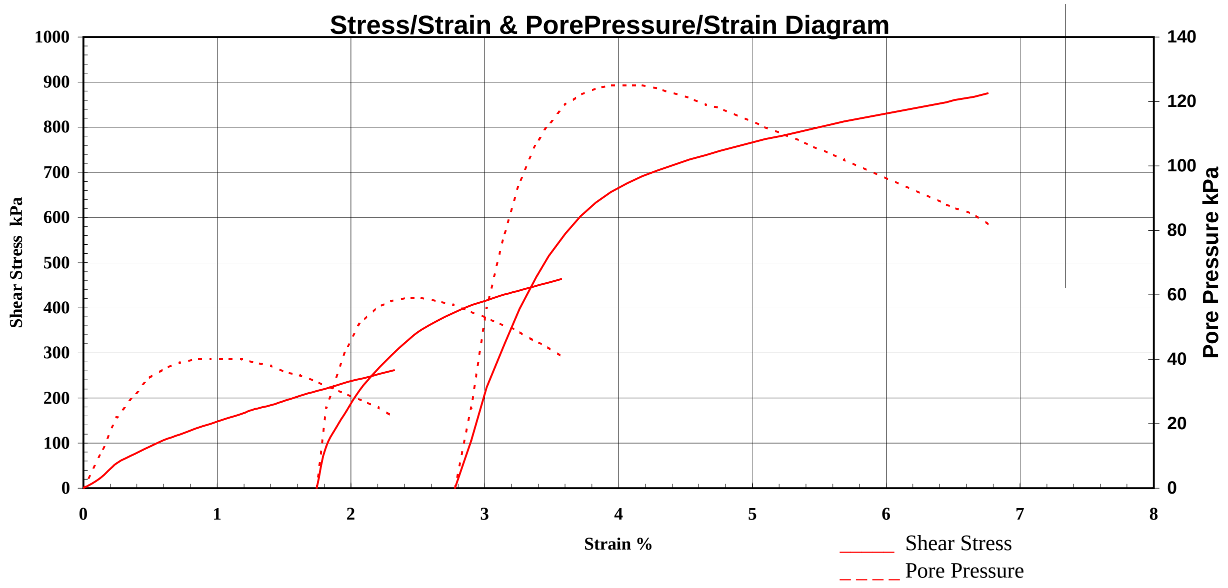
Client Id.: TPA 17

Depth (m): 5.0-5.4

Description



Stress Path Diagram



Stress/Strain & PorePressure/Strain Diagram

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801847-CU
Project:	077692009	**Test Date:**	13/02/2008
		Report Date:	20/02/2008
Client Id.:	TPA 17	**Depth (m):**	5.0-5.4

Description

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 801847
BH: 17
AFTER TEST
DATE: 18/2/2008
Depth: 5.0-5.4

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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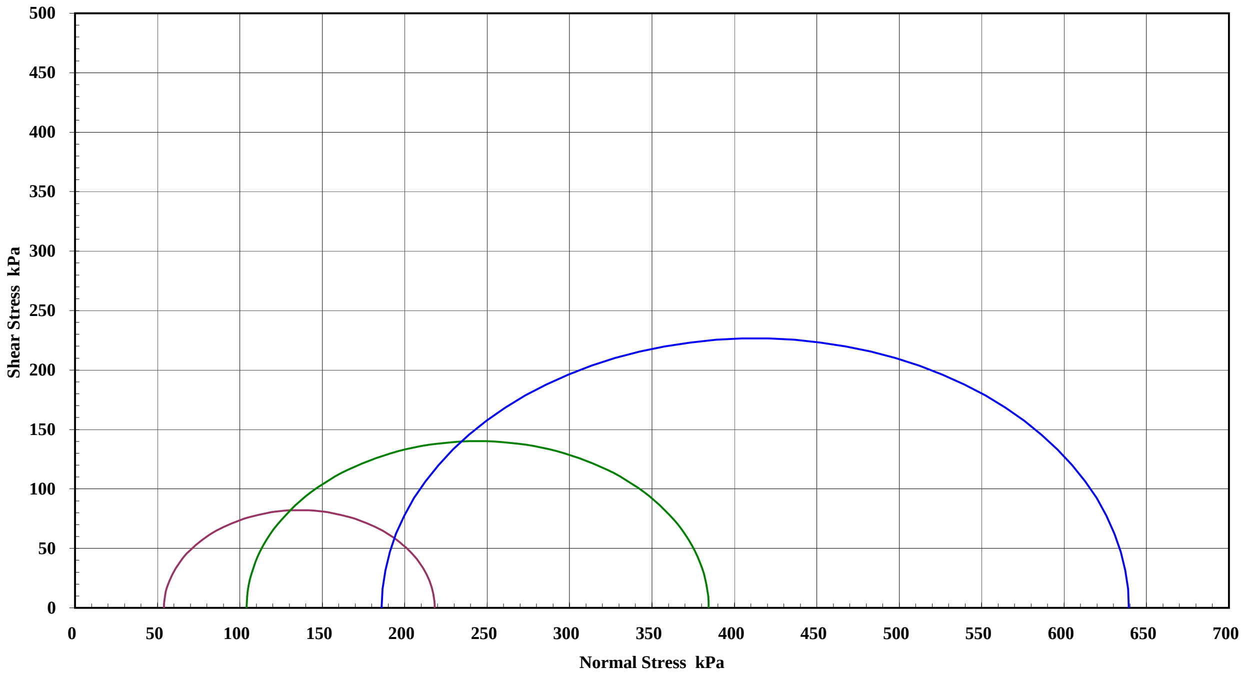
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801848-CU
Project:	077692009	**Test Date:**	8/02/2008
		Report Date:	13/02/2008
Client Id.:	TPA 17	**Depth (m):**	6.2-6.6

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	10.7	17.3	13.8
Angle of Shear Resistance Φ' (Degrees) :	32.5	30.9	31.5

Cell Pressures (kPa):	100-200-400	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				*FAILURE DETAILS*			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
			Initial Moisture	σ'$_1$	σ'$_3$		
Initial Height :	96.7	mm					
Initial Diameter :	47.9	mm	22.3 %	218 kPa	54 kPa	164 kPa	1.91 %
Wet Density :	2.02	t/m^3	Final Moisture	384 kPa	104 kPa	280 kPa	3.79 %
Dry Density :	1.65	t/m^3		639 kPa	186 kPa	453 kPa	6.03 %
Rate of Strain:	0.008	%/min	22.4 %				
B Response:	99	%					

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801848-CU

Project: 077692009

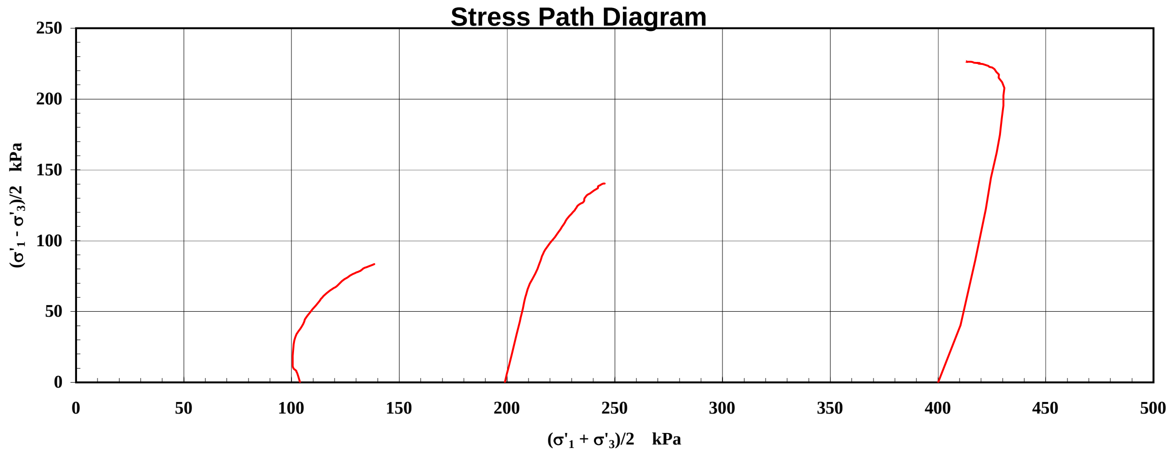
Test Date: 8/02/2008

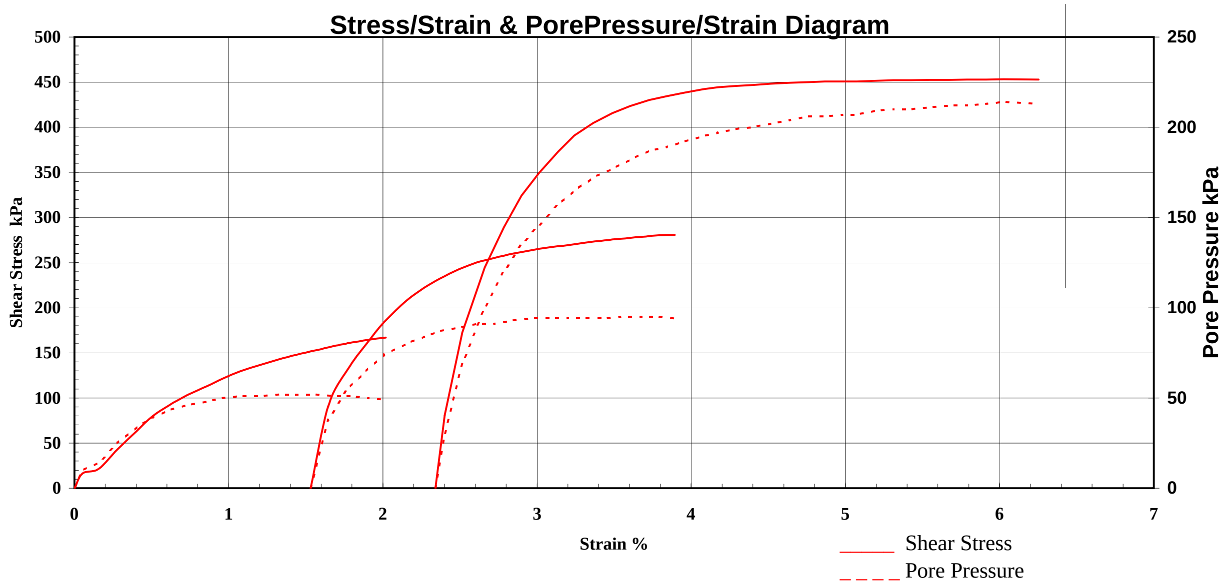
Report Date: 13/02/2008

Client Id.: TPA 17

Depth (m): 6.2-6.6

Description





Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801848-CU

Project: 077692009

Test Date: 8/02/2008

Report Date: 13/02/2008

Client Id.: TPA 17

Depth (m): 6.2-6.6

Description

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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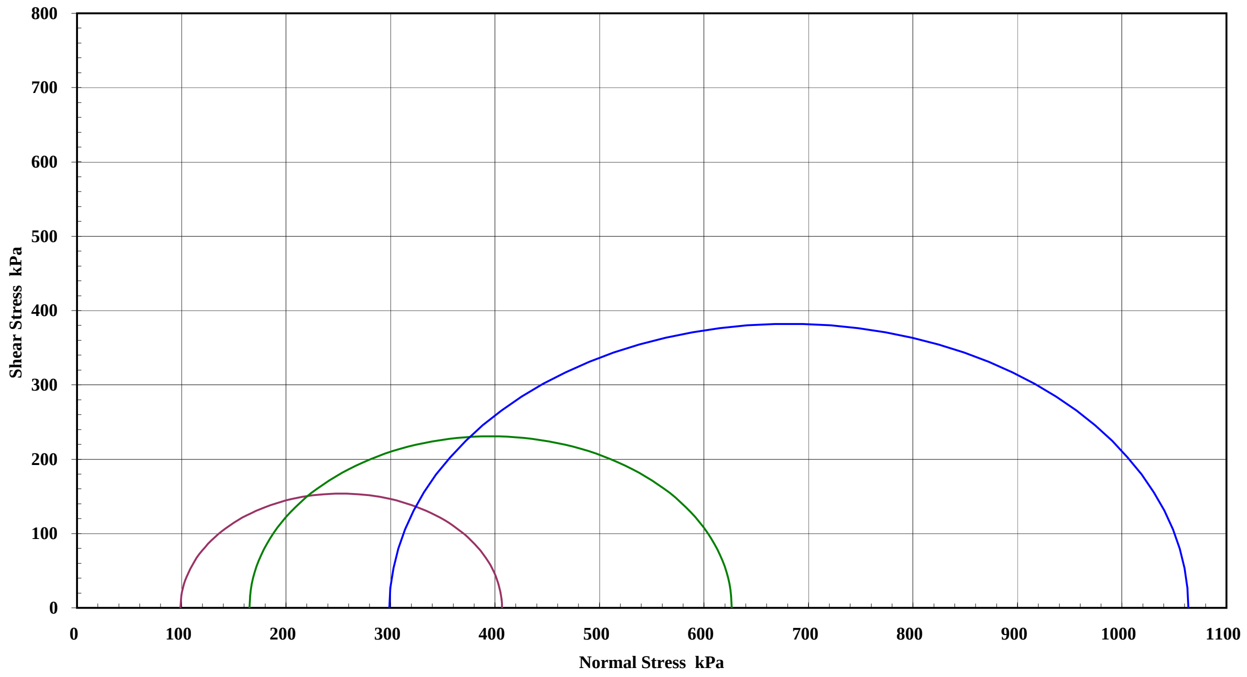
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801849-CU
Project:	077692009	**Test Date:**	14/02/2008
		Report Date:	20/02/2008
Client Id.:	TPA 17	**Depth (m):**	7.5-7.9

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	21.0	24.5	23.0
Angle of Shear Resistance **Φ'** (Degrees) :	32.6	32.0	32.2

Cell Pressures (kPa): 100-200-400

Failure Criteria: Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.9	mm	Initial Moisture
Initial Diameter :	48.0	mm	14.0 %
Wet Density :	2.15	t/m^3	Final Moisture
Dry Density :	1.89	t/m^3	
Rate of Strain:	0.009	%/min	14.8 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
407 kPa	99 kPa	308 kPa	2.40 %
627 kPa	165 kPa	462 kPa	3.00 %
1064 kPa	299 kPa	765 kPa	4.71 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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Authorised Signatory

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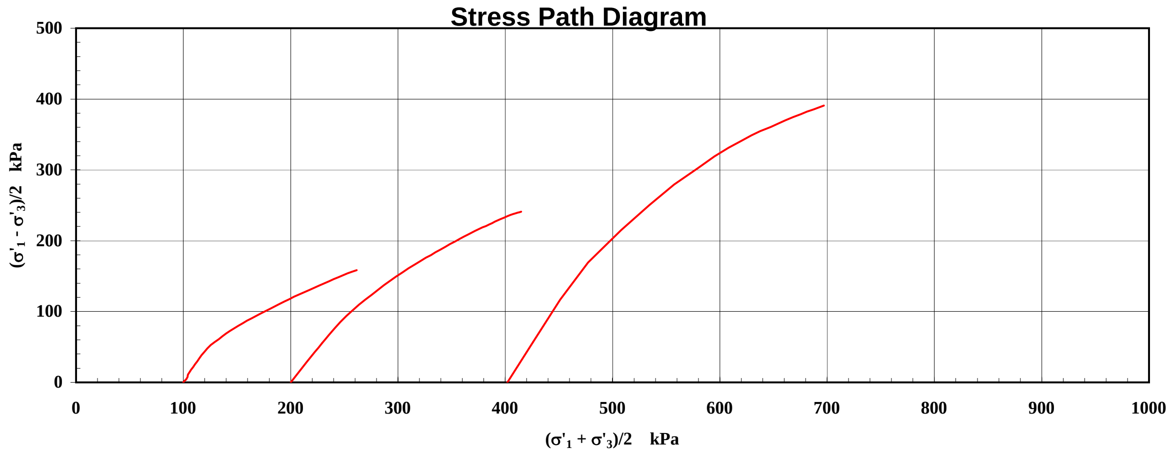
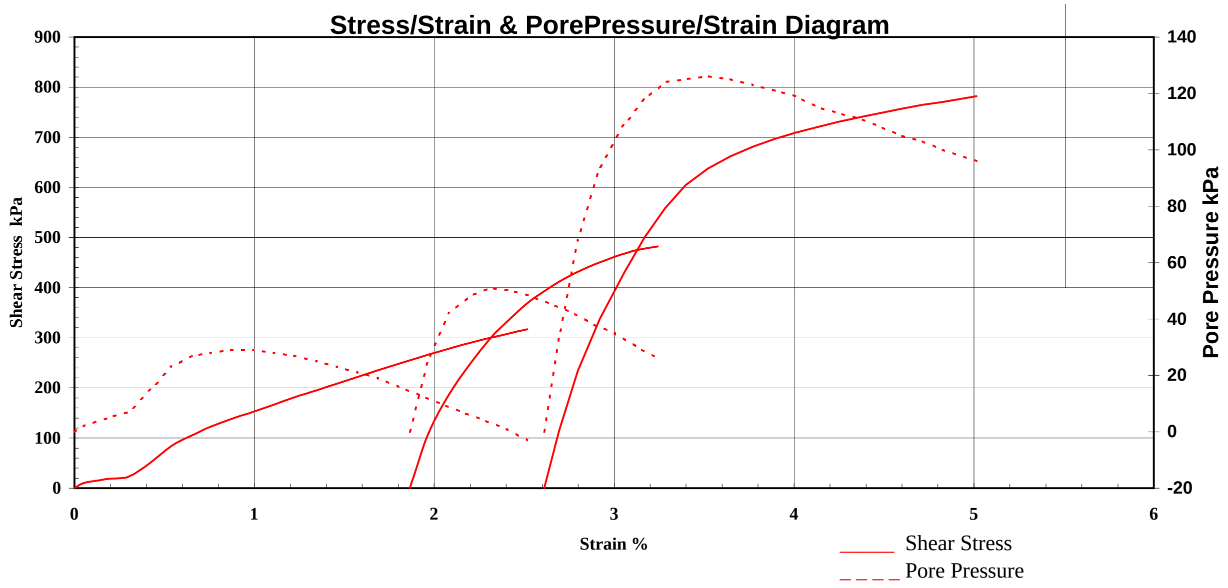
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801849-CU
Project:	077692009	**Test Date:**	14/02/2008
		Report Date:	20/02/2008
Client Id.:	TPA 17	**Depth (m):**	7.5-7.9

Description





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801849-CU
Project:	077692009	**Test Date:**	14/02/2008
		Report Date:	20/02/2008
Client Id.:	TPA 17	**Depth (m):**	7.5-7.9

Description

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801861-CU

Project: 077692009

Test Date: 11/02/2008

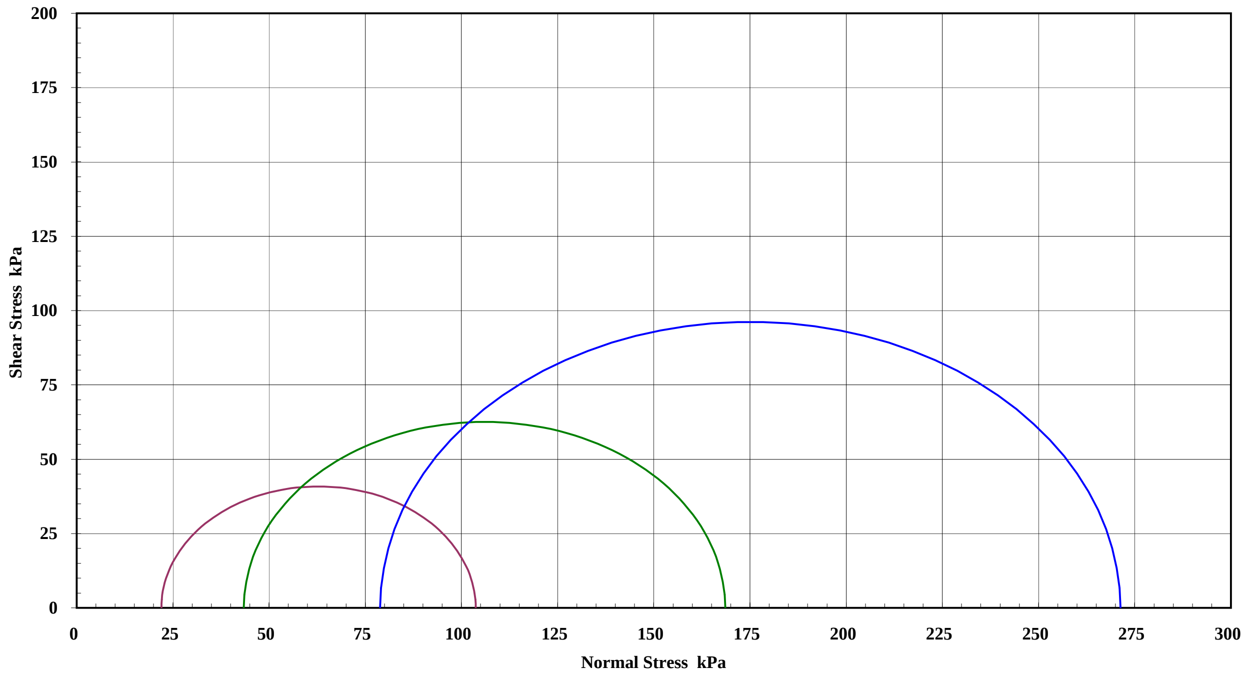
Report Date: 16/02/2008

Client Id.: TPA 22

Depth (m): 1.5-1.9

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	10.7	12.5	11.6
Angle of Shear Resistance Φ' (Degrees) :	30.2	29.1	29.5

Cell Pressures (kPa): 50-100-200

Failure Criteria: Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.6	mm	Initial Moisture
Initial Diameter :	47.0	mm	26.5 %
Wet Density :	1.99	t/m^3	Final Moisture
Dry Density :	1.57	t/m^3	
Rate of Strain:	0.008	%/min	22.8 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'$_1$	σ'$_3$		
104 kPa	22 kPa	82 kPa	1.90 %
168 kPa	43 kPa	125 kPa	4.37 %
271 kPa	79 kPa	192 kPa	7.00 %

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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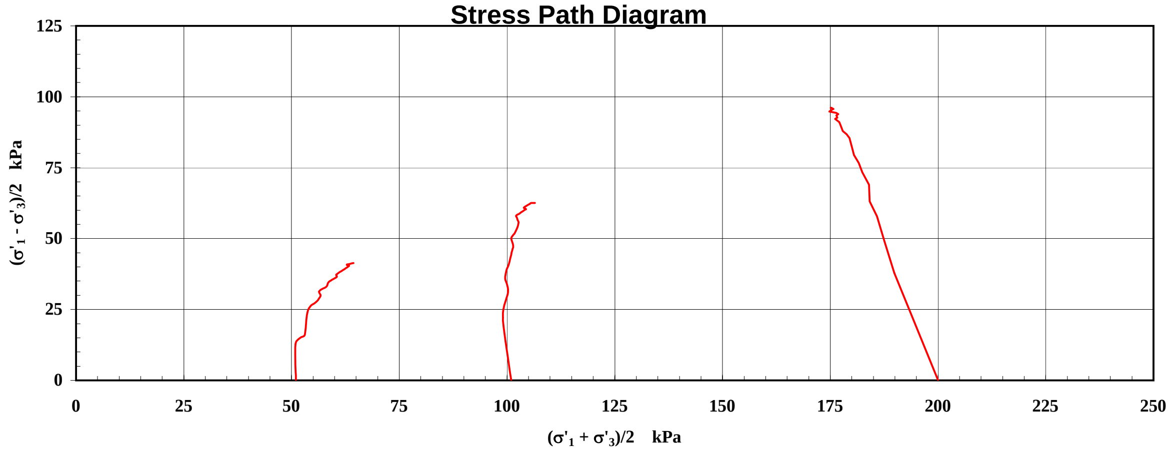
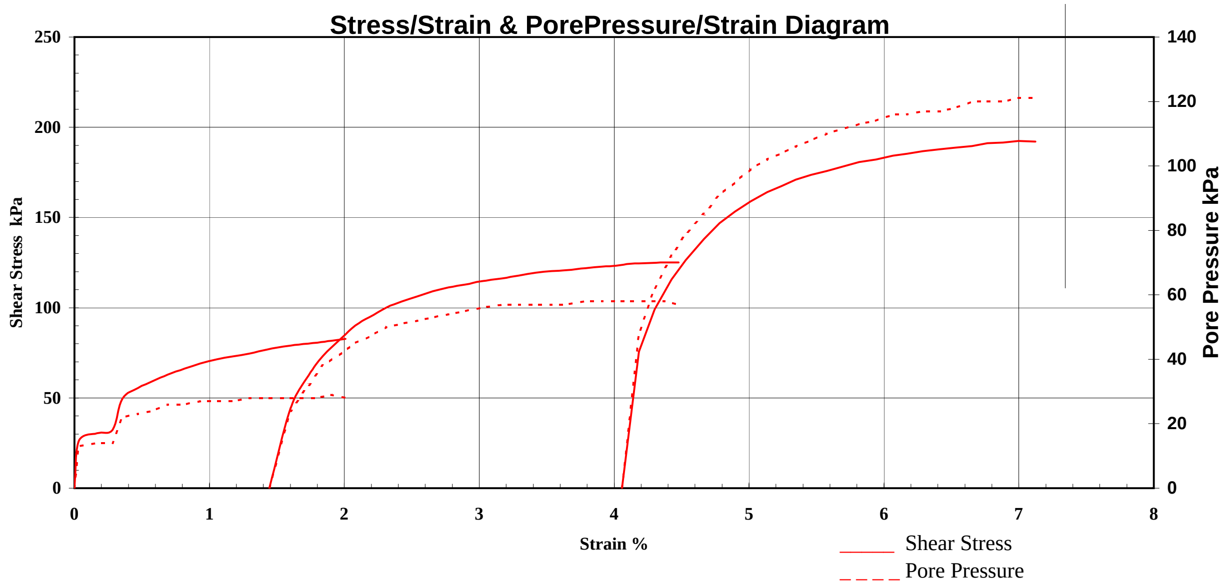
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801861-CU
Project:	077692009	**Test Date:**	11/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 22	**Depth (m):**	1.5-1.9

Description





Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801861-CU
Project:	077692009	**Test Date:**	11/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 22	**Depth (m):**	1.5-1.9

Description

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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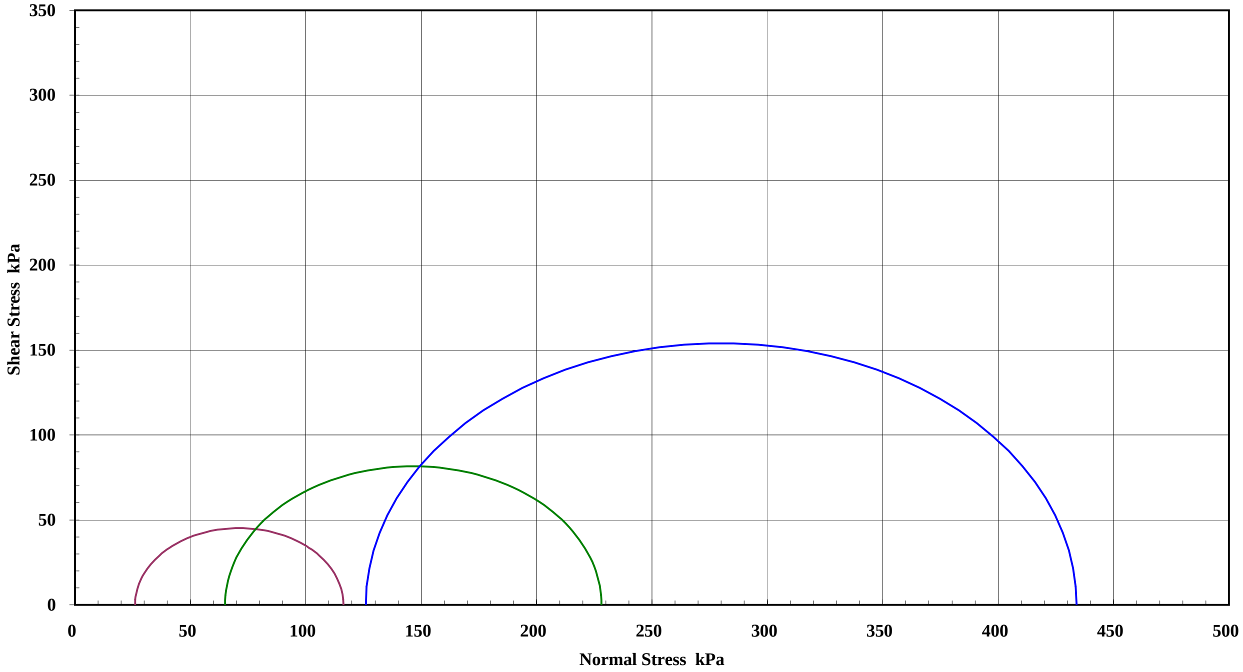
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801862-CU
Project:	077692009	**Test Date:**	10/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 22	**Depth (m):**	3.3-3.7

Description:

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	12.3	2.4	7.9
Angle of Shear Resistance Φ' (Degrees) :	28.9	32.9	31.6

Cell Pressures (kPa):	60-120-240	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS				*FAILURE DETAILS*			
Sample Details			*Moisture Contents*	*Principal Effective Stresses*		*Deviator Stress*	*Strain*
Initial Height :	95.8	mm	Initial Moisture	σ'_1	σ'_3		
Initial Diameter :	44.7	mm	21.6 %	116 kPa	26 kPa	90 kPa	2.23 %
Wet Density :	2.13	t/m^3	Final Moisture	228 kPa	65 kPa	163 kPa	4.16 %
Dry Density :	1.75	t/m^3		434 kPa	126 kPa	308 kPa	6.49 %
Rate of Strain:	0.008	%/min	19.2 %				
B Response:	98	%					

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801862-CU

Project: 077692009

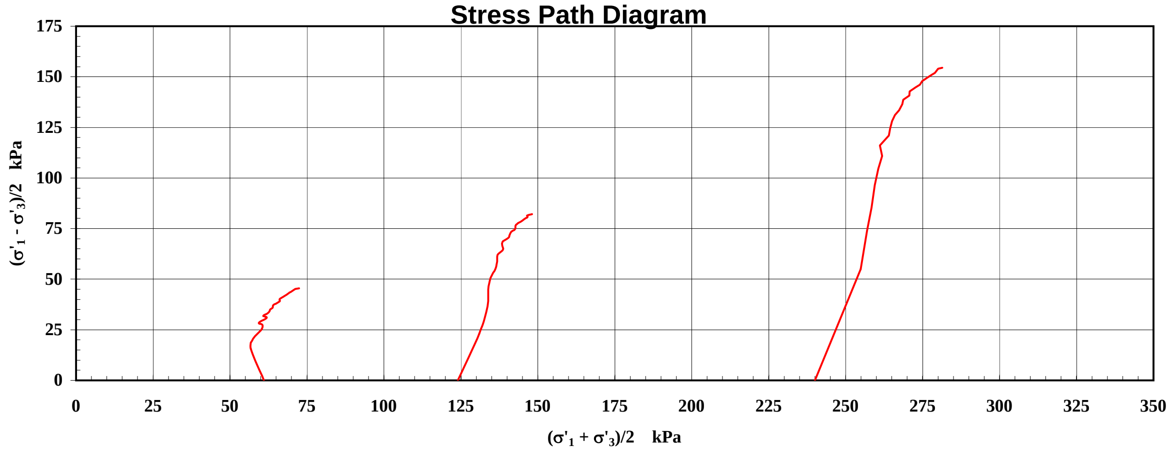
Test Date: 10/02/2008

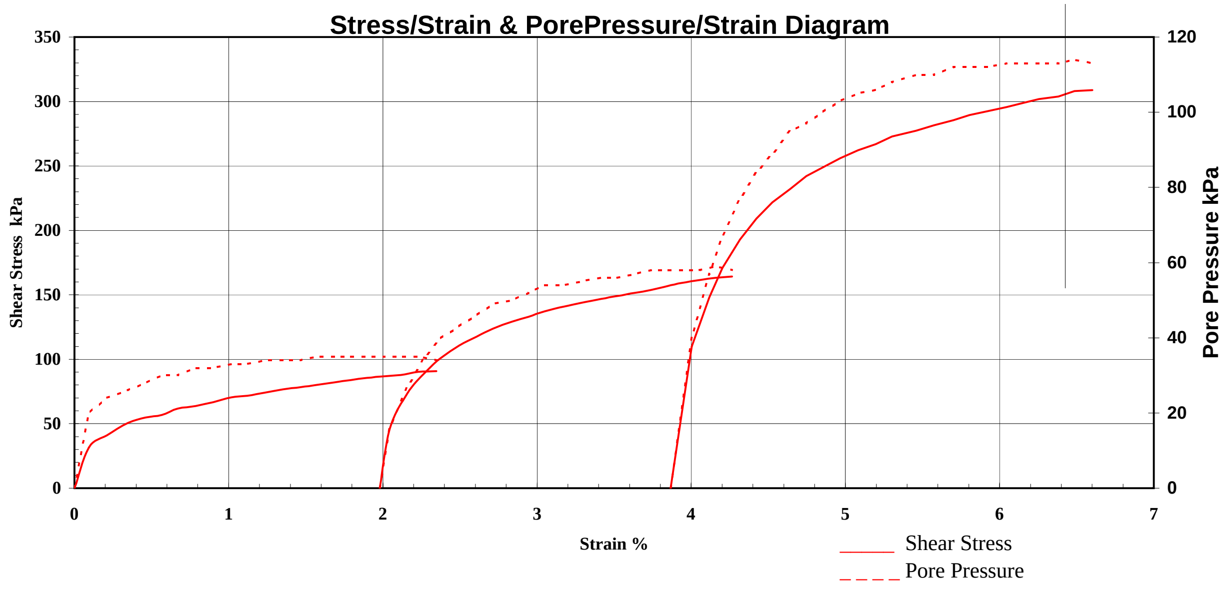
Report Date: 16/02/2008

Client Id.: TPA 22

Depth (m): 3.3-3.7

Description





Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801862-CU
Project:	077692009	**Test Date:**	10/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 22	**Depth (m):**	3.3-3.7

Description

CLIENT: GOLDER ASSOCIATES
PROJECT: 077692009
LAB SAMPLE No. 801862
BH: TPA 22
AFTER TEST
DATE: 13/2/08
DEPTH: 3.3-3.7

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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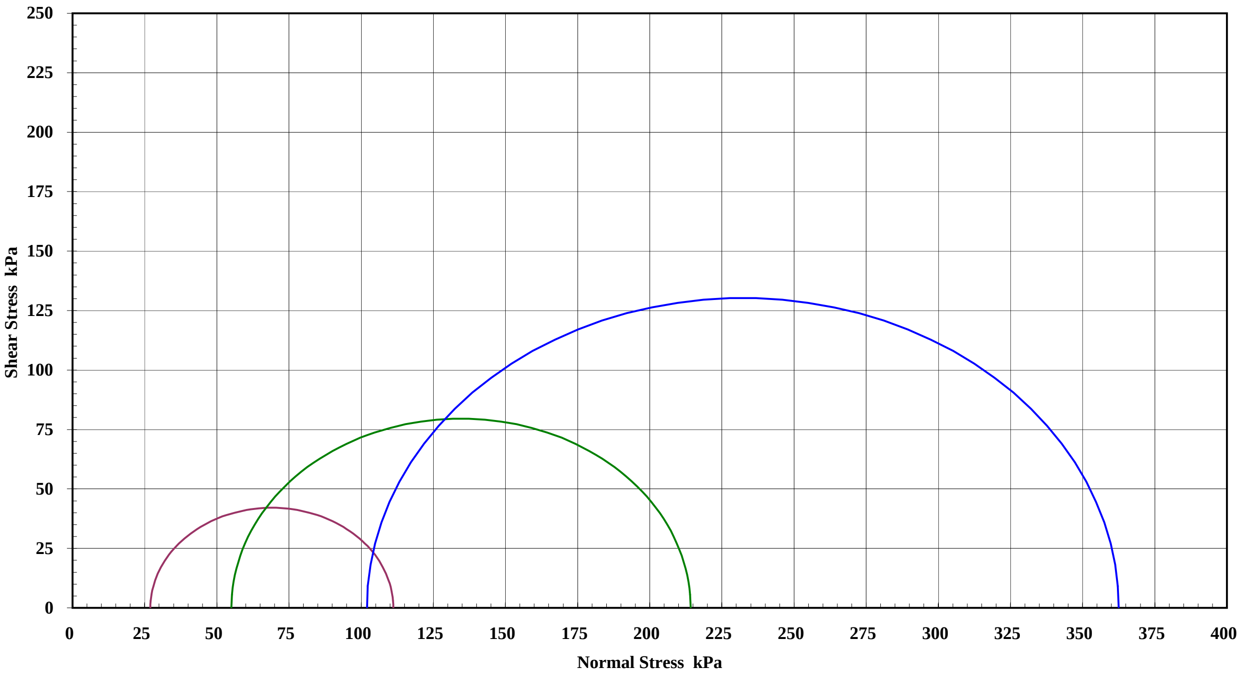
Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801863-CU
Project:	077692009	**Test Date:**	10/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 22	**Depth (m):**	4.5-4.9
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	3.1	11.4	6.8
Angle of Shear Resistance **Φ'** (Degrees) :	34.9	31.3	32.6

Cell Pressures (kPa):	50-100-200	Failure Criteria:	Peak Principal Stress Ratio

SAMPLE & TEST DETAILS

Sample Details			*Moisture Contents*
Initial Height :	96.5	mm	Initial Moisture
Initial Diameter :	47.4	mm	24.5 %
Wet Density :	2.04	t/m^3	Final Moisture
Dry Density :	1.64	t/m^3	
Rate of Strain:	0.008	%/min	23.3 %
B Response:	99	%	

FAILURE DETAILS

Principal Effective Stresses		*Deviator Stress*	*Strain*
σ'_1	σ'_3		
111 kPa	27 kPa	84 kPa	1.63 %
214 kPa	55 kPa	159 kPa	3.87 %
363 kPa	102 kPa	261 kPa	6.27 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Golder Associates Pty Ltd

Report No.: 801863-CU

Project: 077692009

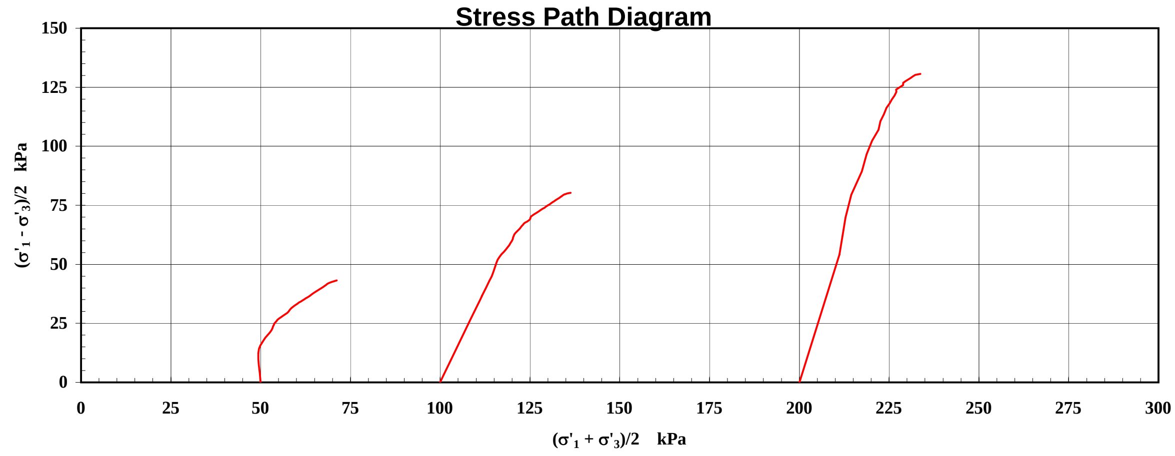
Test Date: 10/02/2008

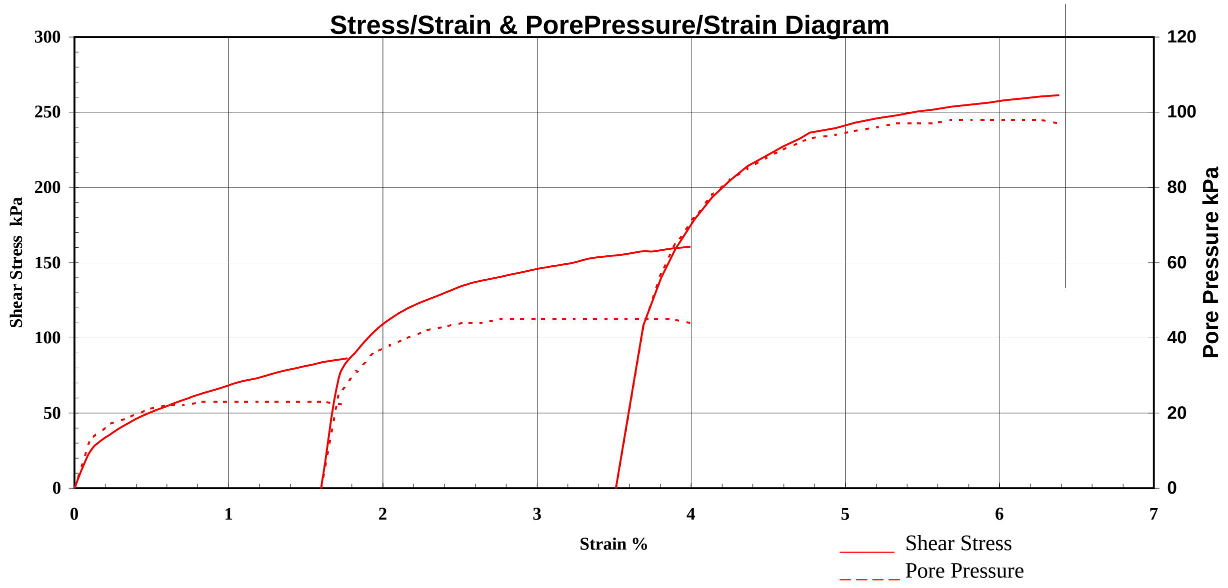
Report Date: 16/02/2008

Client Id.: TPA 22

Depth (m): 4.5-4.9

Description


Stress Path Diagram


Stress/Strain & PorePressure/Strain Diagram

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Golder Associates Pty Ltd	**Report No.:**	801863-CU
Project:	077692009	**Test Date:**	10/02/2008
		Report Date:	16/02/2008
Client Id.:	TPA 22	**Depth (m):**	4.5-4.9

Description

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received

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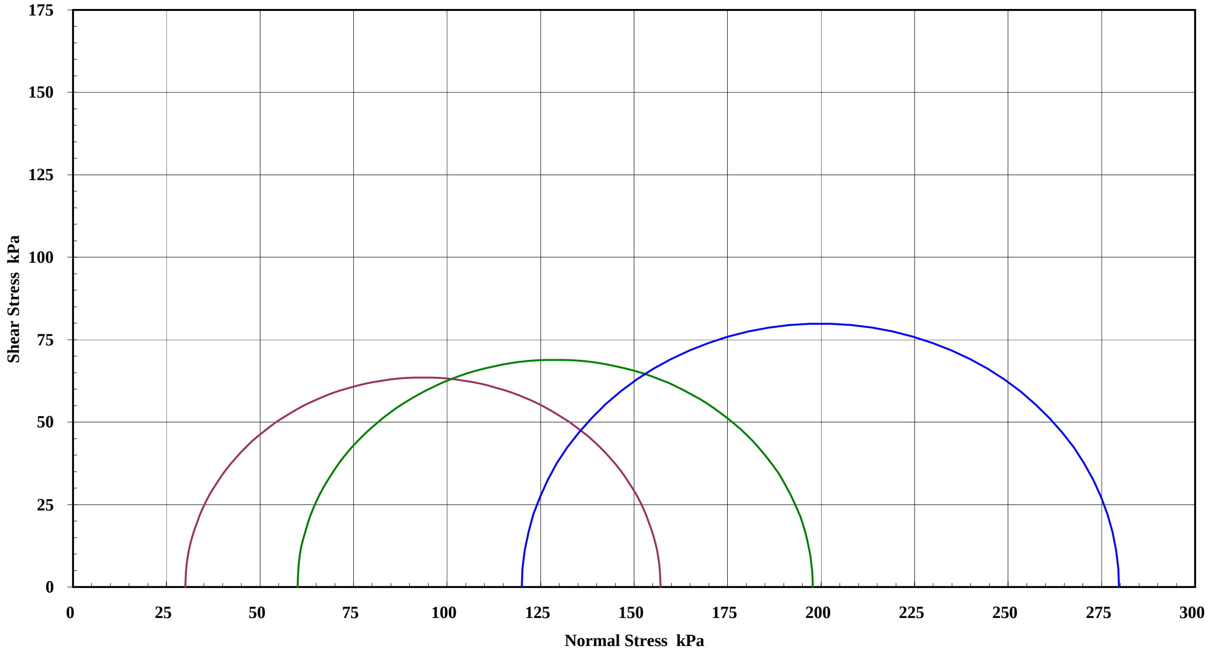
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801867-UU
Project:	77692009	**Test Date:**	6/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA23	**Depth (m):**	3.0-3.4
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	49.9	49.6	49.8
Angle of Shear Resistance **Φ** (Degrees) :	8.7	8.9	8.8

Cell Pressures (kPa):	30-60-120	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS				***FAILURE DETAILS***			
Sample Details			*Moisture Contents*	*Principal Stresses*		*Deviator Stress*	*Strain*
			Initial Moisture	σ_1	σ_3		
Initial Height :	96.2	mm	23.8 %	157 kPa	30 kPa	127 kPa	2.49 %
Initial Diameter :	47.4	mm	Final Moisture	198 kPa	60 kPa	138 kPa	3.18 %
Wet Density :	2.05	t/m^3		280 kPa	120 kPa	160 kPa	4.27 %
Dry Density :	1.66	t/m^3					
Rate of Strain:	1.040	%/min	23.8 %				

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd

Report No.: 801867-UU

Project: 77692009

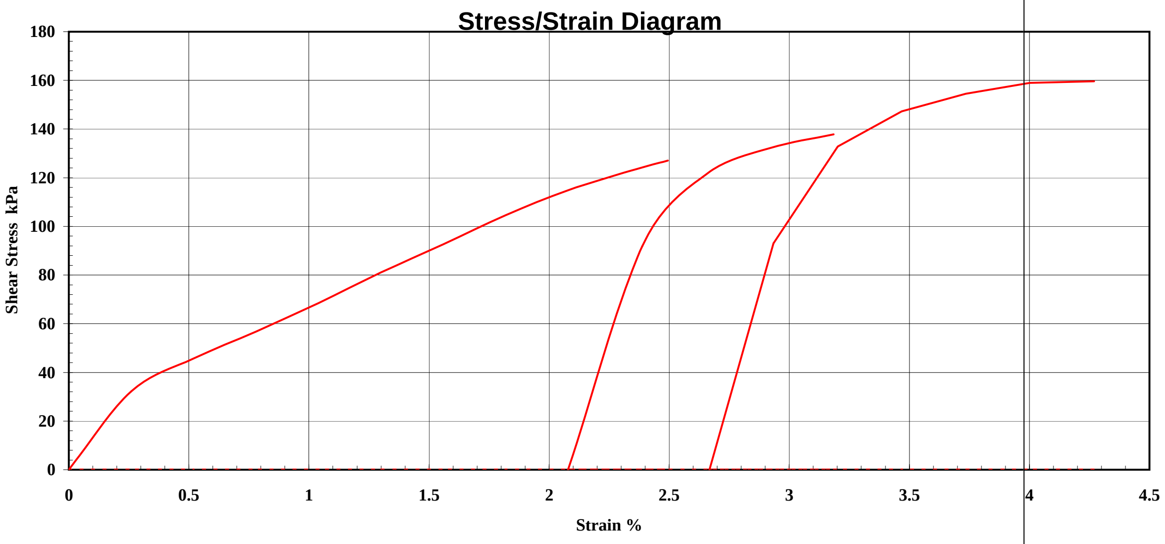
Test Date: 6/02/2008

Report Date: 7/02/2008

Client Id.: TPA23

Depth (m): 3.0-3.4

Description:



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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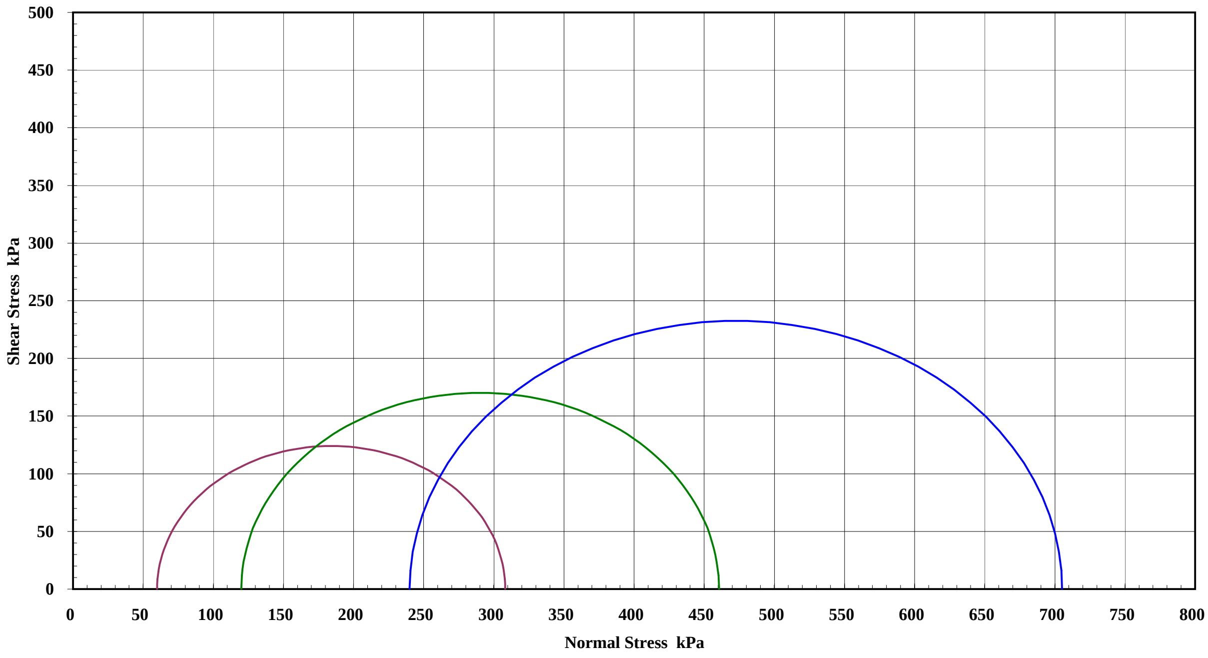
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client:	Golder Associates Pty Ltd	**Report No.:**	801868-UU
Project:	77692009	**Test Date:**	6/02/2008
		Report Date:	7/02/2008
Client Id.:	TPA23	**Depth (m):**	6.0-6.4
Description:			

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C (kPa) :	48.9	75.6	62.6
Angle of Shear Resistance Φ (Degrees) :	25.8	20.0	21.9

Cell Pressures (kPa):	60-120-240	Failure Criteria:	Peak Shear Stress

SAMPLE & TEST DETAILS

Sample Details		
Initial Height :	96.4	mm
Initial Diameter :	46.5	mm
Wet Density :	2.12	t/m^3
Dry Density :	1.80	t/m^3
Rate of Strain:	1.037	%/min

Moisture Contents
Initial Moisture
17.7 %
Final Moisture
17.7 %

FAILURE DETAILS

Principal Stresses		*Deviator Stress*	*Strain*
σ_1	σ_3		
308 kPa	60 kPa	248 kPa	3.11 %
461 kPa	120 kPa	341 kPa	5.00 %
705 kPa	240 kPa	465 kPa	8.38 %

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.1

Client: Golder Associates Pty Ltd

Report No.: 801868-UU

Project: 77692009

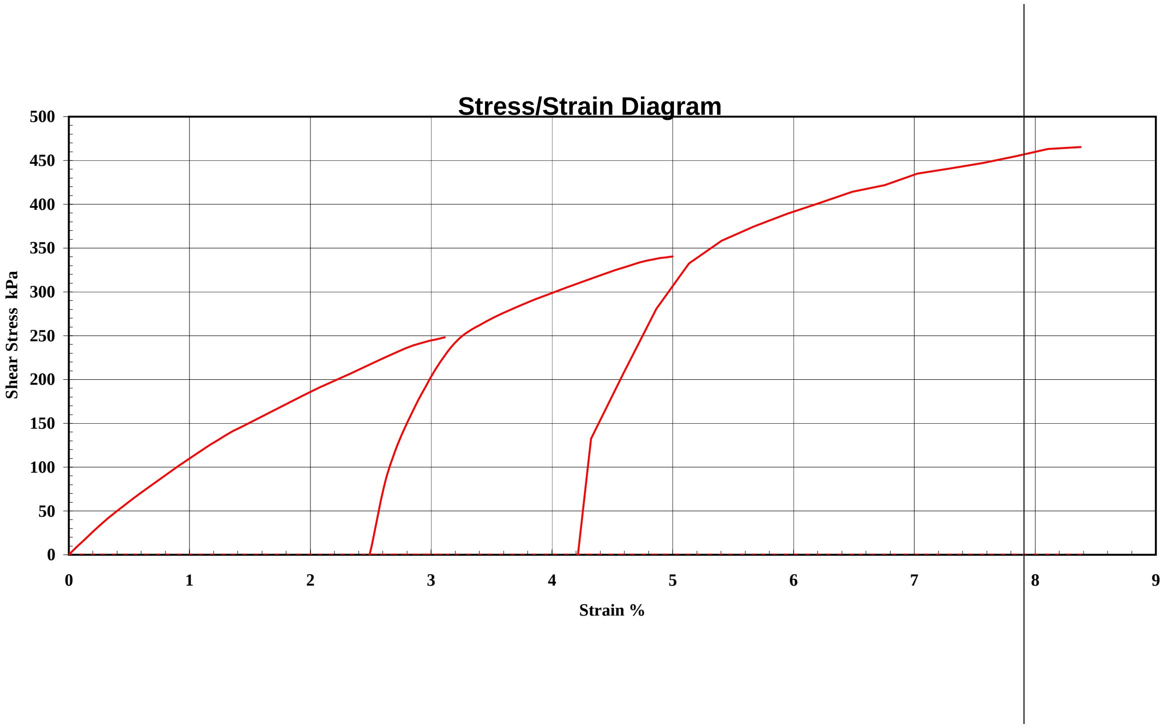
Test Date: 6/02/2008

Report Date: 7/02/2008

Client Id.: TPA23

Depth (m): 6.0-6.4

Description:



Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as received

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Appendix D
ASS / PASS Field Screening and Laboratory Records & Cross Sections

Test Location	Depth Range (m - BGL)		Material Description	pH_{KCl}	sTAA (%S)	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Acid Neutralising Capacity %$CaCO_3$ (if pH more than 6.5)	Net Acidity %S (S_{CR}+Existing Acidity - ANC/FF)	Is This ASS	Is This PASS	Liming Rate for Existing Acidity (Neutralises AASS only) (kg/m^3)	Liming Rate for Net Acidity (Neutralises both AASS & PASS) (kg/m^3)
TPA1	0.00	0.25	Sandy Clay	8.9	< 0.020		0.000	0.680	1.5	0.520	No	YES	NA	39.3
TPA1	0.50	0.75	Clay	8.8	< 0.020		0.000	0.020	1.500	-0.140	No	No	NA	NA
TPA1	1.00	1.25	Clay	8.6	< 0.020		0.000	0.020	1.5	-0.140	No	No	NA	NA
TPA1	7.00	7.45	Sandy Clay	8.6	< 0.020		0.000	0.020	0.81	-0.067	No	No	NA	NA
TPA3	0.50	0.75	Clay	8.3	< 0.020		0.000	1.050	0.76	0.969	No	YES	NA	73.3
TPA3	0.75	1.00	Clay	8.1	< 0.020		0.000	0.670	0.81	0.583	No	YES	NA	44.1
TPA3	1.00	1.25	Clay	8.9	< 0.020		0.000	0.030	1.22	-0.100	No	No	NA	NA
TPA5	1.50	1.80	Silty Sand	9.1	< 0.020		0.000	0.020	8.67	-0.906	No	No	NA	NA
TPA5	2.00	2.25	Silty Clay	9.1	< 0.020		0.000	0.140	11.9	-1.131	No	YES	NA	No Additional Lime Required
TPA7	0.00	0.25	Sandy Silt	9.2	< 0.020		0.000	0.090	7.65	-0.727	No	YES	NA	No Additional Lime Required
TPA7	0.25	0.50	Sandy Silt	9.2	< 0.020		0.000	0.140	10.9	-1.024	No	YES	NA	No Additional Lime Required
TPA7	0.50	0.75	Clay	9.2	< 0.020		0.000	0.040	1.58	-0.129	No	YES	NA	No Additional Lime Required
TPA7	0.75	1.00	Clay	9.2	< 0.020		0.000	0.020	1.94	-0.187	No	No	NA	NA
TPA7	1.00	1.25	Clay	9.1	< 0.020		0.000	0.020	5.36	-0.552	No	No	NA	NA
TPA9	0.00	0.30	Silty Sand	9.2	< 0.020		0.000	0.150	9.85	-0.902	No	YES	NA	No Additional Lime Required
TPA9	0.60	0.70	Sandy Silt	8.8	< 0.020		0.000	0.140	1.000	0.033	No	YES	NA	2.5
TPA10	1.20	1.50	Silty Clay	8.7	< 0.020		0.000	0.050	3.04	-0.275	No	YES	NA	No Additional Lime Required
TPA13	0.00	0.25	Sandy Silt	8.9	< 0.020		0.000	0.120	9.12	-0.854	No	YES	NA	No Additional Lime Required
TPA13	0.25	0.50	Sandy Silt	9.0	< 0.020		0.000	0.400	10.9	-0.764	No	YES	NA	No Additional Lime Required
TPA13	0.50	0.75	Sandy Silt	8.8	< 0.020		0.000	0.360	8.11	-0.506	No	YES	NA	No Additional Lime Required
TPA13	0.75	1.00	Sandy Clay	8.7	< 0.020		0.000	0.810	7.4	0.020	No	YES	NA	1.5
TPA13	1.00	1.25	Clay	9.2	< 0.020		0.000	0.240	13.3	-1.180	No	YES	NA	No Additional Lime Required
TPA17	0.00	0.25	Silty Sand	9.2	< 0.020		0.000	0.100	4.26	-0.355	No	YES	NA	No Additional Lime Required
TPA17	0.50	0.75	Silty Sand	9.2	< 0.020		0.000	0.900	3.47	0.529	No	YES	NA	40.0
TPA17	1.00	1.25	Silty Sand	9.3	< 0.020		0.000	0.700	0.56	0.640	No	YES	NA	48.4
TPA22	0.00	0.25	Sandy Clay	9.1	< 0.020		0.000	0.170	16.3	-1.571	No	YES	NA	No Additional Lime Required
TPA22	0.50	0.75	Sandy Clay	8.9	< 0.020		0.000	0.440	4.87	-0.080	No	YES	NA	No Additional Lime Required
TPA22	1.00	1.25	Clay	8.9	< 0.020		0.000	0.050	2.74	-0.243	No	YES	NA	No Additional Lime Requirec

Note:

Liming rates assume a bulk density of 1.6t/m^3

Fineness Factor (FF) = 3.00

TABLE D2
SUMMARY OF ACID SULFATE TEST RESULTS

Client	Port of Townsville
Job Title	Offshore Drilling Project
Location	Townsville Port
Project Number	077692009

Test Location	Depth (m) m-BBL		Material Description	pHf	pH fox	reaction	Interpreted PASS Potential		
							high	medium	low
TPA1	0.00	0.25	Sandy CLAY	7.4	2.3	Moderate		X	
TPA1	0.25	0.50	CLAY	7.7	5.2	Slight			X
TPA1	0.50	0.75	CLAY	7.5	5.4	Slight			X
TPA1	0.75	1.00	CLAY	7.2	5.3	Slight			X
TPA1	1.00	1.25	CLAY	7.1	5.3	Slight			X
TPA3	0.00	0.25	CLAY	8.2	6.3	Slight			X
TPA3	0.25	0.50	CLAY	7.8	1.8	Vigorous	X		
TPA3	0.50	0.75	CLAY	7.6	1.8	Vigorous	X		
TPA3	0.75	1.00	CLAY	8.0	3.1	Slight			X
TPA3	1.00	1.25	CLAY	8.4	5.5	Slight			X
TPA5	1.50	1.80	Clayey silty SAND	7.9	6.0	Slight			X
TPA5	1.80	2.00	Silty SAND	8.3	2.5	Slight	X		
TPA5	2.00	2.25	Silty CLAY	7.1	5.6	Slight			X
TPA5	2.25	2.50	Silty CLAY	8.0	6.0	Slight			X
TPA9	0.00	0.30	Silty SAND	9.1	5.7	Slight			X
TPA9	0.30	0.60	Sandy SILT	9.4	6.1	Slight			X
TPA9	0.60	0.70	Sandy SILT	9.3	5.6	Slight			X
TPA9	0.70	1.15	Sandy SILT	9.1	5.5	Slight			X
TPA10	1.20	1.50	Silty CLAY	8.6	6.0	Slight			X
TPA10	1.90	2.35	CLAY	7.8	6.0	Slight			X
TPA10	5.85	6.30	CLAY	7.5	5.3	Slight			X
TPA17	0.00	0.25	Silty SAND	8.8	5.8	Moderate			X
TPA17	0.25	0.50	Silty SAND	9.1	5.8	Moderate			X
TPA17	0.50	0.75	Silty SAND	9.3	5.9	Moderate			X
TPA17	0.75	1.00	Silty SAND	9.1	5.7	Moderate			X
TPA17	1.00	1.25	Silty SAND	9.2	5.6	Slight			X
TPA22	0.00	0.25	Sandy CLAY	9.0	6.0	Slight			X
TPA22	0.25	0.50	Sandy CLAY	9.0	3.2	Slight	X		
TPA22	0.50	0.75	Sandy CLAY	9.3	5.8	Slight			X
TPA22	0.75	1.00	CLAY	9.1	5.9	Slight			X
TPA22	1.00	1.25	CLAY	9.6	5.8	Slight			X

Notes

BBL - Below Bed Level

Golder Associates

TABLE D1
SUMMARY OF pH FIELD SCREENING TESTS

Client	Port of Townsville
Job Title	Offshore Drilling Project
Location	Townsville Port
Project Number	077692009

Input By: KLF
Date: 3/06/08
Checked By: BW
Date: 3/06/08

J:\2geo07\077692009 - TPA - Port Expansion Project\LAB_TESTING\PASS & CONTAM NEW\077692009 - pH Field Tests.xls

Test Location	Sample Depth (m)		Laboratory Certificate Number (to be deleted before final)	Arsenic	Cadmium	Chromium	Copper	Mercury	Lead	Nickel	Zinc
TPA1	0.00	0.25	EB0803667	<5	<1	9	8	<0.1	18	4	13
TPA1	0.50	0.75	EB0803667	<5	<1	6	7	<0.1	15	4	8
TPA1	1.00	1.25	EB0803667	<5	<1	9	6	<0.1	16	7	17
TPA1	7.00	7.45	EB0803667	<5	<1	8	7	<0.1	28	5	6
TPA3	0.00	0.25	EB0803667	<5	<1	10	10	<0.1	19	5	15
TPA3	0.75	1.00	EB0803667	<5	<1	8	9	<0.1	20	5	7
TPA3	4.50	4.95	EB0803667	14	<1	16	11	<0.1	13	13	30
TPA4	3.00	3.45	EB0803667	<5	<1	7	<5	<0.1	5	<2	6
TPA4	6.00	6.45	EB0803667	<5	<1	4	<5	<0.1	<5	<2	<5
TPA5	1.50	1.80	EB0803667	8	<1	15	6	<0.1	10	8	29
TPA5	1.80	2.00	EB0803667	6	<1	11	9	<0.1	21	6	18
TPA5	2.00	2.25	EB0803667	<5	<1	12	6	<0.1	15	5	12
TPA5	2.25	2.50	EB0803667	<5	<1	11	18	<0.1	12	6	12
TPA7	0.00	0.25	EB0803667	8	<1	16	7	<0.1	10	9	28
TPA7	0.75	1.00	EB0803667	<5	<1	8	6	<0.1	13	3	17
TPA8	2.50	2.95	EB0803667	<5	<1	16	7	<0.1	11	11	30
TPA8	5.50	5.95	EB0803667	7	<1	19	11	<0.1	15	12	35
TPA8	7.00	7.45	EB0803667	<5	<1	2	<5	<0.1	<5	<2	6
TPA9	0.00	0.30	EB0801371	8	<1	13	6	<0.1	8	8	34
TPA9	0.60	0.70	EB0801371	10	<1	16	6	<0.1	9	9	**382**
TPA10	1.20	1.50	EB0801371	<5	<1	9	8	<0.1	24	7	14
TPA10	1.90	2.35	EB0803667	<5	<1	10	<5	<0.1	20	6	17
TPA10	5.85	6.30	EB0803667	<5	<1	6	<5	<0.1	8	4	12
TPA13	0.00	0.25	EB0803667	9	<1	14	8	<0.1	9	8	30
TPA13	0.75	1.00	EB0803667	8	<1	16	9	<0.1	10	10	32
TPA13	2.50	2.95	EB0803667	8	<1	16	11	<0.1	11	9	25
TPA13	4.50	4.95	EB0803667	8	<1	16	12	<0.1	12	10	27
TPA13	8.00	8.45	EB0803667	7	<1	12	11	<0.1	11	9	23
TPA17	0.00	0.25	EB0801371	<5	<1	11	12	<0.1	25	8	33
TPA17	0.50	0.75	EB0801371	6	<1	7	<5	<0.1	8	4	22
TPA17	1.00	1.25	EB0801371	6	<1	8	6	<0.1	8	5	25
TPA17	2.00	2.45	EB0803667	<5	<1	6	19	<0.1	**72**	3	16
TPA17	4.00	4.45	EB0803667	5	<1	6	<5	<0.1	8	3	13
TPA22	0.00	0.25	EB0801371	8	<1	19	9	<0.1	15	11	35
TPA22	0.50	0.75	EB0801371	<5	<1	13	11	<0.1	27	8	24
TPA22	1.00	1.25	EB0801371	<5	<1	11	12	<0.1	25	8	32
Environmental Investigation Level (EIL) Thresholds$^{(1)}$				**20**	**3**	**50**	**60**	**1**	**300**	**60**	**200**
Health based Investigation Level (HIL) Thresholds - Exposure Setting A (Standard Residential)$^{(1\ \&\ 2)}$				**100**	**20**	**100**	**1000**	**15**	**300**	**600**	**7000**
Health based Investigation Level (HIL) Thresholds - Exposure Setting F (Industrial/Commercial)$^{(1\ \&\ 2)}$				**500**	**100**	**500**	**5000**	**75**	**1500**	**3000**	**35000**
National Ocean Disposal Guidelines for Dredged Material: Screening Level - Low $^{(3)}$				**20**	**1.5**	**80**	**65**	**0.15**	**50**	**21**	**200**
National Ocean Disposal Guidelines for Dredged Material: Screening Level - Median $^{(3)}$				**70**	**10**	**370**	**270**	**1**	**220**	**52**	**410**

Notes:

All results are expressed as mg/kg unless otherwise specified

(1) Draft Internal Guideline - QLD EPA Contaminated Land Unit, January 1999

(2) Environmental and Health Based Investigation Levels from Draft Guidelines for Assessment and Management of Contaminated Land in Queensland, May 1998

(3) National Ocean Disposal Guidelines for Dredged Material, Environment Australia, May 2002

EIL for Chromium is Cr (III)

HIL for Chromium is Cr (VI)

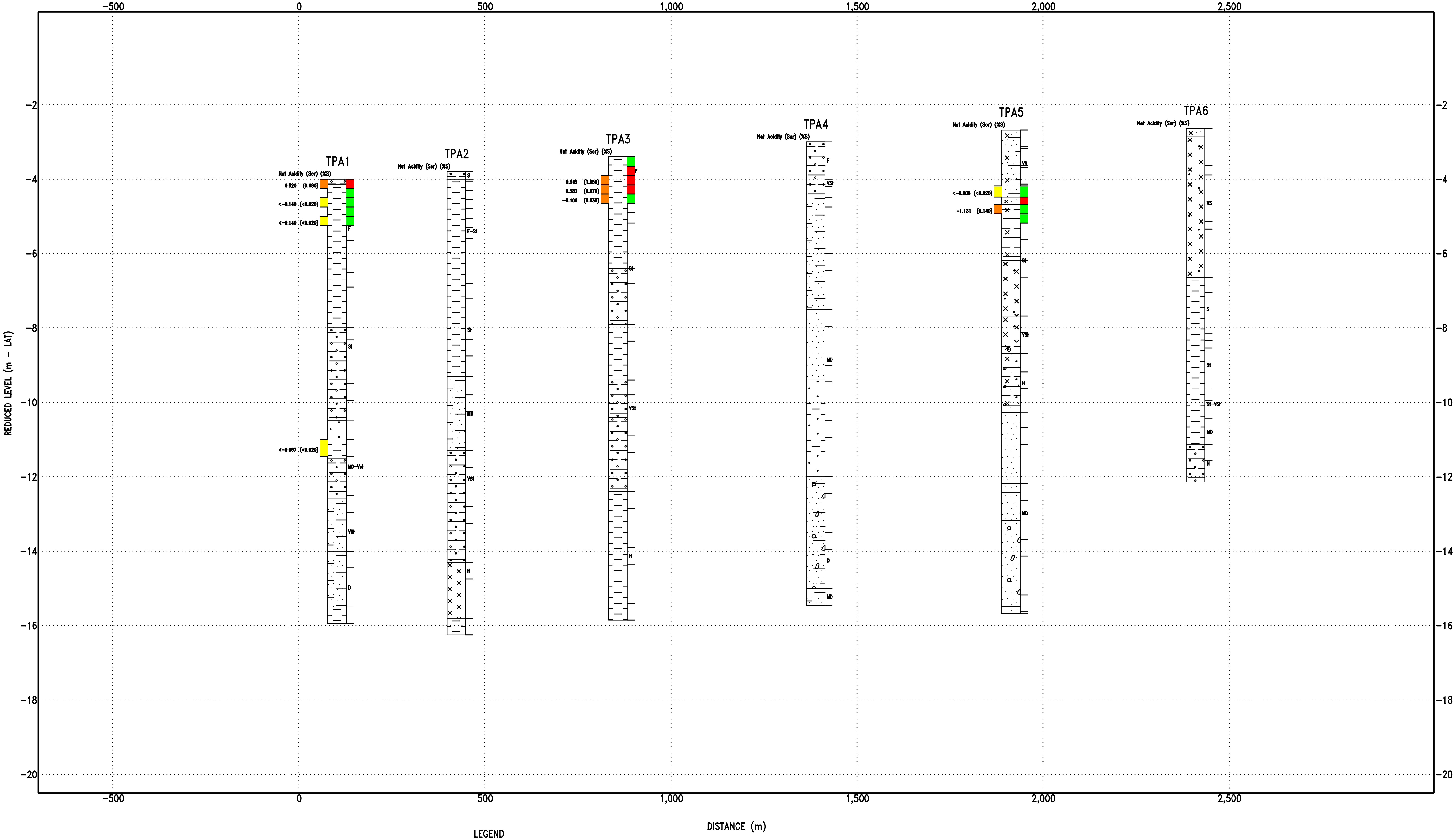
Figures in bold underline exceed either the EIL/HIL Thresholds or NODG Screening Levels

Golder Associates

TABLE D3
SUMMARY OF ANALYTICAL RESULTS
METALS

Client	Port of Townsville
Job Title	Offshore Drilling Project
Location	Townsville Port
Project Number	077692009

INPUT BY: KLF
DATE: 3/06/08
CHECKED BY: BW
DATE: 3/06/08



LEGEND

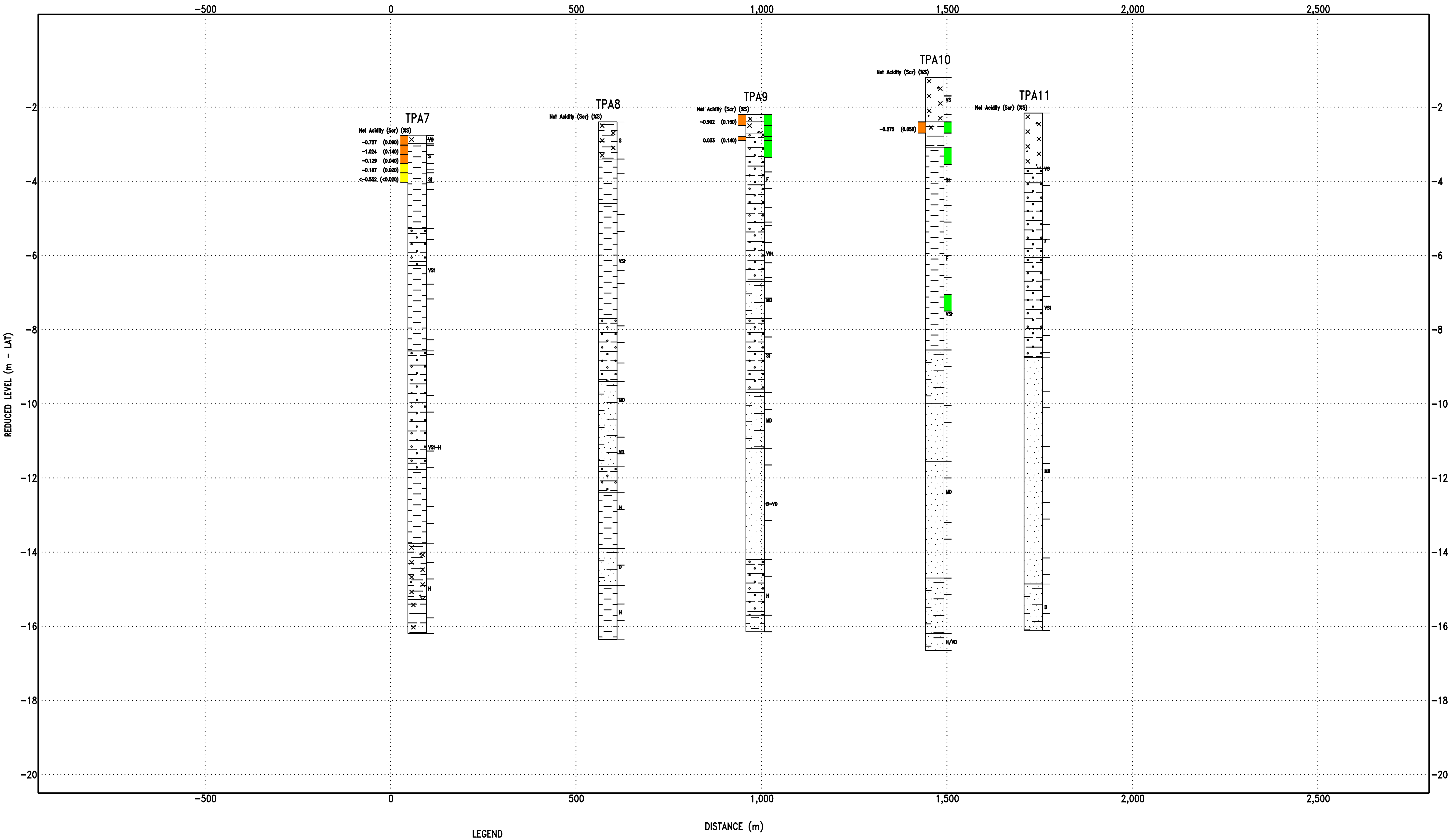
FIELD INDICATORS
- 🟥 HIGH FIELD PASS POTENTIAL
- 🟦 MODERATE FIELD PASS POTENTIAL
- 🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS
- 🟧 EXCEEDS QASSIT ACTION LEVEL
- 🟨 BELOW QASSIT ACTION LEVEL

- ▨ Sandy CLAY
- ▨ CLAY
- ▨ Interbedded SAND & CLAY
- ▨ Clayey SAND
- ▨ SILT
- ▨ SAND
- ▨ Clayey Gravelly SAND
- ▨ Clayey Silty SAND
- ▨ Silty SAND
- ▨ Silty CLAY
- ▨ Sandy SILT
- ▨ Sandy SILT

Golder Associates

CLIENT	Port of Townsville		PROJECT	Offshore Drilling Project
DRAWN	WSB	DATE May 2008	TITLE	INFERRED SUBSURFACE CROSS SECTION AS1
CHECKED	RAJ	DATE May 2008		
SCALE	H 1:10000 V 1:100	A3	PROJECT No 077692009	FIGURE No AS1



FIELD INDICATORS

🟥 HIGH FIELD PASS POTENTIAL

🟦 MODERATE FIELD PASS POTENTIAL

🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS

🟧 EXCEEDS QASSIT ACTION LEVEL

🟨 BELOW QASSIT ACTION LEVEL

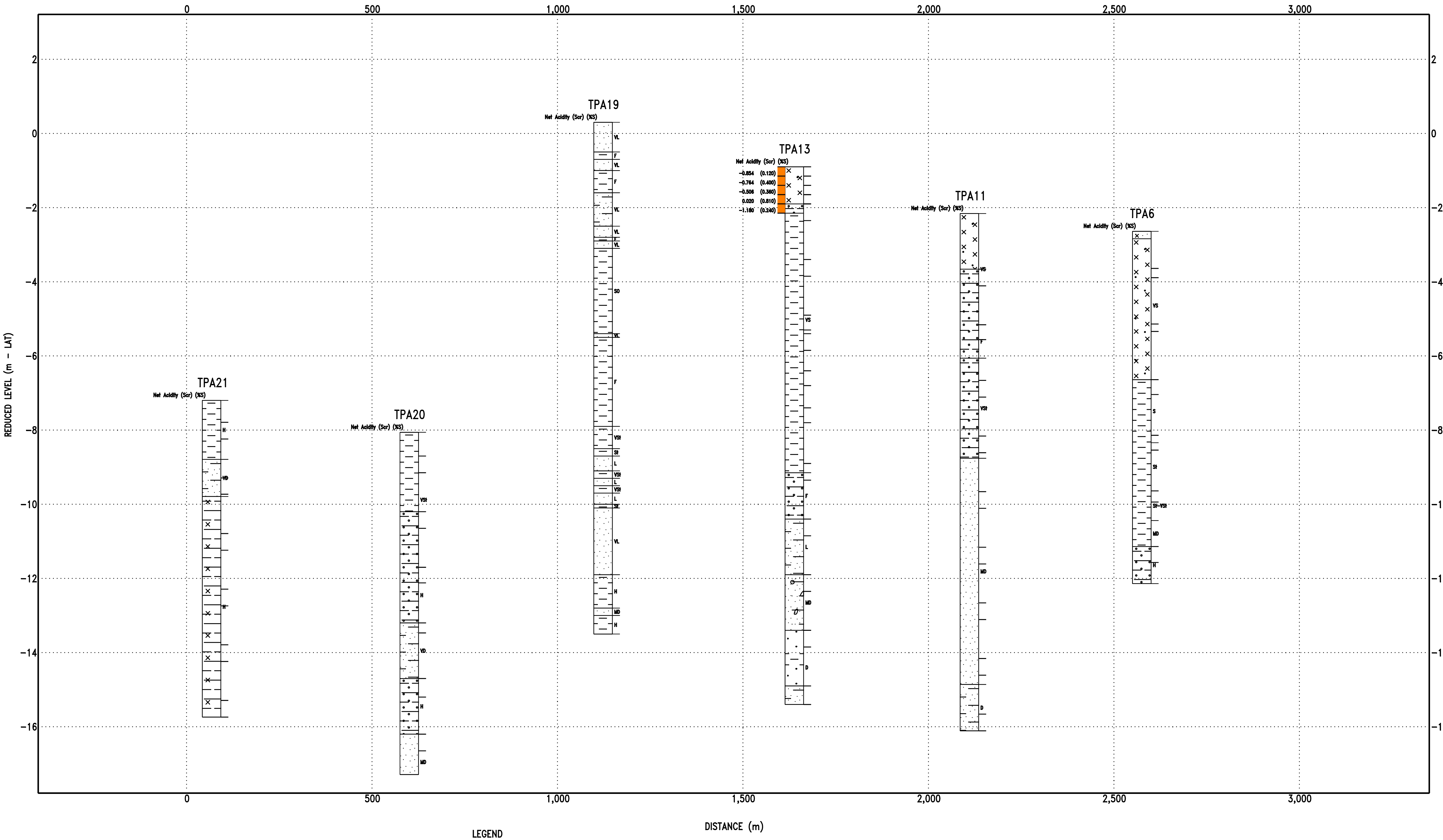
LEGEND

- Sandy SILT
- Silty CLAY
- CLAY
- Clayey SAND
- SAND
- Sandy CLAY
- Gravelly Clayey SILT
- Clayey SILT
- Silty SAND

Golder Associates

CLIENT: Port of Townsville
PROJECT: Offshore Drilling Project
DRAWN: WSB
DATE: May 2008
CHECKED: RAJ
DATE: May 2008
TITLE: INFERRED SUBSURFACE CROSS SECTION AS2
SCALE: H 1:10000 V 1:100
A3
PROJECT No: 077692009
FIGURE No: AS2

GAP_CNS_PASS_REV0 (2).GLB FENCE A3 PASS_REV0 J:\2GEO07\077692009 - TPA - PORT EXPANSION PROJECT\GINT\077692009 PASS.GPJ GAP_CNS_PASS_REV0.GDT 19/06/2008 11:31:35 AM



FIELD INDICATORS
🟥 HIGH FIELD PASS POTENTIAL
🟦 MODERATE FIELD PASS POTENTIAL
🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS
🟧 EXCEEDS QASSIT ACTION LEVEL
🟨 BELOW QASSIT ACTION LEVEL

LEGEND

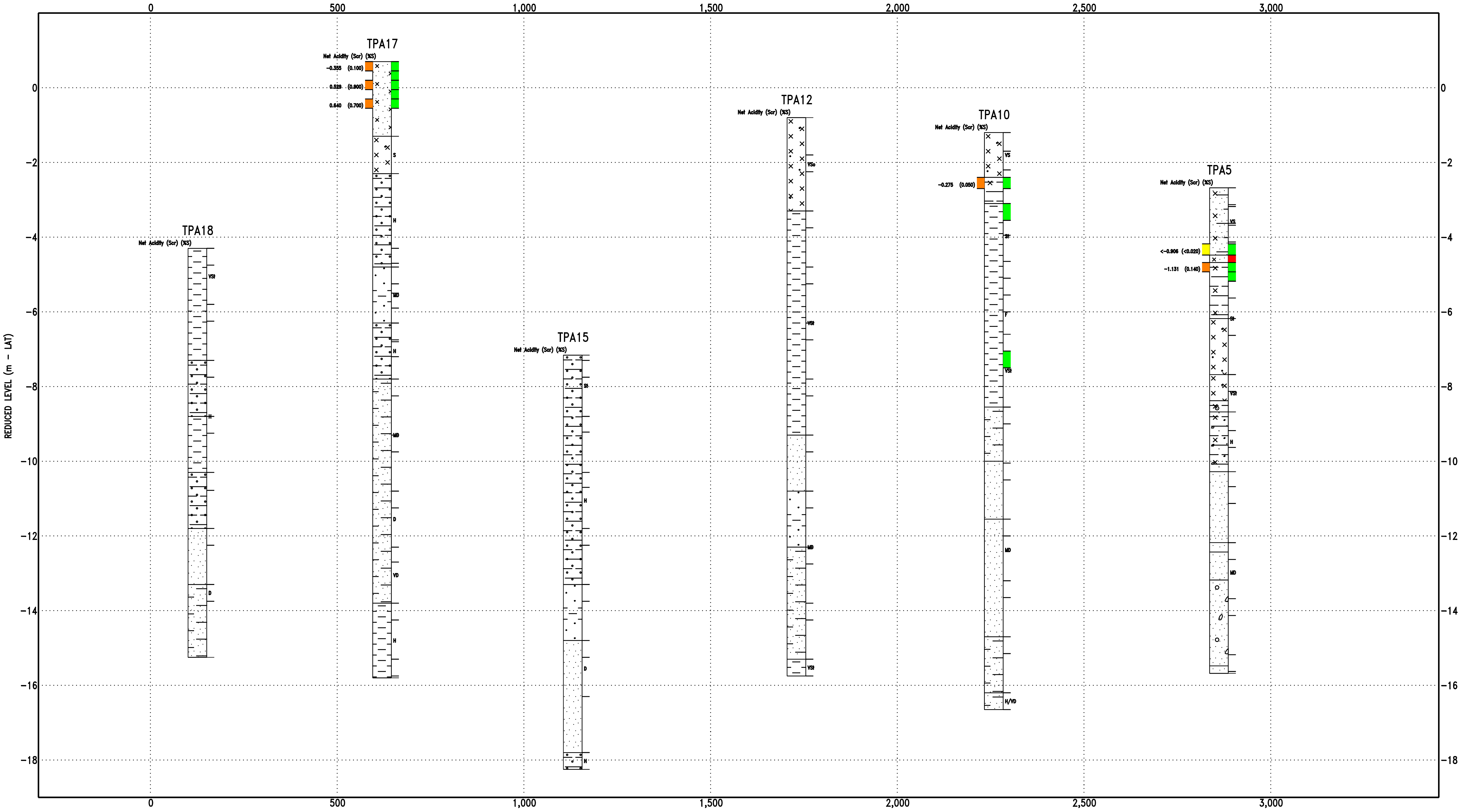
Sandy SILT
Sandy CLAY
SAND
Clayey SAND
Sandy SILT
CLAY

Clayey Gravelly SAND
Interbedded SAND & CLAY
Silty CLAY
Silty SAND

CLIENT
Port of Townsville
DRAWN WSB
DATE May 2008
CHECKED RAJ
DATE May 2008
SCALE H 1:10000 V 1:100
A3

PROJECT
Offshore Drilling Project
TITLE
INFERRED SUBSURFACE CROSS SECTION AS3
PROJECT No 077692009
FIGURE No AS3

GAP_CNS_PASS_REV0 (2).GLB FENCE_A3 PASS_REV0 J:\2GE007\077692009 - TPA - PORT EXPANSION PROJECT\GINT\077692009 PASS.GPJ GAP_CNS_PASS_REV0.GDT 19/06/2008 11:43:55 AM



LEGEND

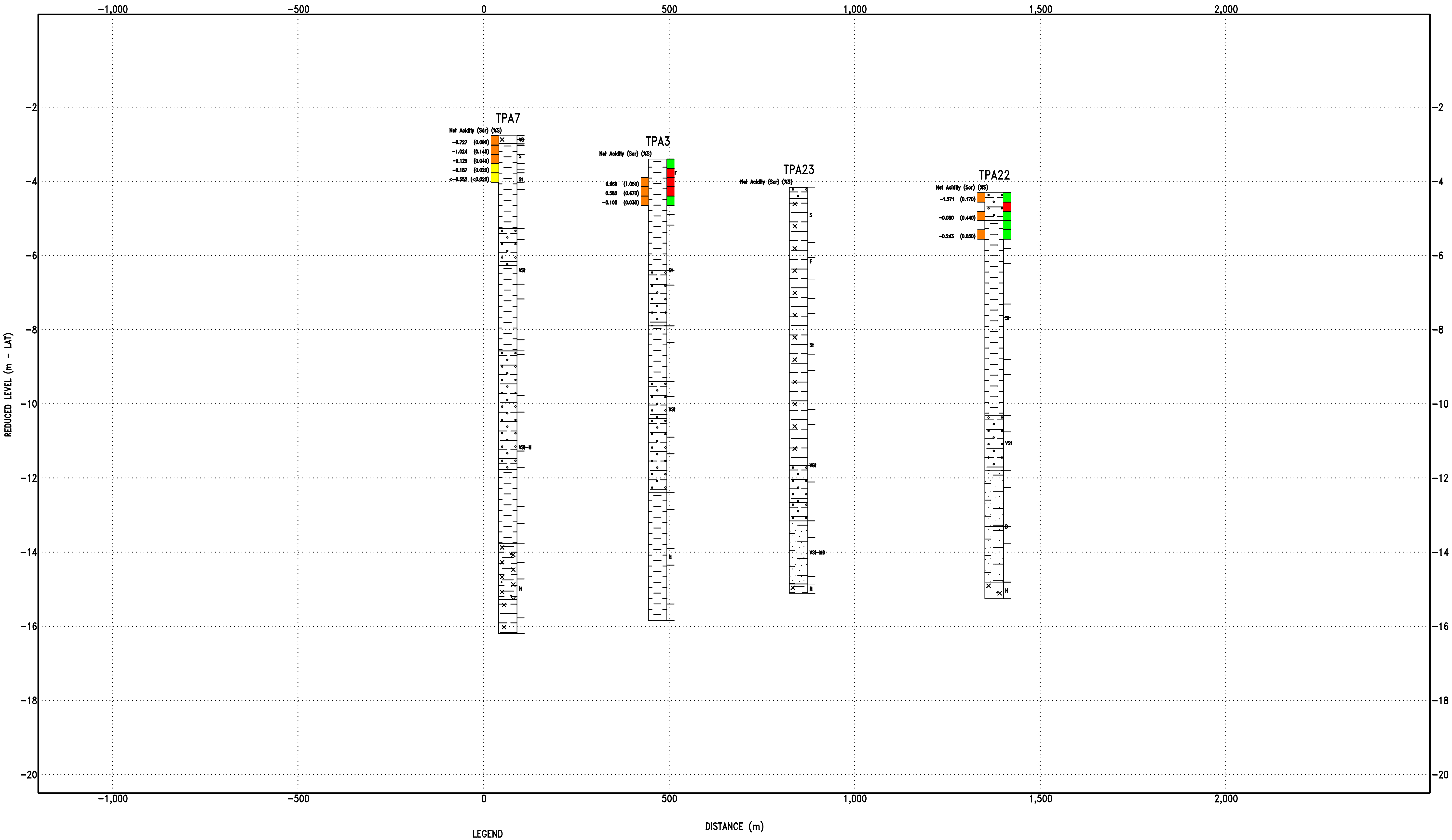
FIELD INDICATORS
🟥 HIGH FIELD PASS POTENTIAL
🟦 MODERATE FIELD PASS POTENTIAL
🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS
🟧 EXCEEDS QASSIT ACTION LEVEL
🟨 BELOW QASSIT ACTION LEVEL

▨ Sandy SILT
▨ Silty CLAY
▨ CLAY
▨ Clayey SAND
▨ SAND
▨ Interbedded SAND & CLAY
▨ Sandy CLAY
▨ Silty SAND
▨ Clayey Silty SAND
▨ Sandy SILT
▨ Gravelly Silty CLAY
▨ Sandy Silty CLAY

Golder Associates

CLIENT Port of Townsville
DRAWN WSB DATE May 2008
CHECKED RAJ DATE May 2008
SCALE H 1:10000 V 1:100 A3
PROJECT Offshore Drilling Project
TITLE INFERRED SUBSURFACE CROSS SECTION AS4
PROJECT No 077692009
FIGURE No AS4



LEGEND

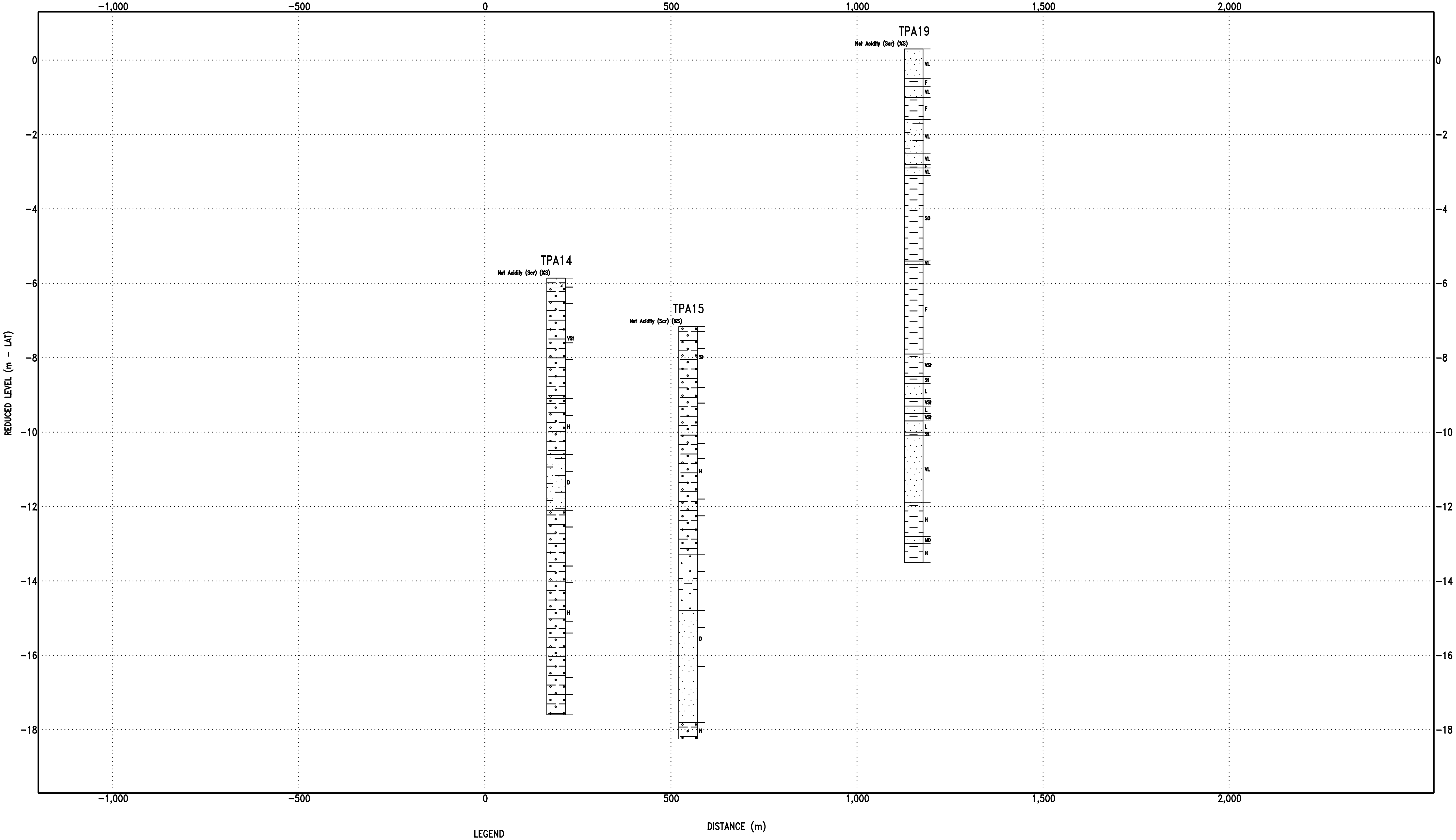
FIELD INDICATORS
🟥 HIGH FIELD PASS POTENTIAL
🟦 MODERATE FIELD PASS POTENTIAL
🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS
🟧 EXCEEDS QASSIT ACTION LEVEL
🟨 BELOW QASSIT ACTION LEVEL

Sandy CLAY
CLAY
Clayey SAND
Sandy SILT
Silty CLAY
Clayey SILT
Gravelly Clayey SILT

Golder Associates

CLIENT	Port of Townsville		PROJECT	Offshore Drilling Project
DRAWN	WSB	DATE May 2008	TITLE	INFERRED SUBSURFACE CROSS SECTION AS5
CHECKED	RAJ	DATE May 2008		
SCALE	H 1:10000 V 1:100	A3	PROJECT No 077692009	FIGURE No AS5

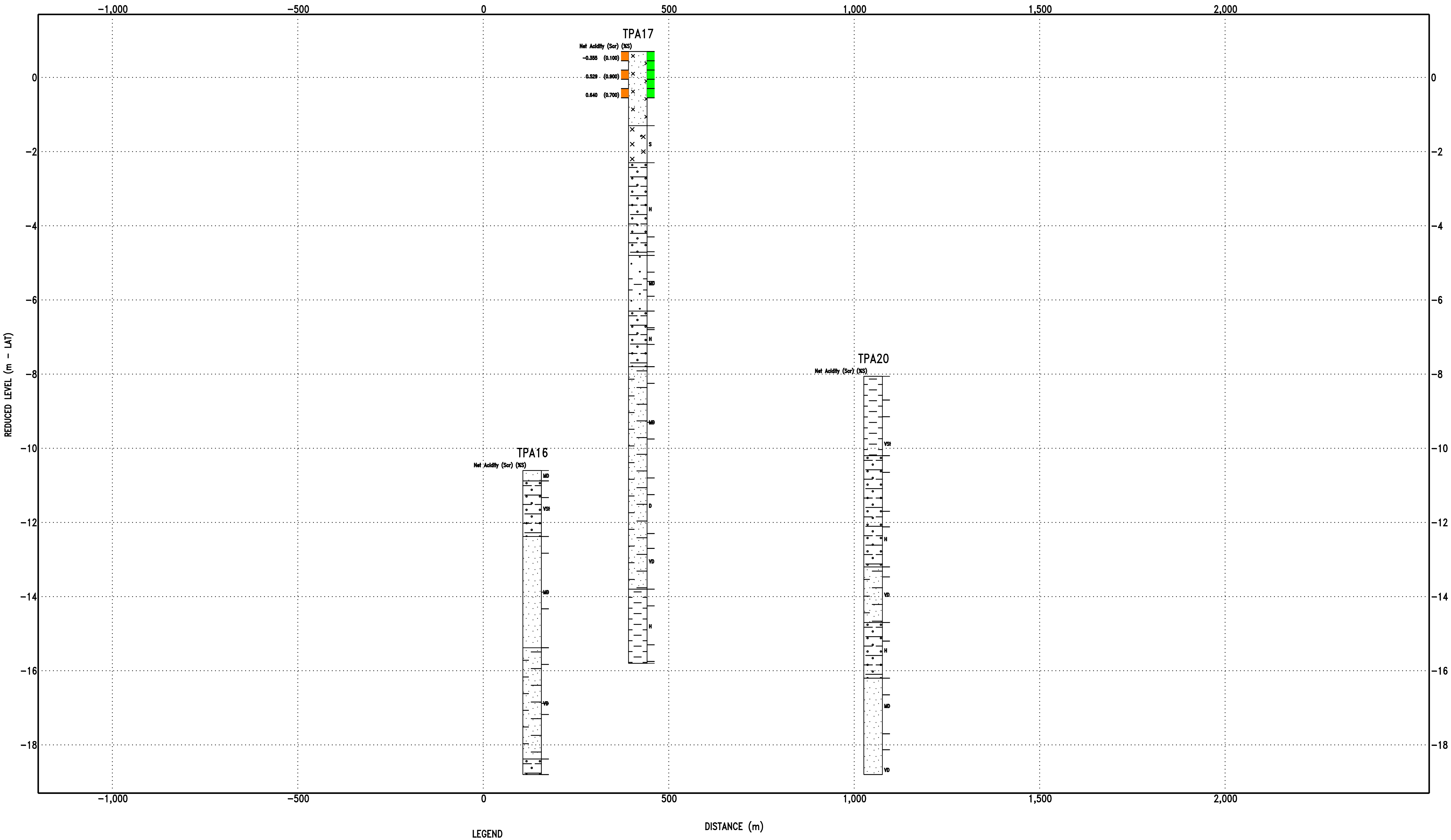


FIELD INDICATORS
- 🟥 HIGH FIELD PASS POTENTIAL
- 🟦 MODERATE FIELD PASS POTENTIAL
- 🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS
- 🟧 EXCEEDS QASSIT ACTION LEVEL
- 🟨 BELOW QASSIT ACTION LEVEL

LEGEND
- ▨ Sandy Gravelly CLAY
- ▨ Sandy CLAY
- ▨ Clayey SAND
- ▨ Interbedded SAND & CLAY
- ▨ SAND
- ▨ CLAY

CLIENT Port of Townsville		PROJECT Offshore Drilling Project	
DRAWN WSB	DATE May 2008	TITLE INFERRED SUBSURFACE CROSS SECTION AS6	
CHECKED RAJ	DATE May 2008		
SCALE H 1:10000 V 1:100	A3	PROJECT No 077692009	FIGURE No AS6



FIELD INDICATORS

- 🟥 HIGH FIELD PASS POTENTIAL
- 🟦 MODERATE FIELD PASS POTENTIAL
- 🟩 LOW FIELD PASS POTENTIAL

LABORATORY TESTS

- 🟧 EXCEEDS QASSIT ACTION LEVEL
- 🟨 BELOW QASSIT ACTION LEVEL

LEGEND

- SAND
- Sandy CLAY
- Clayey SAND
- Silty SAND
- Sandy SILT
- Interbedded SAND & CLAY
- CLAY

Golder Associates

CLIENT	Port of Townsville	PROJECT	Offshore Drilling Project
DRAWN	WSB	DATE	May 2008
CHECKED	RAJ	DATE	May 2008
TITLE	INFERRED SUBSURFACE CROSS SECTION AS7		
SCALE	H 1:10000 V 1:100		A3
PROJECT No	077692009	FIGURE No	AS7

CERTIFICATE OF ANALYSIS

Work Order	: **EB0801041**	Page	: 1 of 5
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR W BINMORE	Contact	: Tim Kilmister
Address	: PO BOX 5298 TOWNSVILLE QLD, AUSTRALIA 4810	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: wbinmore@golder.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 4724 0311	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 077692009	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: TQ		
C-O-C number	: ----	Date Samples Received	: 25-JAN-2008
Sampler	: ----	Issue Date	: 13-FEB-2008
Site	: TOWNSVILLE PORT		
		No. of samples received	: 15
Quote number	: BN/240/07	No. of samples analysed	: 15

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Jessica Garwood	Supervisor - Acid Sulphate Soils	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from □kg/t dry weight□ to □kg/m3 in-situ soil□, multiply □reported results□ x □wet bulk density of soil in t/m3□.**
- **pH FOX Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Vigorous; 4 - Very Vigorous**
- **Retained Acidity not required because pH KCl greater than or equal to 4.5**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	TPA 17 0-0.25	TPA 17 0.25-0.5	TPA 17 0.5-0.75	TPA 17 0.75-1.0	TPA 17 1.0-1.25
			Client sampling date / time	26-JAN-2008 15:00	26-JAN-2008 15:00	26-JAN-2008 15:00	26-JAN-2008 15:00	26-JAN-2008 15:00
				EB0801041-001	**EB0801041-002**	**EB0801041-003**	**EB0801041-004**	**EB0801041-005**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.2**	----	**9.2**	----	**9.3**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	<2	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	<0.02	----	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.10**	----	**0.09**	----	**0.07**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**63**	----	**55**	----	**43**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**4.26**	----	**3.47**	----	**0.56**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**851**	----	**694**	----	**112**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**1.36**	----	**1.11**	----	**0.18**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	<0.02	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	<10	----	<10
Liming Rate	----	1	kg CaCO3/t	<1	----	<1	----	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**8.8**	**9.1**	**9.3**	**9.1**	**9.2**
pH (Fox)	----	0.1	pH Unit	**5.8**	**5.8**	**5.9**	**5.7**	**5.6**
Reaction Rate	----	1	-	**2**	**2**	**2**	**2**	**1**

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**TPA 9 01 0-0.3**	**TPA 9 02 0.3-0.6**	**TPA 9 03 0.6-0.7**	**TPA 9 04 0.7-1.15**	**TPA 10 03 1.2-1.5**
			Client sampling date / time	13-JAN-2008 15:00	13-JAN-2008 15:00	13-JAN-2008 15:00	13-JAN-2008 15:00	09-JAN-2008 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB0801041-006**	**EB0801041-007**	**EB0801041-008**	**EB0801041-009**	**EB0801041-010**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.2**	----	**8.8**	----	**8.7**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	<2	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	<0.02	----	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.15**	----	**0.14**	----	**0.05**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**92**	----	**89**	----	**31**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**9.85**	----	**1.00**	----	**3.04**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**1970**	----	**201**	----	**607**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**3.16**	----	**0.32**	----	**0.97**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	<0.02	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	<10	----	<10
Liming Rate	----	1	kg CaCO3/t	<1	----	<1	----	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**9.1**	**9.4**	**9.3**	**9.1**	**8.6**
pH (Fox)	----	0.1	pH Unit	**5.7**	**6.1**	**5.6**	**5.5**	**6.0**
Reaction Rate	----	1	-	**1**	**1**	**1**	**1**	**1**

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**TPA 22 0-0.25**	**TPA 22 0.25-0.5**	**TPA 22 0.5-0.75**	**TPA 22 0.75-1.0**	**TPA 22 1.0-1.25**
			Client sampling date / time	02-JAN-2008 15:00	02-JAN-2008 15:00	02-JAN-2008 15:00	02-JAN-2008 15:00	02-JAN-2008 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB0801041-011**	**EB0801041-012**	**EB0801041-013**	**EB0801041-014**	**EB0801041-015**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.1**	----	**8.9**	----	**8.9**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	<2	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	<0.02	----	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.17**	----	**0.44**	----	**0.05**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**109**	----	**272**	----	**34**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**16.3**	----	**4.87**	----	**2.74**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**3260**	----	**974**	----	**548**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**5.23**	----	**1.56**	----	**0.88**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	<0.02	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	<10	----	<10
Liming Rate	----	1	kg CaCO3/t	<1	----	<1	----	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**9.0**	**9.0**	**9.3**	**9.1**	**9.6**
pH (Fox)	----	0.1	pH Unit	**6.0**	**3.2**	**5.8**	**5.9**	**5.8**
Reaction Rate	----	1	-	**1**	**1**	**1**	**1**	**1**

CERTIFICATE OF ANALYSIS

Work Order	: **EB0801371**	Page	: 1 of 4
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR W BINMORE	Contact	: Tim Kilmister
Address	: PO BOX 5298 TOWNSVILLE QLD, AUSTRALIA 4810	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: wbinmore@golder.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 4724 0311	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 077692009	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: TQ		
C-O-C number	: ----	Date Samples Received	: 25-JAN-2008
Sampler	: ----	Issue Date	: 13-FEB-2008
Site	: Townsville Port		
		No. of samples received	: 9
Quote number	: EN/002/05	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Phillip Kennedy	2IC Environmental Laboratory	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **LCS recovery for EG005T (Total Metals) analyses fall outside Dynamic Control Limits. They are however within ALS Static Control Limits and hence deemed acceptable.**

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	**TPA 9-01 0-0.3**	**TPA 9-03 0.6-0.7**	**TPA 10-03 1.2-1.5**	**TPA 17 0-0.25**	**TPA 17 0.5-0.75**
			Client sampling date / time	13-NOV-2007 15:00	13-NOV-2007 15:00	09-NOV-2007 15:00	[26-JAN-2008]	[26-JAN-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0801371-001**	**EB0801371-002**	**EB0801371-003**	**EB0801371-004**	**EB0801371-005**
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	**27.5**	**20.0**	**20.3**	**26.2**	**19.1**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**8**	**10**	<5	<5	**6**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**13**	**16**	**9**	**11**	**7**
Copper	7440-50-8	5	mg/kg	**6**	**6**	**8**	**12**	<5
Lead	7439-92-1	5	mg/kg	**8**	**9**	**24**	**25**	**8**
Nickel	7440-02-0	2	mg/kg	**8**	**9**	**7**	**8**	**4**
Zinc	7440-66-6	5	mg/kg	**34**	**382**	**14**	**33**	**22**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL**

			Client sample ID	**TPA 17 1.0-1.25**	**TPA 22 0-0.25**	**TPA 22 0.5-0.75**	**TPA 22 1.0-1.25**	----
			Client sampling date / time	[26-JAN-2008]	02-JAN-2008 15:00	02-JAN-2008 15:00	02-JAN-2008 15:00	----
Compound	CAS Number	LOR	Unit	**EB0801371-006**	**EB0801371-007**	**EB0801371-008**	**EB0801371-009**	**----**
EA055: Moisture Content								
^ Moisture Content (dried @ 103)	----	1.0	%	**22.5**	**30.0**	**28.3**	**25.9**	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**6**	**8**	<5	<5	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	**8**	**19**	**13**	**11**	----
Copper	7440-50-8	5	mg/kg	**6**	**9**	**11**	**12**	----
Lead	7439-92-1	5	mg/kg	**8**	**15**	**27**	**25**	----
Nickel	7440-02-0	2	mg/kg	**5**	**11**	**8**	**8**	----
Zinc	7440-66-6	5	mg/kg	**25**	**35**	**24**	**32**	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----

CERTIFICATE OF ANALYSIS

Work Order	: **EB0803667**	Page	: 1 of 10
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR W BINMORE	Contact	: Tim Kilmister
Address	: PO BOX 5298 TOWNSVILLE QLD, AUSTRALIA 4810	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: wbinmore@golder.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 4724 0311	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 077692009	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: TQ		
C-O-C number	: ----	Date Samples Received	: 19-MAR-2008
Sampler	: ----	Issue Date	: 01-APR-2008
Site	: Townsville Port		
		No. of samples received	: 38
Quote number	: EN/002/05	No. of samples analysed	: 38

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Jessica Garwood	Supervisor - Acid Sulphate Soils	Inorganics
Kim McCabe	Senior Inorganic Chemist	Inorganics
Stephen Hislop	Senior Inorganic Chemist	Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG005T (total Metals): Eb0803477-011 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.**
- **EG005T (Total Metals): Poor matrix spike recovery on EB0803477-012 due to sample matrix interferences. Confirmed by visual inspection.**
- **Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.**
- **pH FOX Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Vigorous; 4 - Very Vigorous**
- **Retained Acidity not required because pH KCl greater than or equal to 4.5**

Analytical Results

Sub-Matrix: **SOIL**

			Client sample ID	**TPA 1 0-0.25**	**TPA 1 0.25-0.50**	**TPA 1 0.5-0.75**	**TPA 1 0.75-1.00**	**TPA 1 1-1.25**
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	CAS Number	LOR	Unit	**EB0803667-001**	**EB0803667-002**	**EB0803667-003**	**EB0803667-004**	**EB0803667-005**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**8.9**	----	**8.8**	----	**8.6**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	<2	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	<0.02	----	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.68**	----	<0.02	----	**0.05**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**425**	----	<10	----	**30**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**7.74**	----	**13.2**	----	**0.92**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**1550**	----	**2650**	----	**183**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**2.48**	----	**4.24**	----	**0.29**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	<0.02	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	<10	----	<10
Liming Rate	----	1	kg CaCO3/t	<1	----	<1	----	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**7.4**	**7.7**	**7.5**	**7.2**	**7.1**
pH (Fox)	----	0.1	pH Unit	**2.3**	**5.2**	**5.4**	**5.3**	**5.3**
Reaction Rate	----	1	-	**2**	**1**	**1**	**1**	**1**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**22.4**	----	**21.5**	----	**21.0**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	----	<5	----	<5
Cadmium	7440-43-9	1	mg/kg	<1	----	<1	----	<1
Chromium	7440-47-3	2	mg/kg	**9**	----	**6**	----	**9**
Copper	7440-50-8	5	mg/kg	**8**	----	**7**	----	**6**
Lead	7439-92-1	5	mg/kg	**18**	----	**15**	----	**16**
Nickel	7440-02-0	2	mg/kg	**4**	----	**4**	----	**7**
Zinc	7440-66-6	5	mg/kg	**13**	----	**8**	----	**17**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	----	<0.1	----	<0.1

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**TPA 1** **7-7.45**	**TPA 3** **0-0.25**	**TPA 3** **0.25-0.50**	**TPA 3** **0.5-0.75**	**TPA 3** **0.75-1.00**
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-006**	**EB0803667-007**	**EB0803667-008**	**EB0803667-009**	**EB0803667-010**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**8.6**	----	----	**8.4**	**8.1**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	<0.02	----	----	**1.05**	**0.67**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	**655**	**417**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**0.81**	----	----	**0.76**	**0.81**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**163**	----	----	**152**	**163**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**0.26**	----	----	**0.24**	**0.26**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	**0.89**	**0.49**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	**553**	**309**
Liming Rate	----	1	kg CaCO3/t	<1	----	----	**42**	**23**
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	----	**8.2**	**7.8**	**7.6**	**8.0**
pH (Fox)	----	0.1	pH Unit	----	**6.3**	**1.8**	**1.8**	**3.1**
Reaction Rate	----	1	-	----	**1**	**3**	**4**	**1**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**21.0**	**23.8**	----	----	**21.0**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	----	----	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	<1
Chromium	7440-47-3	2	mg/kg	**8**	**10**	----	----	**8**
Copper	7440-50-8	5	mg/kg	**9**	**10**	----	----	**9**
Lead	7439-92-1	5	mg/kg	**28**	**19**	----	----	**20**
Nickel	7440-02-0	2	mg/kg	**5**	**5**	----	----	**5**
Zinc	7440-66-6	5	mg/kg	**6**	**15**	----	----	**7**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	<0.1

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	**TPA 3 1-1.25**	**TPA 3 4.5-4.95**	**TPA 4 3-3.45**	**TPA 4 6-6.45**	**TPA 5 1.5-1.8**
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-011**	**EB0803667-012**	**EB0803667-013**	**EB0803667-014**	**EB0803667-015**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**8.9**	----	----	----	**9.1**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.03**	----	----	----	<0.02
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**21**	----	----	----	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**1.22**	----	----	----	**8.67**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**245**	----	----	----	**1730**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**0.39**	----	----	----	**2.78**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	<10
Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**8.4**	----	----	----	**7.9**
pH (Fox)	----	0.1	pH Unit	**5.5**	----	----	----	**6.0**
Reaction Rate	----	1	-	**1**	----	----	----	**1**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	----	**8.5**	**12.4**	**10.4**	**27.9**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	----	**14**	<5	<5	**8**
Cadmium	7440-43-9	1	mg/kg	----	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	----	**16**	**7**	**4**	**15**
Copper	7440-50-8	5	mg/kg	----	**11**	<5	<5	**6**
Lead	7439-92-1	5	mg/kg	----	**13**	**5**	<5	**10**
Nickel	7440-02-0	2	mg/kg	----	**13**	<2	<2	**8**
Zinc	7440-66-6	5	mg/kg	----	**30**	**6**	<5	**29**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	<0.1	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	TPA 5 1.8-2.00	TPA 5 2-2.25	TPA 5 2.25-2.50	TPA 7 0-0.25	TPA 7 0.25-0.50
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-016**	**EB0803667-017**	**EB0803667-018**	**EB0803667-019**	**EB0803667-020**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	**9.1**	----	**9.2**	**9.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	<0.02	----	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	----	**0.14**	----	**0.09**	**0.14**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	**90**	----	**59**	**85**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	----	**11.9**	----	**7.65**	**10.9**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	----	**2370**	----	**1530**	**2180**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	----	**3.80**	----	**2.45**	**3.50**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	<10	<10
Liming Rate	----	1	kg CaCO3/t	----	<1	----	<1	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**8.3**	**7.1**	**8.0**	----	----
pH (Fox)	----	0.1	pH Unit	**2.5**	**5.6**	**6.0**	----	----
Reaction Rate	----	1	-	**1**	**1**	**1**	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**21.3**	**22.6**	**18.7**	**24.1**	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**6**	<5	<5	**8**	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	**11**	**12**	**11**	**16**	----
Copper	7440-50-8	5	mg/kg	**9**	**6**	**18**	**7**	----
Lead	7439-92-1	5	mg/kg	**21**	**15**	**12**	**10**	----
Nickel	7440-02-0	2	mg/kg	**6**	**5**	**6**	**9**	----
Zinc	7440-66-6	5	mg/kg	**18**	**12**	**12**	**28**	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**TPA 7 0.5-0.75**	**TPA 7 0.75-1.00**	**TPA 7 1-1.25**	**TPA 8 2.5-2.95**	**TPA 8 5.5-5.95**
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-021**	**EB0803667-022**	**EB0803667-023**	**EB0803667-024**	**EB0803667-025**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.2**	**9.2**	**9.1**	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.04**	**0.02**	<0.02	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**25**	**14**	<10	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**1.58**	**1.94**	**5.36**	----	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**316**	**387**	**1070**	----	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**0.50**	**0.62**	**1.72**	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	----	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	----	**16.6**	----	**17.2**	**20.0**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	----	<5	----	<5	**7**
Cadmium	7440-43-9	1	mg/kg	----	<1	----	<1	<1
Chromium	7440-47-3	2	mg/kg	----	**8**	----	**16**	**19**
Copper	7440-50-8	5	mg/kg	----	**6**	----	**7**	**11**
Lead	7439-92-1	5	mg/kg	----	**13**	----	**11**	**15**
Nickel	7440-02-0	2	mg/kg	----	**3**	----	**11**	**12**
Zinc	7440-66-6	5	mg/kg	----	**17**	----	**30**	**35**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	----	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**TPA 8 7-7.45**	**TPA 10 1.9-2.35**	**TPA 10 5.85-6.30**	**TPA 13 0-0.25**	**TPA 13 0.25-0.50**
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-026**	**EB0803667-027**	**EB0803667-028**	**EB0803667-029**	**EB0803667-030**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	**8.9**	**9.0**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	----	----	----	**0.12**	**0.40**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	----	----	**73**	**248**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	----	----	----	**9.12**	**10.9**
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	----	----	----	**1820**	**2190**
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	----	----	----	**2.92**	**3.50**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	<10
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	<1
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	----	**7.8**	**7.5**	----	----
pH (Fox)	----	0.1	pH Unit	----	**6.0**	**5.3**	----	----
Reaction Rate	----	1	-	----	**1**	**1**	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**14.1**	**20.4**	**16.2**	**31.7**	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	**9**	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----
Chromium	7440-47-3	2	mg/kg	**2**	**10**	**6**	**14**	----
Copper	7440-50-8	5	mg/kg	<5	<5	<5	**8**	----
Lead	7439-92-1	5	mg/kg	<5	**20**	**8**	**9**	----
Nickel	7440-02-0	2	mg/kg	<2	**6**	**4**	**8**	----
Zinc	7440-66-6	5	mg/kg	**6**	**17**	**12**	**30**	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----

Analytical Results

Sub-Matrix: **SOIL**			*Client sample ID*	**TPA 13 0.5-0.75**	**TPA 13 0.75-1.00**	**TPA 13 1-1.25**	**TPA 13 2.5-2.95**	**TPA 13 4.5-4.95**
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-031**	**EB0803667-032**	**EB0803667-033**	**EB0803667-034**	**EB0803667-035**
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**8.8**	**8.7**	**9.2**	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.02	% S	**0.36**	**0.81**	**0.24**	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**227**	**505**	**149**	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)	----	0.01	% CaCO3	**8.11**	**7.40**	**13.3**	----	----
acidity - Acid Neutralising Capacity (a-19A1)	----	10	mole H+ / t	**1620**	**1480**	**2660**	----	----
sulfidic - Acid Neutralising Capacity (s-19A1)	----	0.01	% pyrite S	**2.60**	**2.37**	**4.26**	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	----	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	----	**38.4**	----	**32.1**	**33.7**
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	----	**8**	----	**8**	**8**
Cadmium	7440-43-9	1	mg/kg	----	<1	----	<1	<1
Chromium	7440-47-3	2	mg/kg	----	**16**	----	**16**	**16**
Copper	7440-50-8	5	mg/kg	----	**9**	----	**11**	**12**
Lead	7439-92-1	5	mg/kg	----	**10**	----	**11**	**12**
Nickel	7440-02-0	2	mg/kg	----	**10**	----	**9**	**10**
Zinc	7440-66-6	5	mg/kg	----	**32**	----	**25**	**27**
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	----	<0.1	<0.1

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	**TPA 13 8-8.45**	**TPA 17 2-2.45**	**TPA 17 4-4.45**	----	----
			Client sampling date / time	[18-MAR-2008]	[18-MAR-2008]	[18-MAR-2008]	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB0803667-036**	**EB0803667-037**	**EB0803667-038**	**----**	**----**
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	----	**8.2**	**7.8**	----	----
pH (Fox)	----	0.1	pH Unit	----	**5.6**	**5.5**	----	----
Reaction Rate	----	1	-	----	**1**	**1**	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**28.2**	**16.0**	**15.3**	----	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**7**	<5	**5**	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	**12**	**6**	**6**	----	----
Copper	7440-50-8	5	mg/kg	**11**	**19**	<5	----	----
Lead	7439-92-1	5	mg/kg	**11**	**72**	**8**	----	----
Nickel	7440-02-0	2	mg/kg	**9**	**3**	**3**	----	----
Zinc	7440-66-6	5	mg/kg	**23**	**16**	**13**	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	----	----

Appendix E
Stability Analysis

E1.0 PRELIMINARY STABILITY ASSESSMENT FOR REVETMENT WALLS

Preliminary stability analyses of revetment profiles typically used in the past by Port of Townsville has been conducted using Morgenstern and Price Method, via the computer program SLOPE/W[1].

In this method, the slope is divided into a large number of slices, each of which is subjected to calculation of “disturbing moment” and “available restoring moment”. These moments are then expressed as a ratio to provide a calculated Factor of Safety (FOS) for a particular potential failure surface.

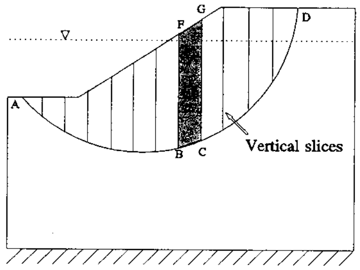


Figure 1 Circular Soil Mass Divided into Vertical Slices

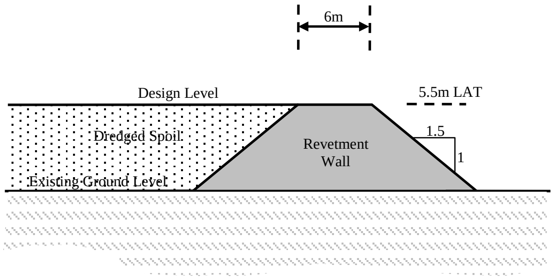
By using a computer, a large number of potential failure surfaces can be analysed, leading to determination of a “critical slip circle” (surface) with the lowest calculated Factor of Safety for the set of conditions being analysed.

Analyses were made for both static and earthquake conditions. The earthquake case was modelled using the method recommended by ANCOLD in their publication “Guidelines for Design of Dams for Earthquake Loading” – 1998. Using this method, a FOS of 1.0 or higher is considered “acceptable”.

As discussed in Section 10.0, preliminary stability assessment was undertaken at four borehole locations (TPA 03, TPA 07, TPA 22 and TPA 23) where proposed reclamination works are proposed. Seven cases were analysed with varying water level condtions, with a further two cases considered at TPA 23 (which gave the lowest FOS in the preceding analysis Cases). Each case is further discussed in the following subsections and the results from the analyses provided.

E1.1 CASE 1

Case 1 comprised the analysis of the construction of revetment wall at slope of 1V:1.5H to a design height of 5.5 m LAT, and backfilling with dredged spoil. The ground surface level on the seaward side of the revetment wall was modeled at the existing depth with the “soft” seabed sediments remaining in place, and a water level at 0.0 m LAT. The Case 1 profile is sketched in the adjacent drawing:



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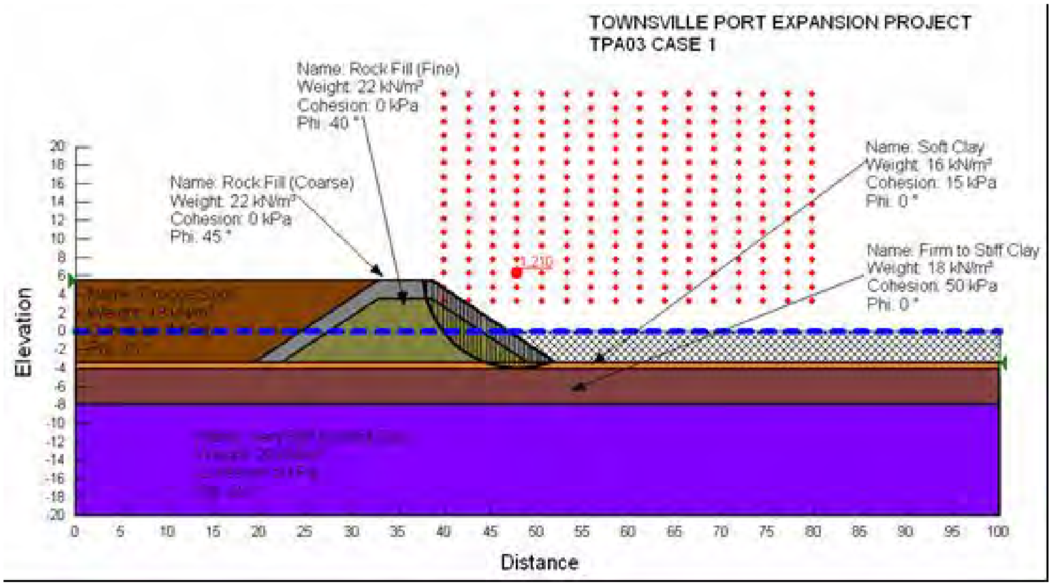
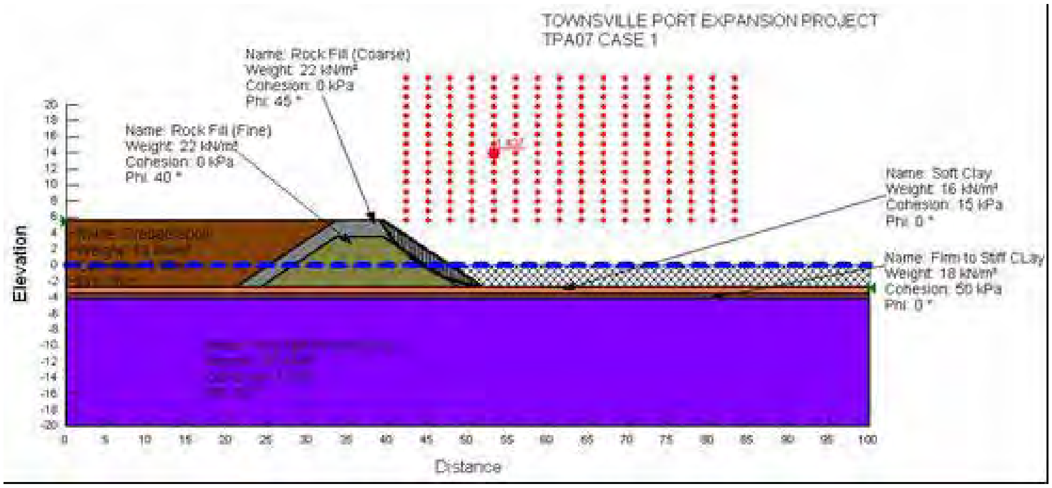
[1] SLOPE/W 2004 by GEO-SLOPE International Ltd

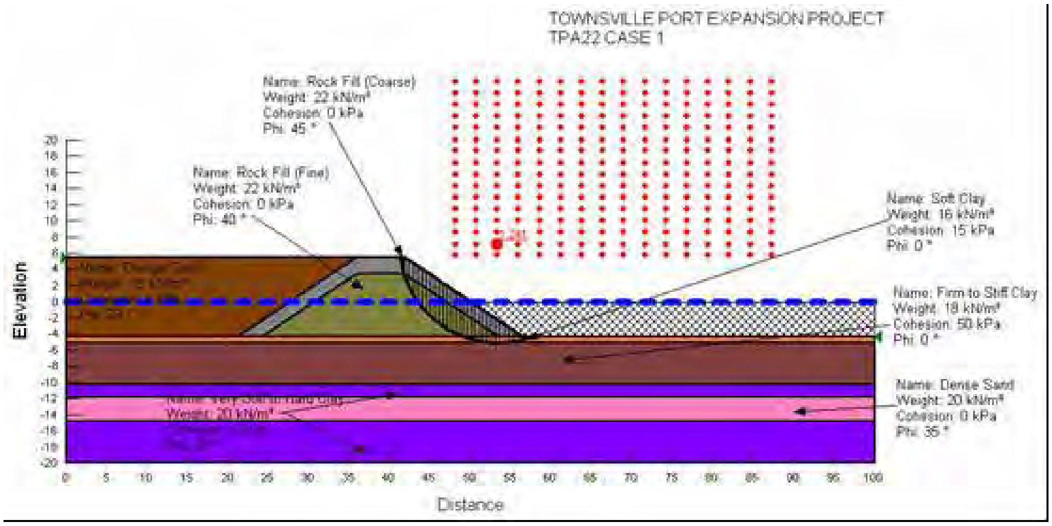
Results of SLOPE/W Analysis for Case 1:



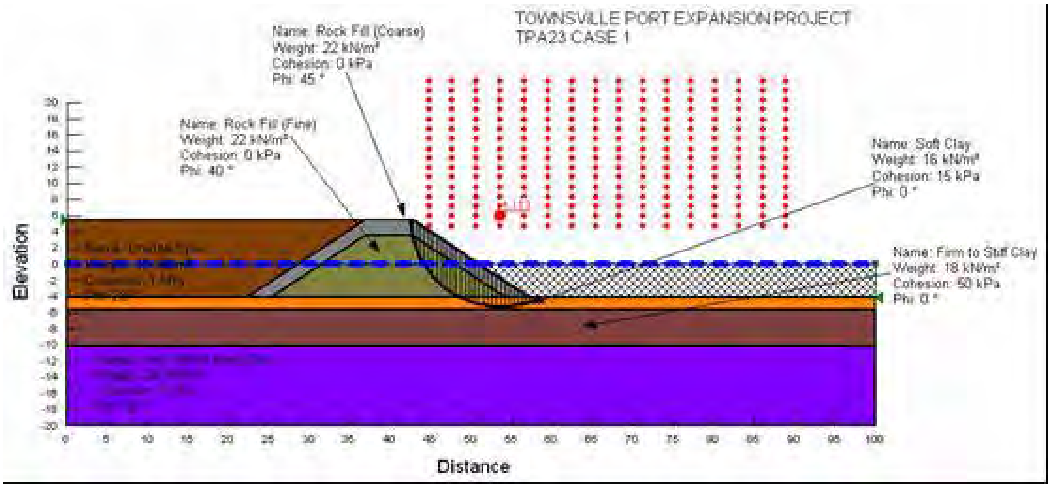
TPA03 - Minimum FOS = 1.2 - Unsatisfactory



TPA07 - Minimum FOS = 1.4 - Satisfactory



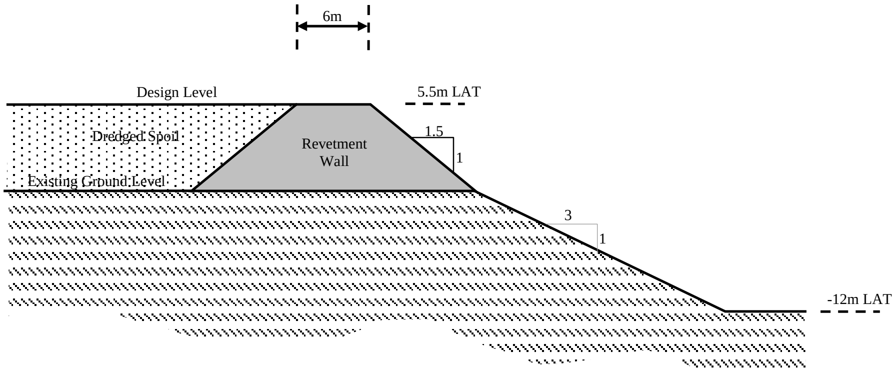
TPA22 - Minimum FOS = 1.2 - Unsatisfactory



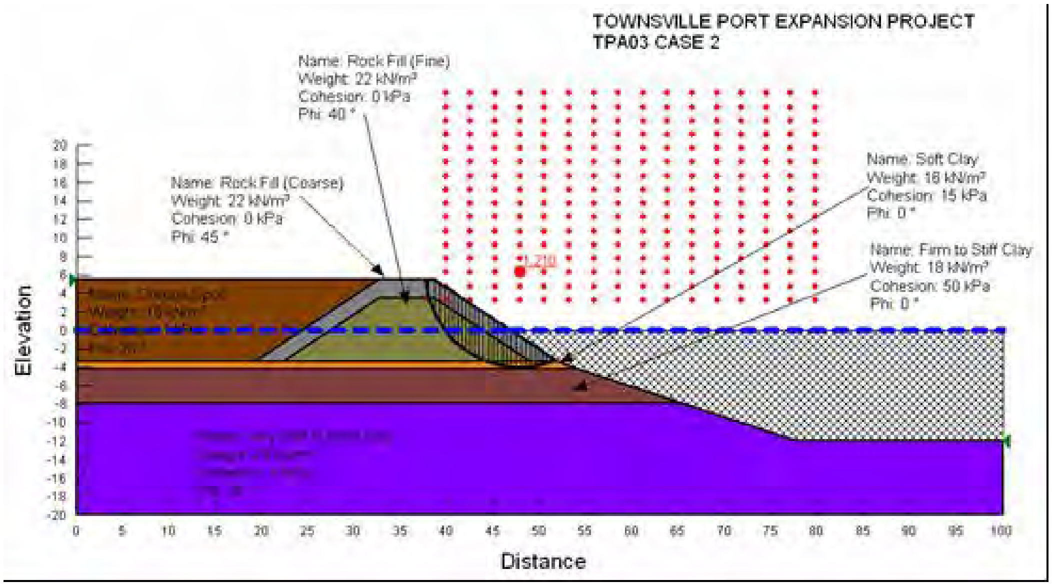
TPA23 - Minimum FOS = 1.1 - Unsatisfactory

E1.2 CASE 2

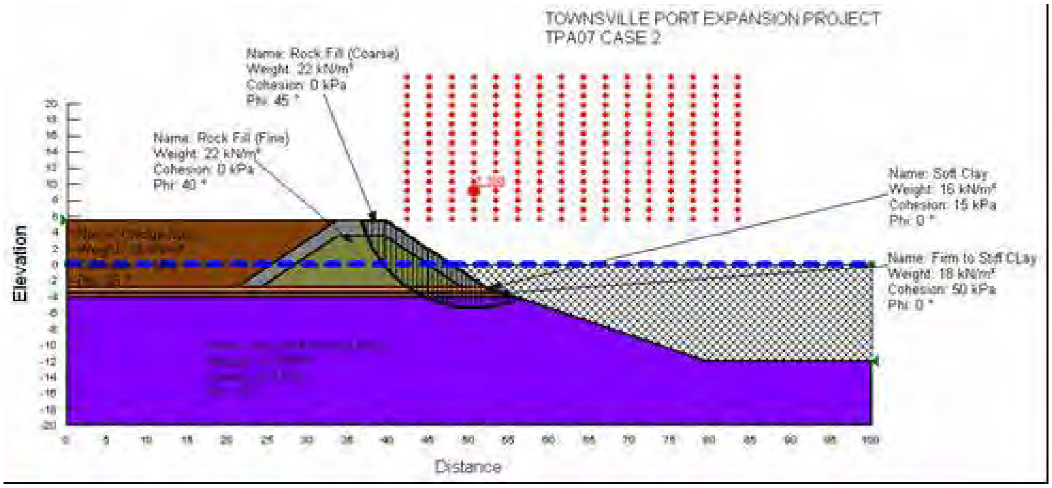
Case 2 comprised a similar profile as Case 1 with the seaward side of the revetment wall dredged at 1V:3H below current bed level to a depth of -12 m LAT. The Case 2 profile is sketched in the drawing below:



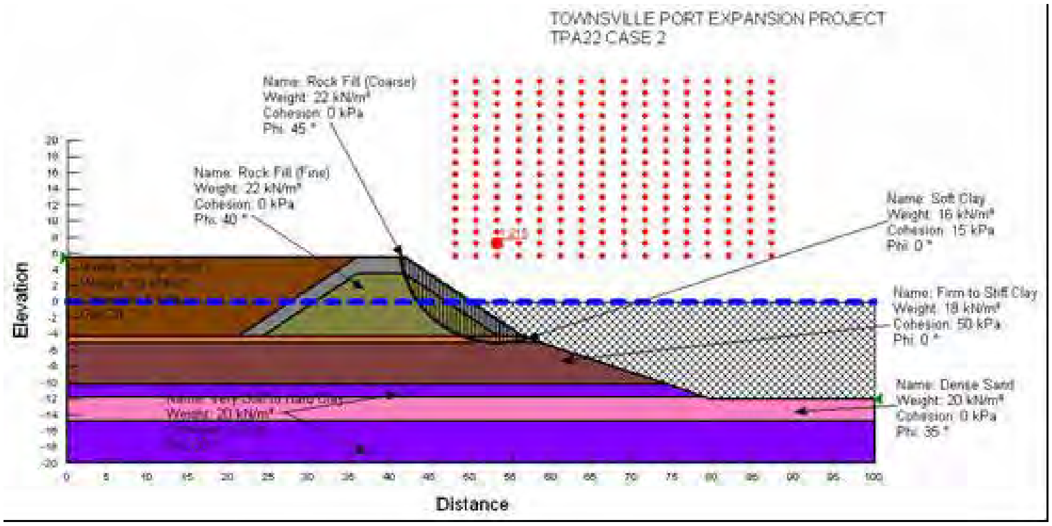
Results of SLOPE/W Analysis for Case 2:



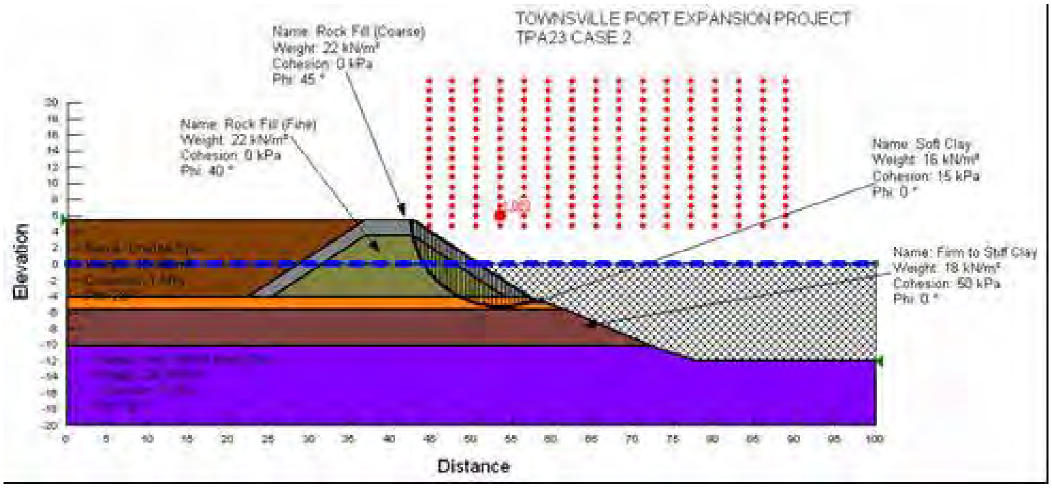
TPA03 - Minimum FOS = 1.2 - Unsatisfactory



TPA07 - Minimum FOS = 1.3 - Satisfactory



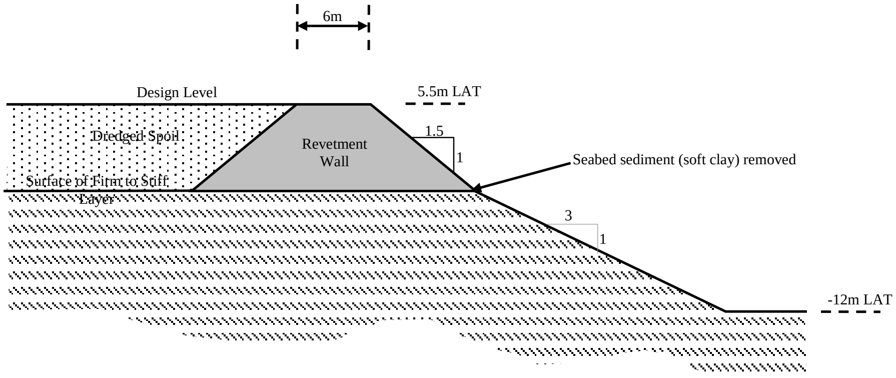
TPA22 - Minimum FOS = 1.2 - Unsatisfactory



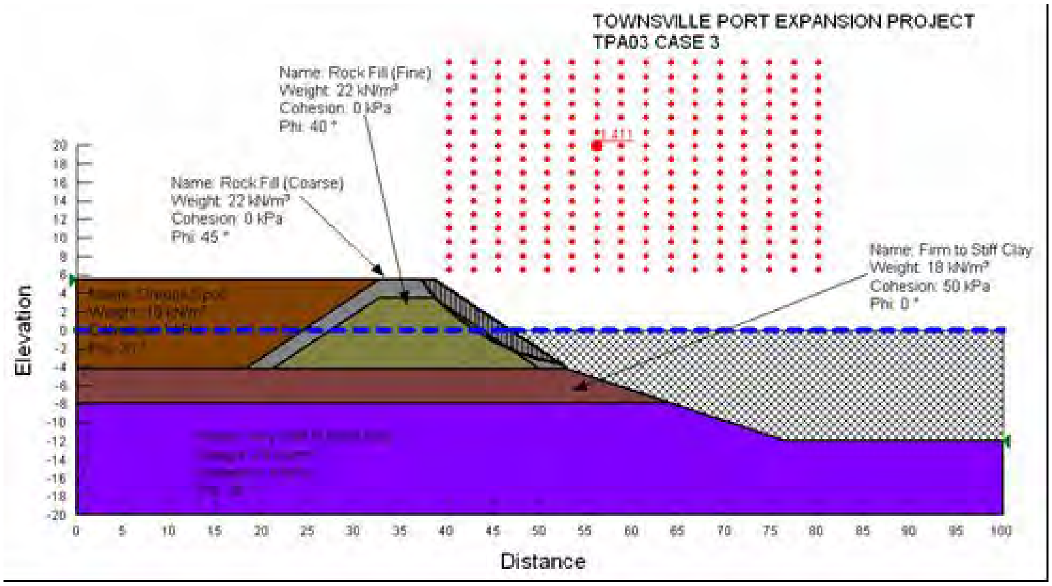
TPA23 - Minimum FOS = 1.0 - Unsatisfactory

E1.3 CASE 3

Case 3 comprises a similar profile as Case 2 with the exception of having the "soft" seabed sediments removed prior to revetment wall construction and backfilling the proposed reclamation area with dredged spoil. The Case 3 profile is sketched in the drawing below:

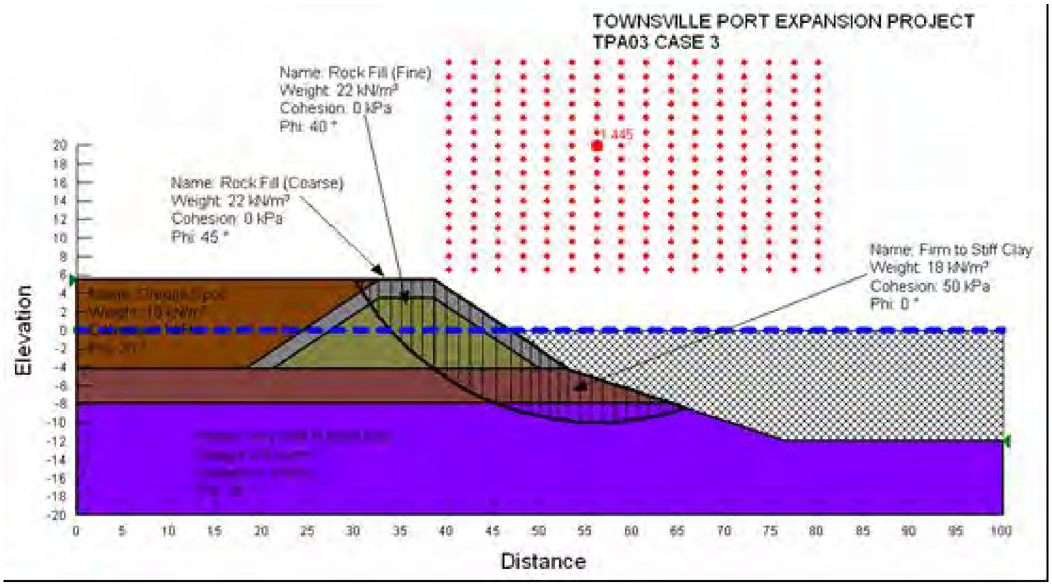


Results of SLOPE/W Analysis for Case 3:

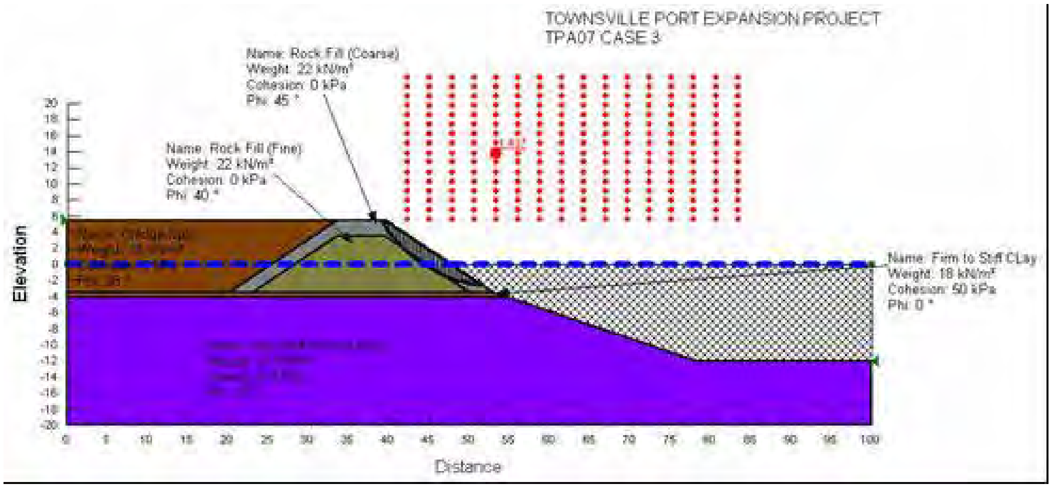


TPA03 - Minimum FOS = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

The analysed minimum FOS "failure" surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

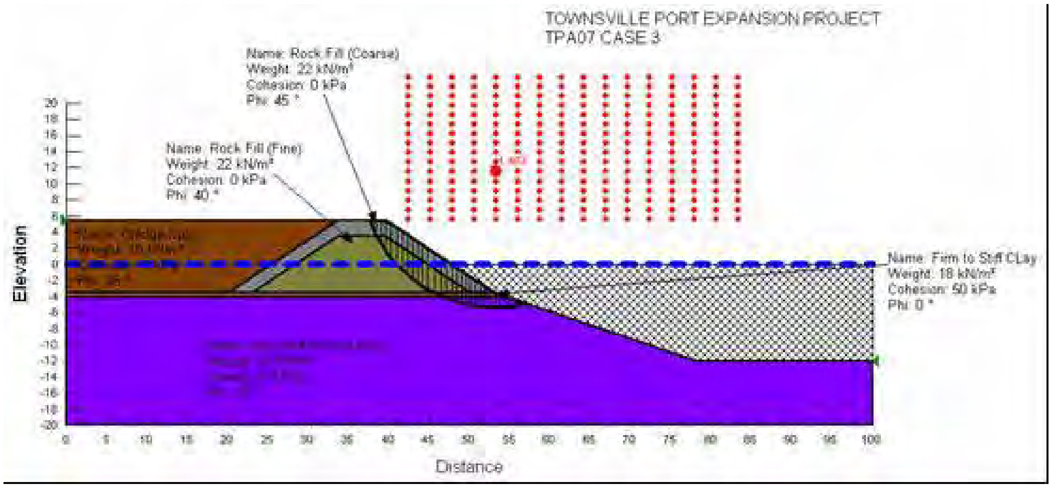


TPA03 – FOS against deeper seated instability = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

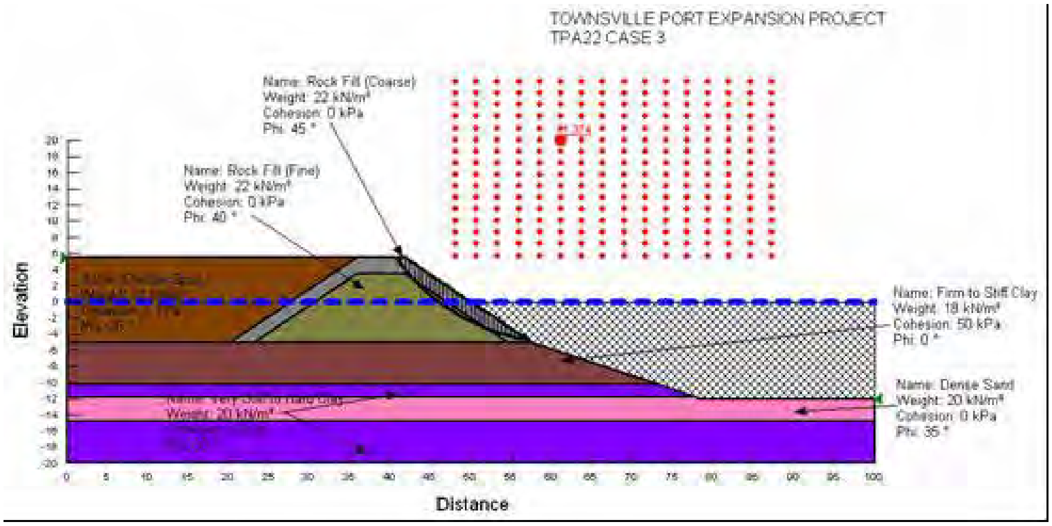


TPA07 - Minimum FOS = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

The analysed minimum FOS "failure" surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

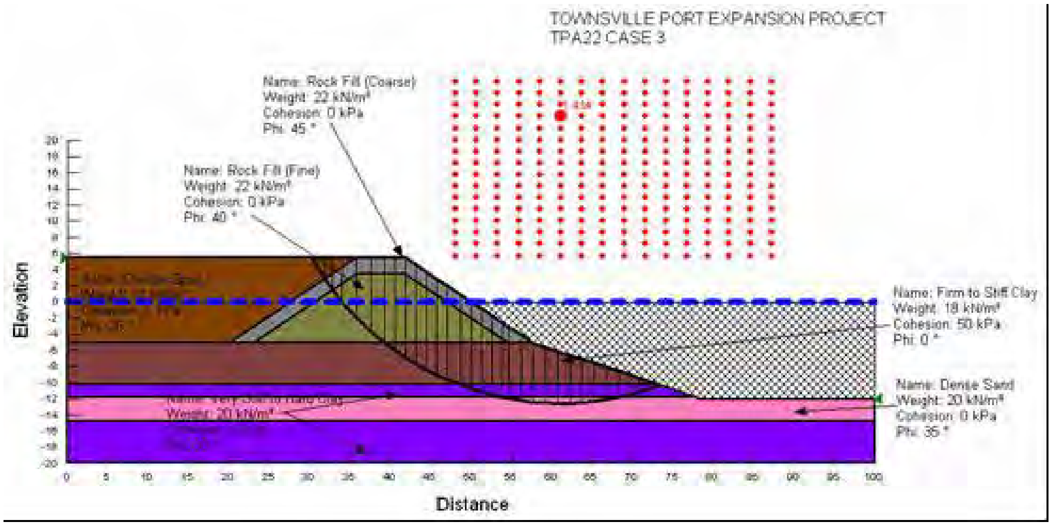


TPA07 - FOS against deeper-seated instability = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

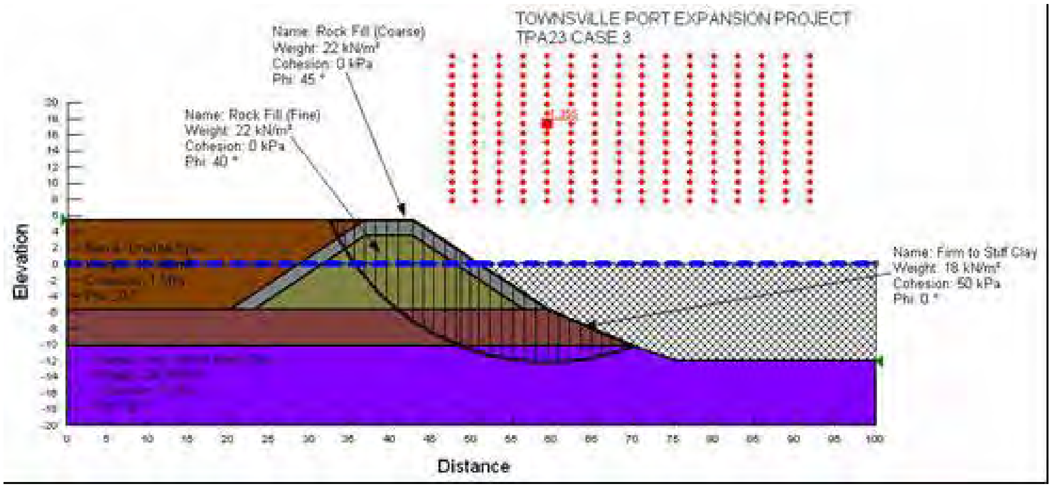


TPA22 - Minimum FOS = 1.3 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

The analysed minimum FOS "failure" surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.



TPA22 - FOS against deeper seated instability = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

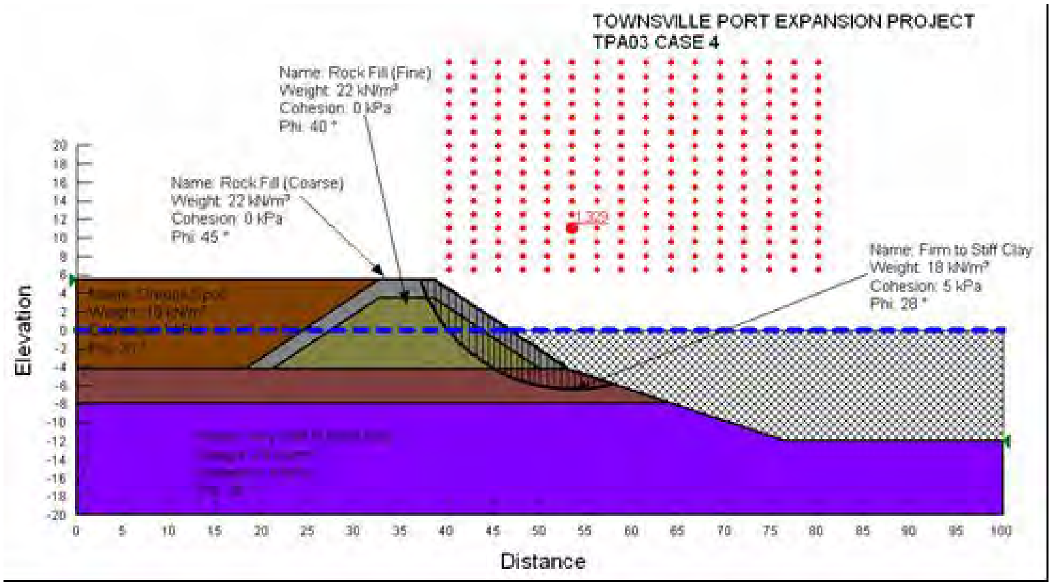


TPA23 - Minimum FOS = 1.3 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

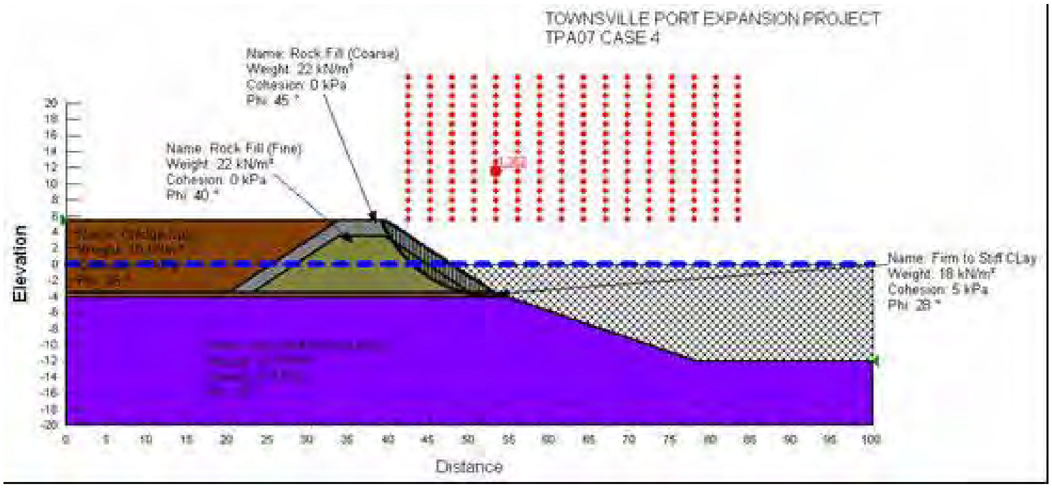
E1.4 CASE 4

The profile for Case 4 was similar to that analysed in Case3, but the simulations were conducted using effective or drained soil parameters.

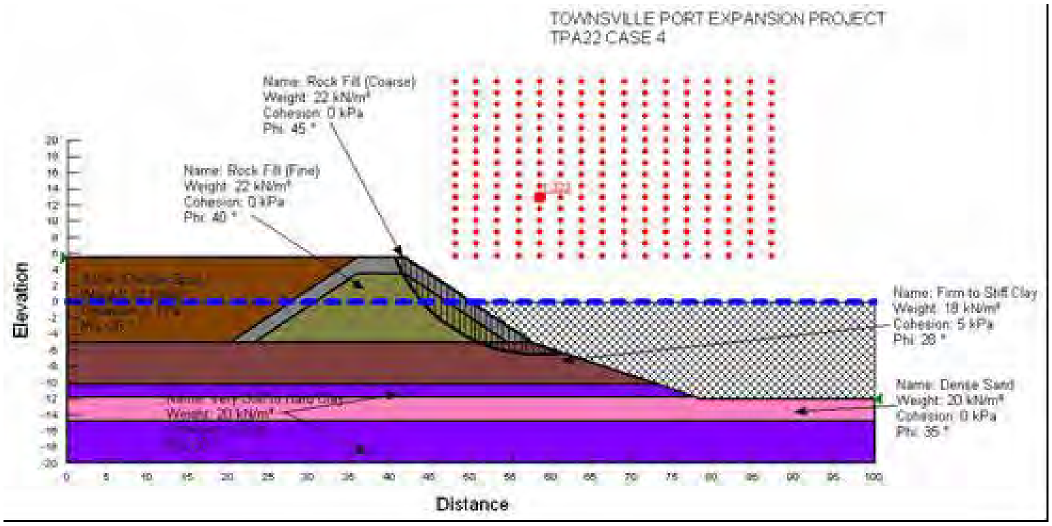
Results of SLOPE/W Analysis for Case 4:



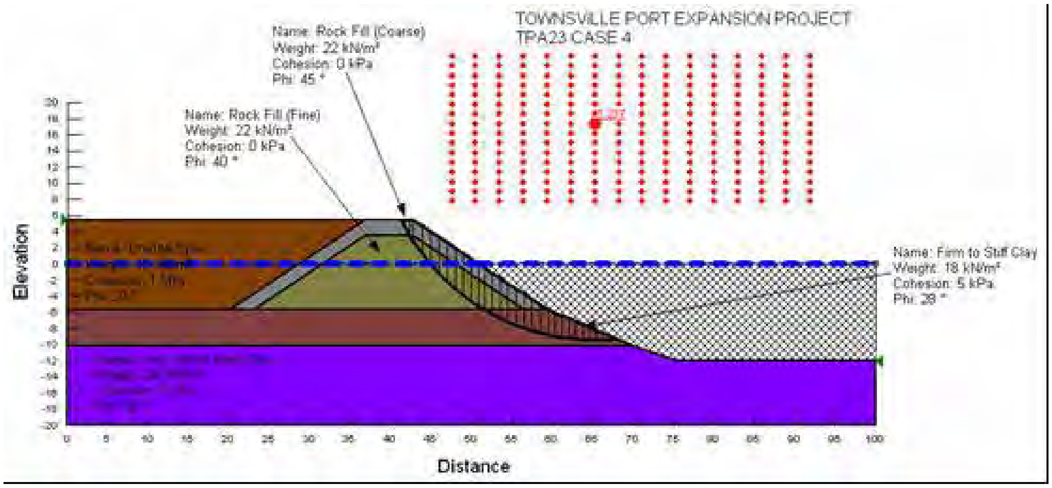
TPA03 - Minimum FOS = 1.3 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled



TPA07 - Minimum FOS = 1.3 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled



TPA22 - Minimum FOS = 1.3 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

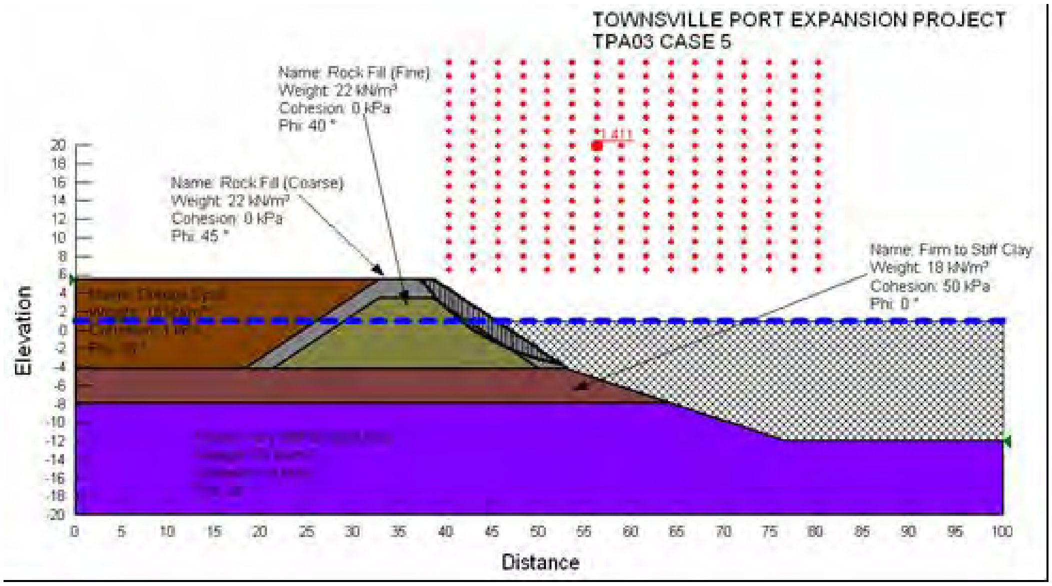


TPA23 - Minimum FOS = 1.2 - Unsatisfactory for the "extreme" water level (0 m LAT) conditions modelled

E1.5 CASE 5

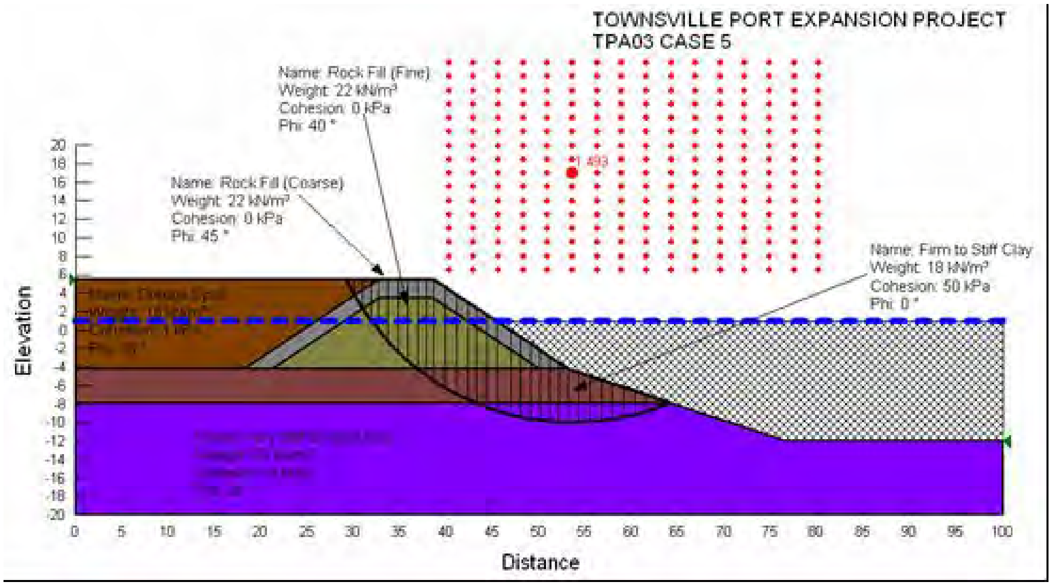
Case 5 comprised of the same profile as that used in both Case 3 and Case 4, but the water level was modeled at 1 m LAT to simulate a more typical or "normal" condition.

<u>Results of SLOPE/W Analysis for Case 5:</u>

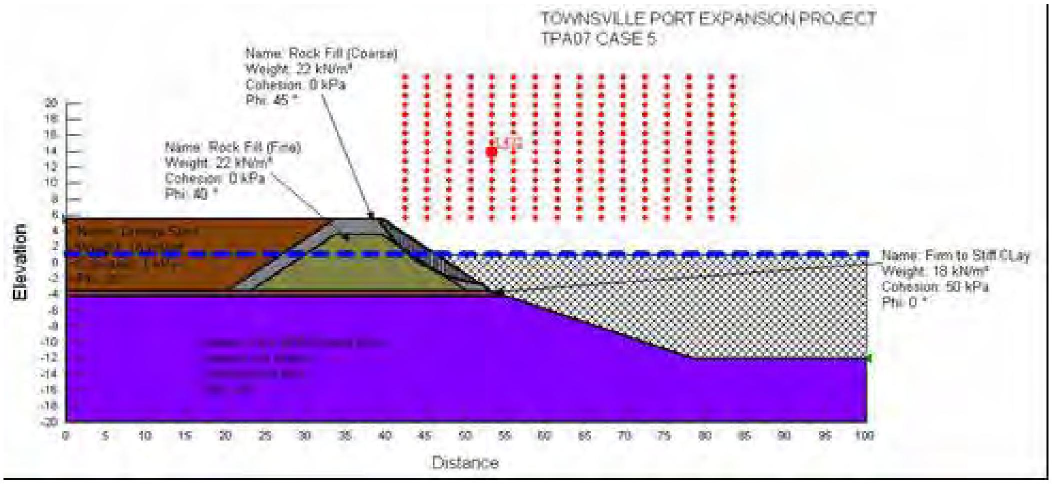


TPA03 - Minimum FOS = 1.4 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

The analysed minimum FOS “failure” surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

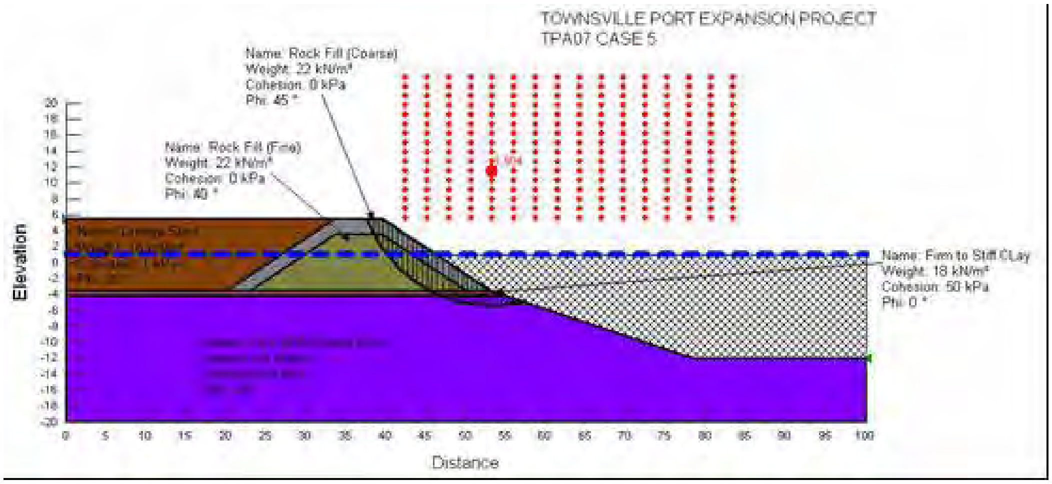


TPA03 - FOS against deeper seated instability = 1.4 - Unsatisfactory for the “normal” water level (1 m LAT) conditions modelled

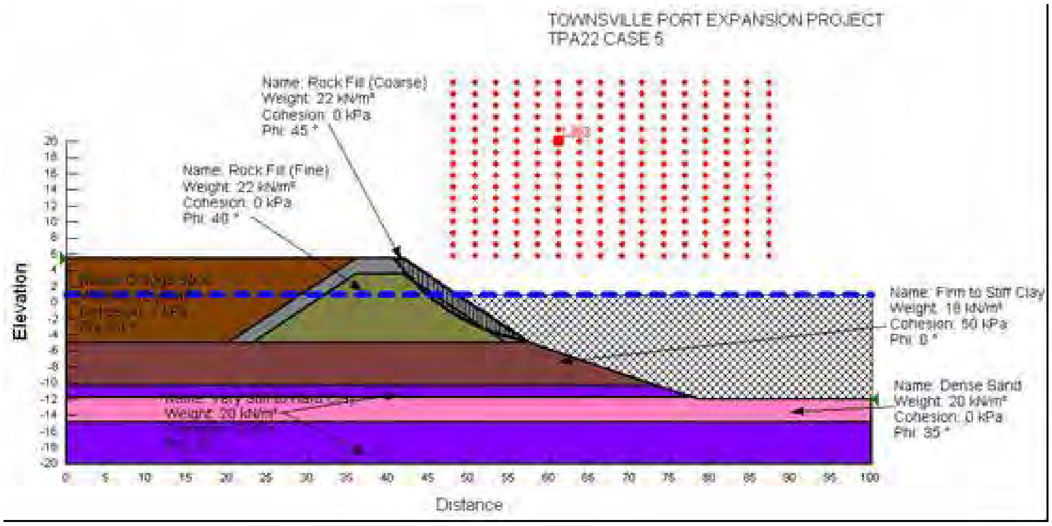


TPA07 - Minimum FOS = 1.4 - Unsatisfactory for the “normal” water level (1 m LAT) conditions modelled

The analysed minimum FOS “failure” surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

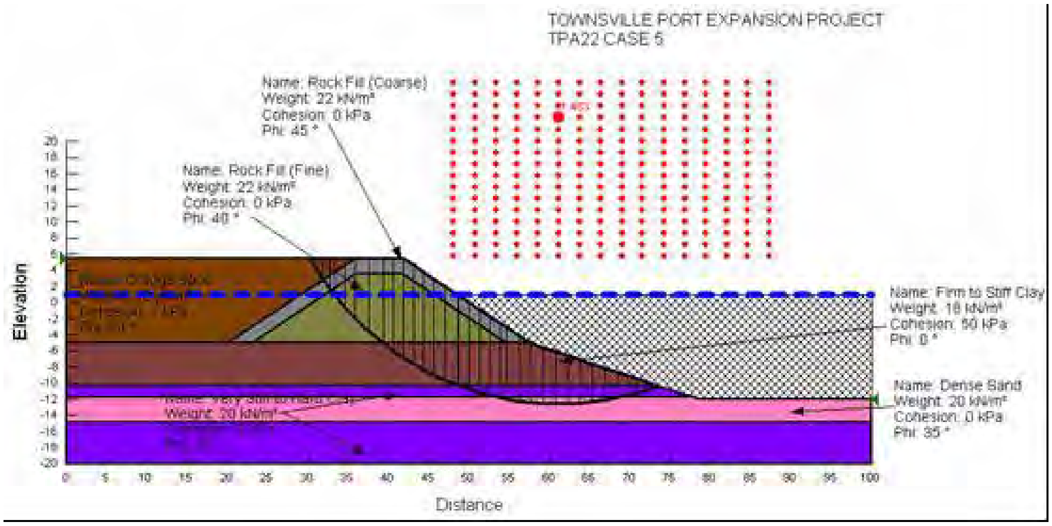


TPA07 - FOS against deeper seated instability = 1.5 - Satisfactory for the "normal" water level (1 m LAT) conditions modelled

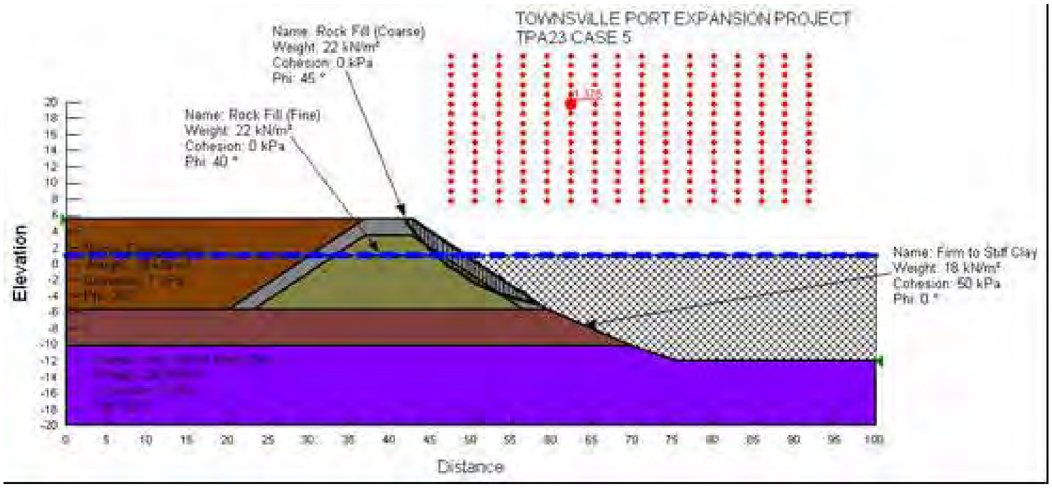


TPA22 - Minimum FOS = 1.3 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

The analysed minimum FOS "failure" surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

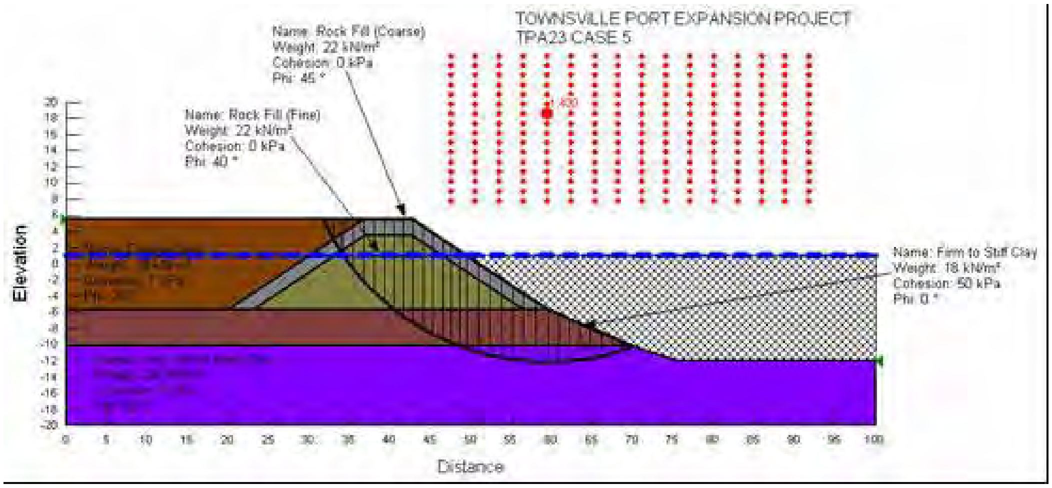


TPA22 - FOS against large scale failure = 1.4 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled



TPA23 - Minimum FOS = 1.3 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

The analysed minimum FOS "failure" surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

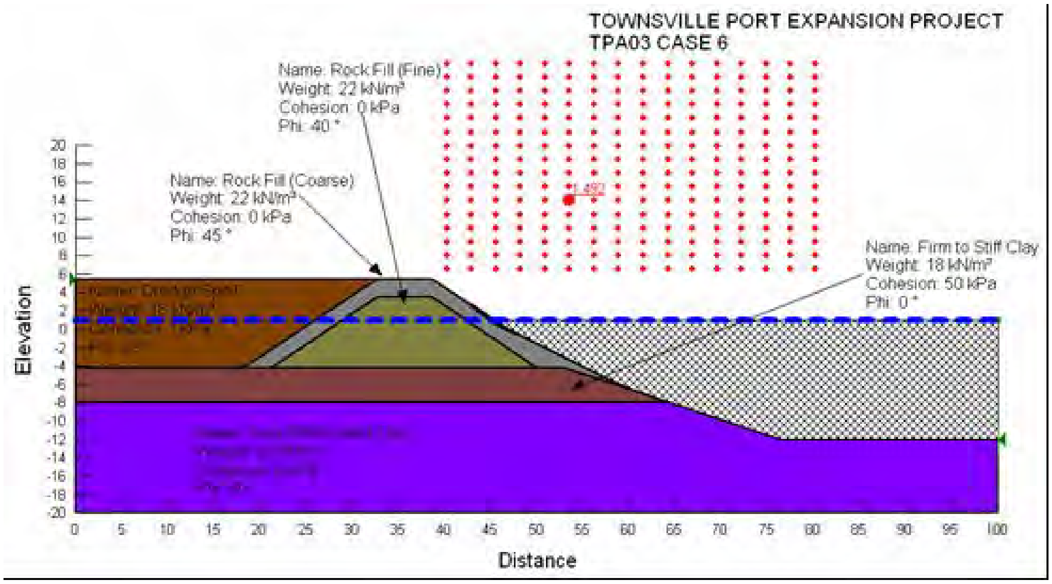


TPA23 - FOS against deeper seated instability = 1.4 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

E1.6 CASE 6

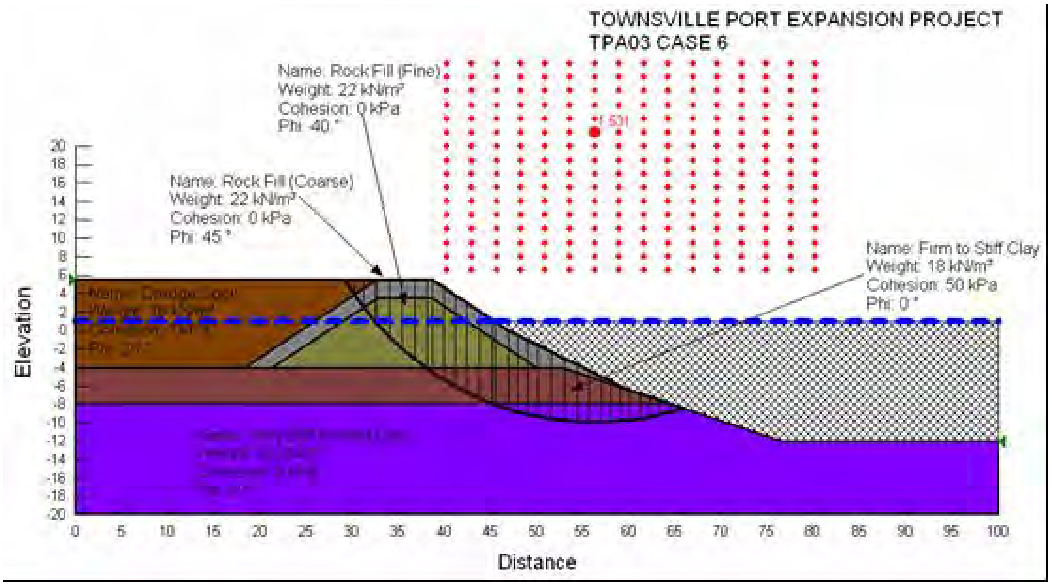
Case 6 comprised of a similar profile as that analysed in Cases 3, 4 and 5, with additional rock toe support placed below -1.0 m LAT at a slope of approximately 1V:2H. The water level was modeled at 1 m LAT to simulate a more typical or "normal" condition.

<u>Results of SLOPE/W Analysis for Case 6:</u>

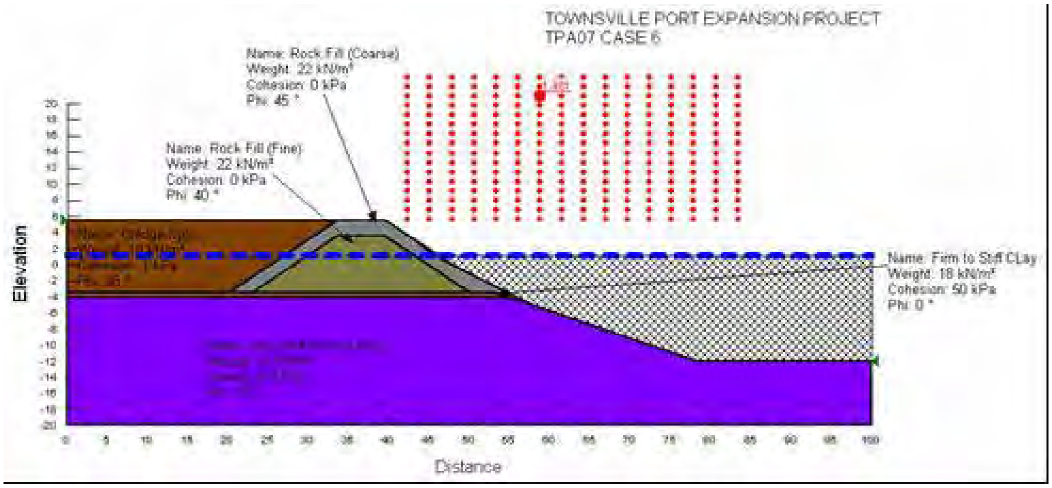


TPA03 - Minimum FOS = 1.4 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

The analysed minimum FOS “failure” surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

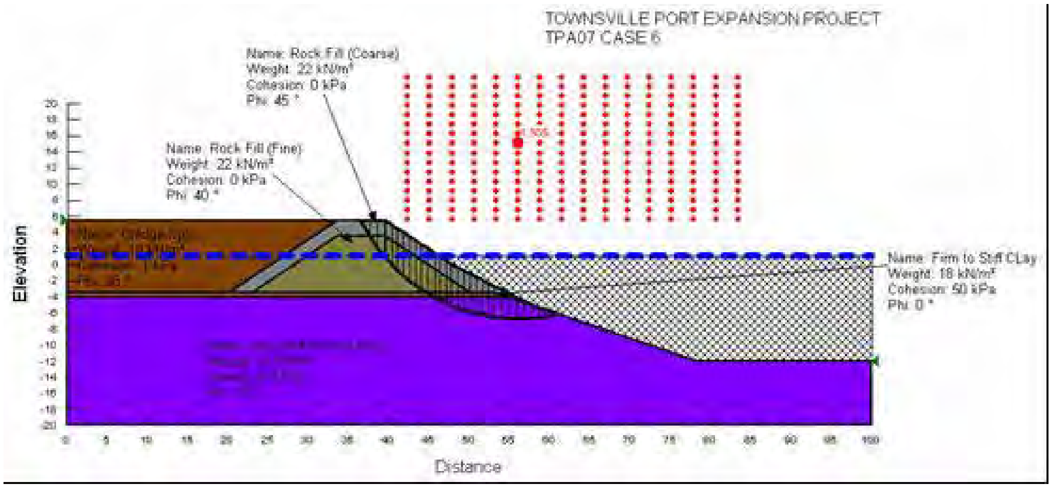


TPA03 - FOS against large scale failure = 1.5 - Satisfactory for the “normal” water level (1 m LAT) conditions modelled

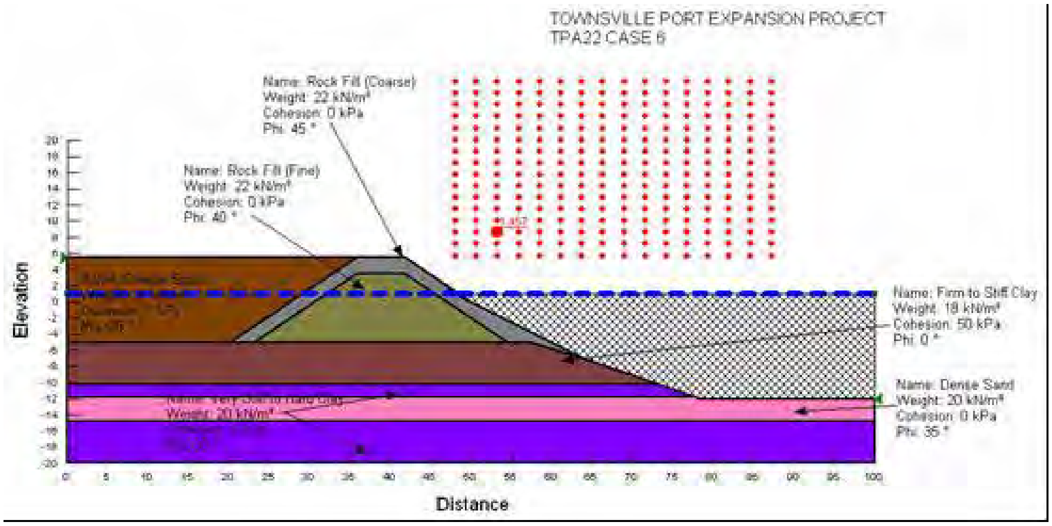


TPA07 - Minimum FOS = 1.4 - Unsatisfactory for the “normal” water level (1 m LAT) conditions modelled

The analysed minimum FOS “failure” surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.

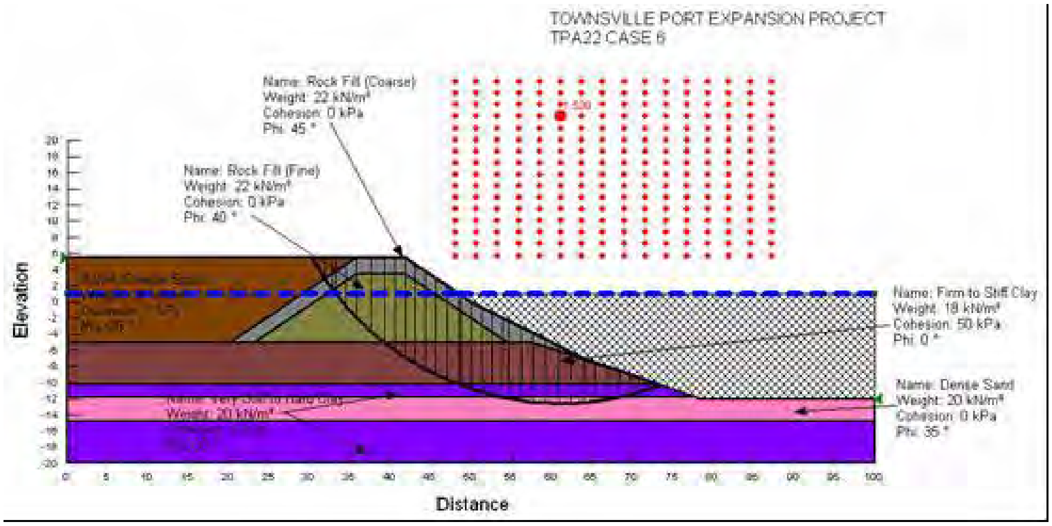


TPA07 - FOS against deeper seated instability = 1.5 - Satisfactory for the "normal" water level (1 m LAT) conditions modelled

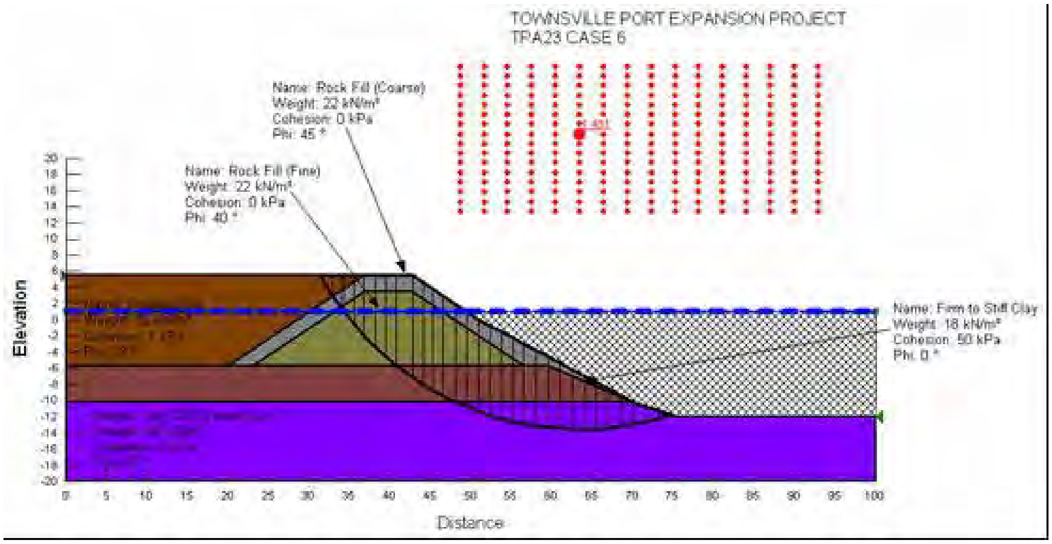


TPA22 - Minimum FOS = 1.4 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

The analysed minimum FOS "failure" surface occurs through the revetment wall materials. Further review of this analysis were conducted for FOS against larger scale (deep seated) failure extending through natural soils.



TPA22 - FOS against deeper seated instability = 1.5 - Satisfactory for the "normal" water level (1 m LAT) conditions modelled

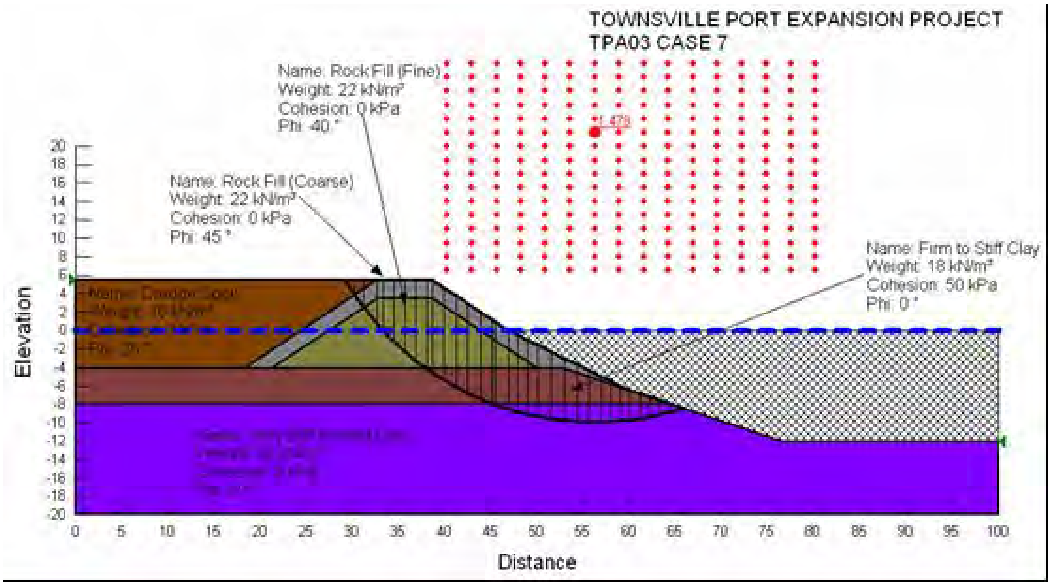


TPA23 - Minimum FOS = 1.4 - Unsatisfactory for the "normal" water level (1 m LAT) conditions modelled

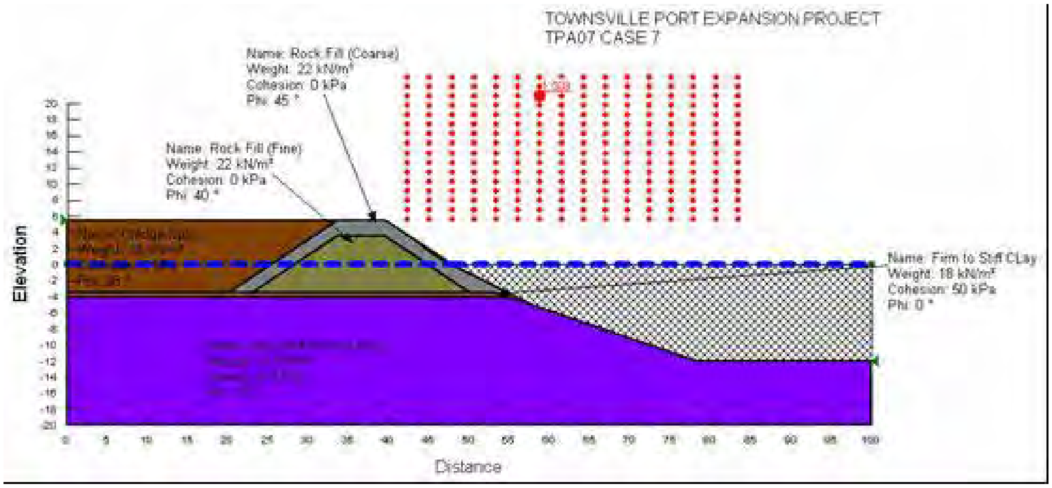
E1.7 CASE 7

Case 7 models a similar profile as that analysed for Case 6 (with the additional toe rock) with the water level at the "extreme" condition (ie water level at 0.0 m LAT).

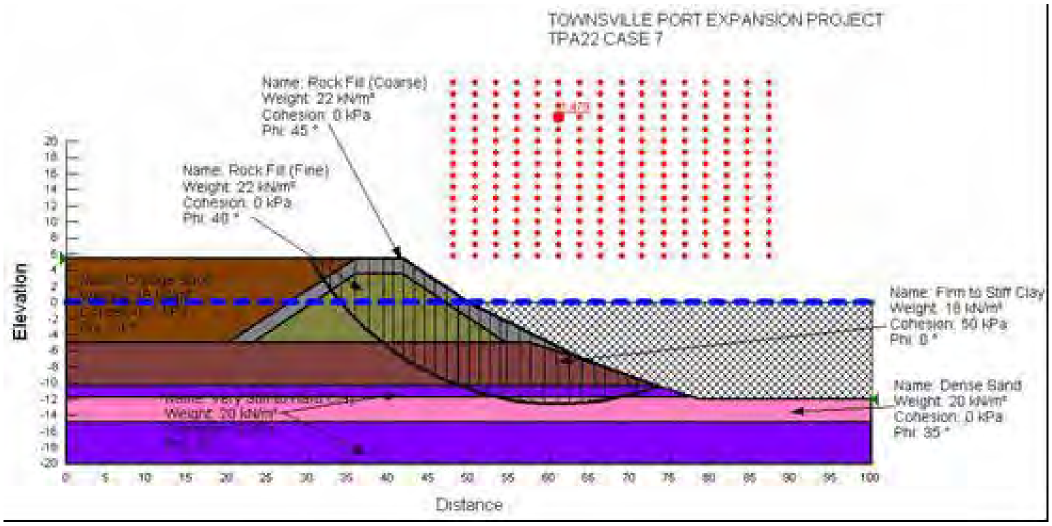
Results of SLOPE/W Analysis for Case 7:



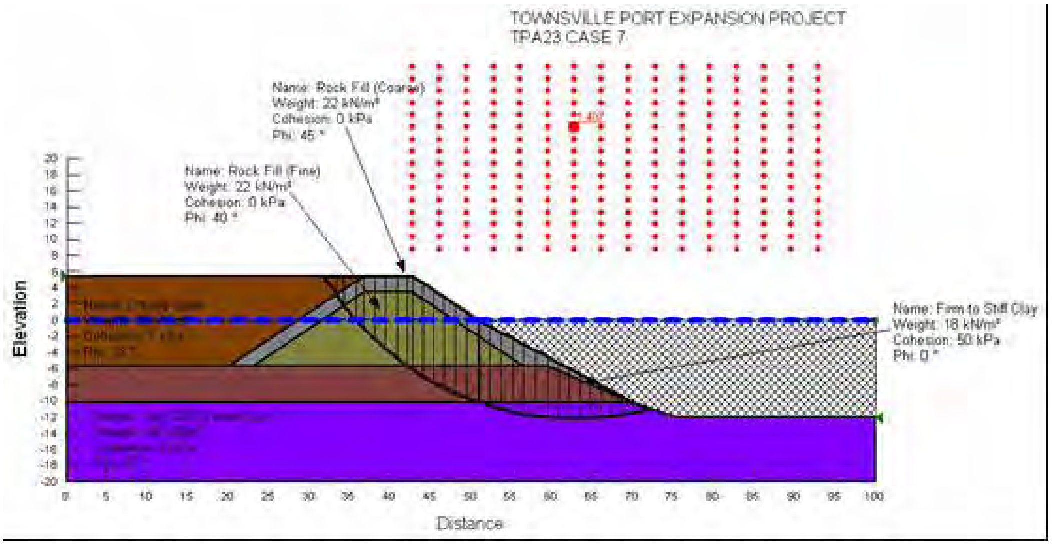
TPA03 - Minimum FOS = 1.4 - Satisfactory for the "extreme"water level (0 m LAT) conditions modelled



TPA07 - Minimum FOS = 1.5 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled



TPA22 - Minimum FOS = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

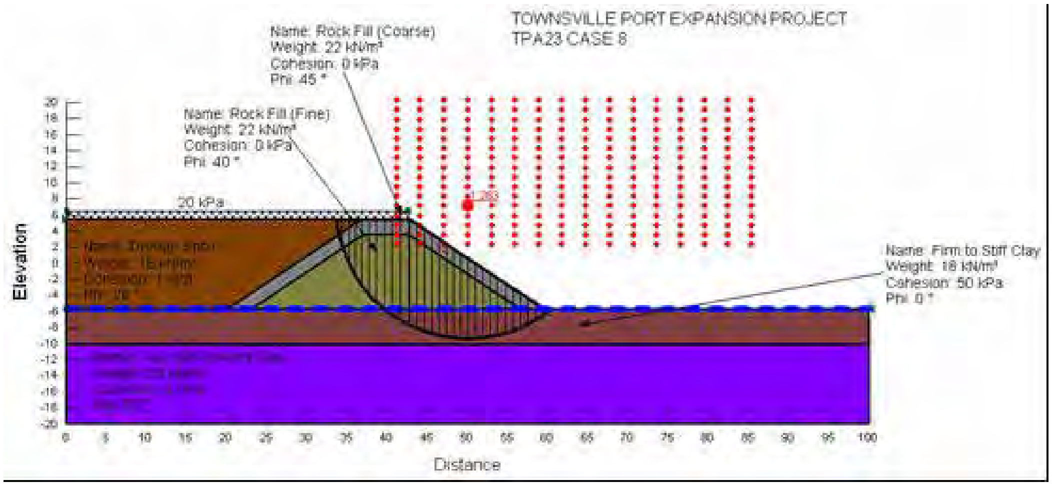


TPA23 - Minimum FOS = 1.4 - Satisfactory for the "extreme" water level (0 m LAT) conditions modelled

E1.8 CASE 8

Case 8 was analysed to provide a preliminary assessment for construction conditions that may be encountered at Borehole TPA 23 if "dry" construction is conducted. The purpose of this model was to provide preliminary details on revetment stability under a dewatered construction . Case 8 comprised construction of the revetment on the firm to stiff material underlying the seabed sediment (ie the "soft" seabed sediments were removed). A temporary surcharge load of 20 kPa was applied to account for live loading from machinery that may occur during construction and the water table was lowered to the base of the natural ground surface simulating dewatering. It should be noted that the profile did not model dredging the seaward side of the revetment to -12 m LAT.

Results of SLOPE/W Analysis for Case 8:

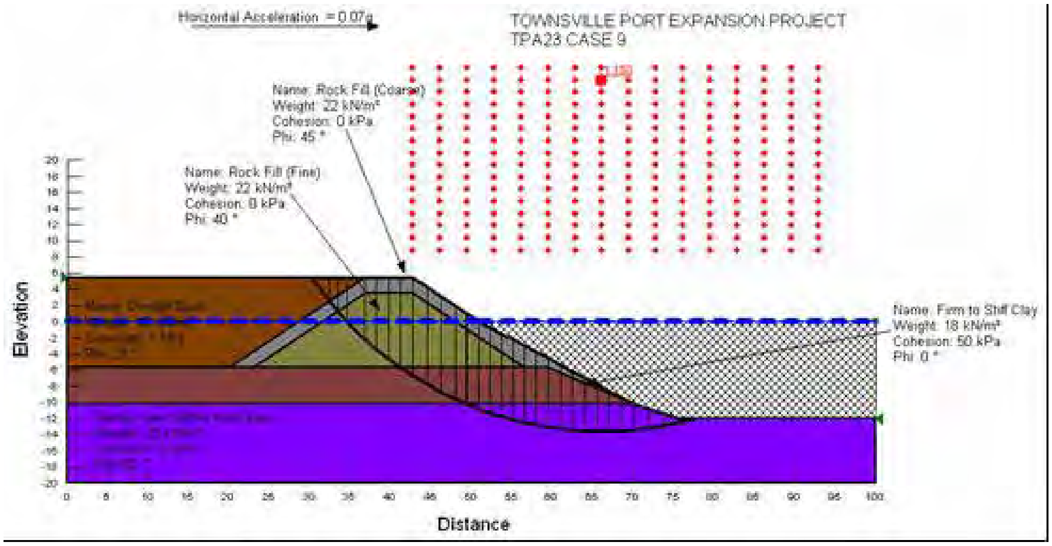


TPA23 - Minimum FOS = 1.2 - Unsatisfactory for temporary loading conditions

E1.9 CASE 9

Case 9 analysed the effect of a horizontal seismic loading of 0.07g on the Case 7 profile at Borehole TPA23. Further analysis and a sensitivity study will be required following finalization of a more detailed design.

Results of SLOPE/W Analysis for Case 8:



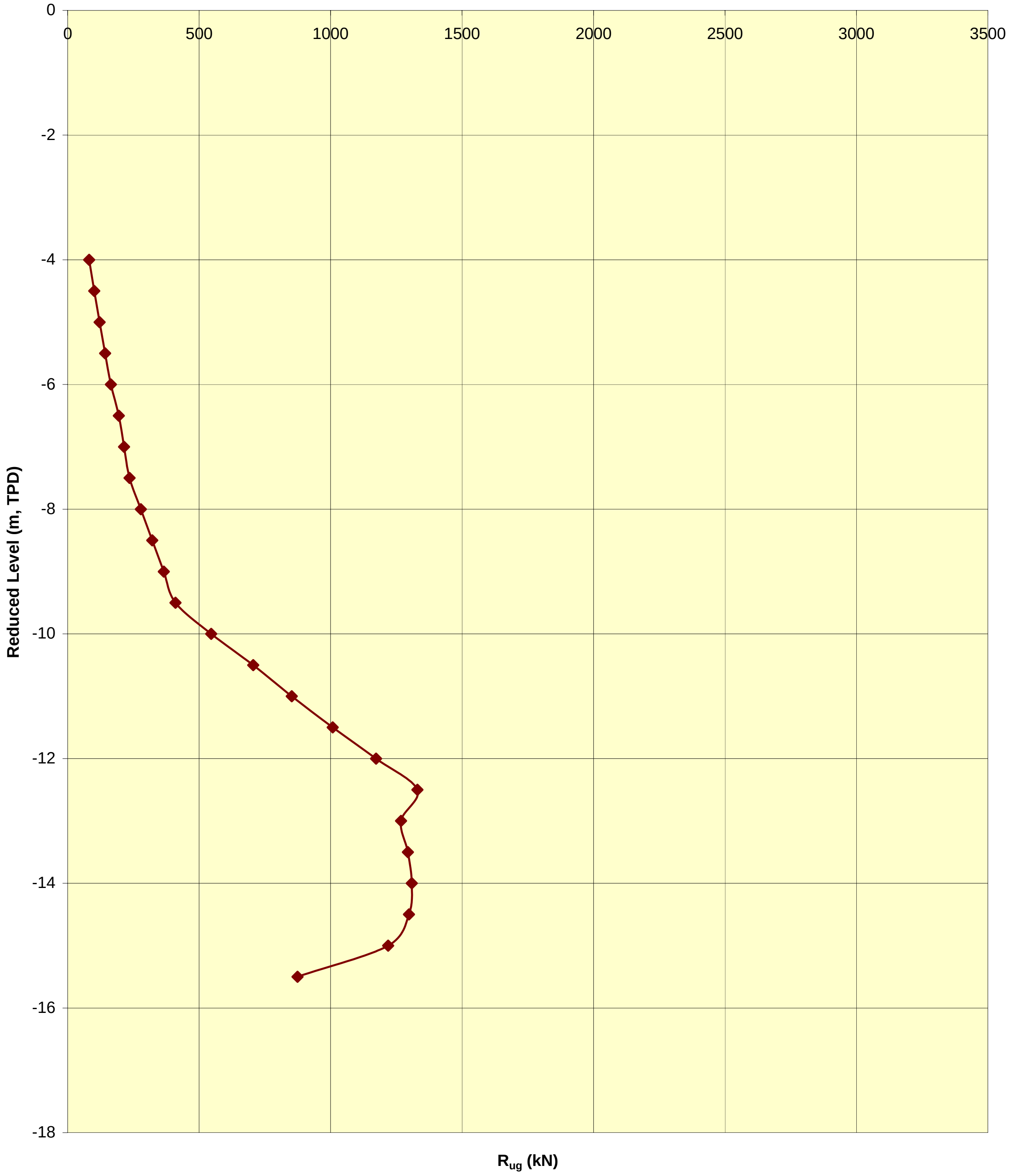
TPA23 - Minimum FOS = 1.1 - Satisfactory for earthquake loading conditions analysed

E1.10 FURTHER INVESTIGATION, MATERIAL CHARACTERISATION AND STABILITY ANALYSES

Detailed stability analyses, including further field investigation and laboratory testing, must will need to be conducted to confirm the results of these preliminary analyses, once revetment locations, construction methodology, dredge locations and profiles, and surcharge loadings are known.

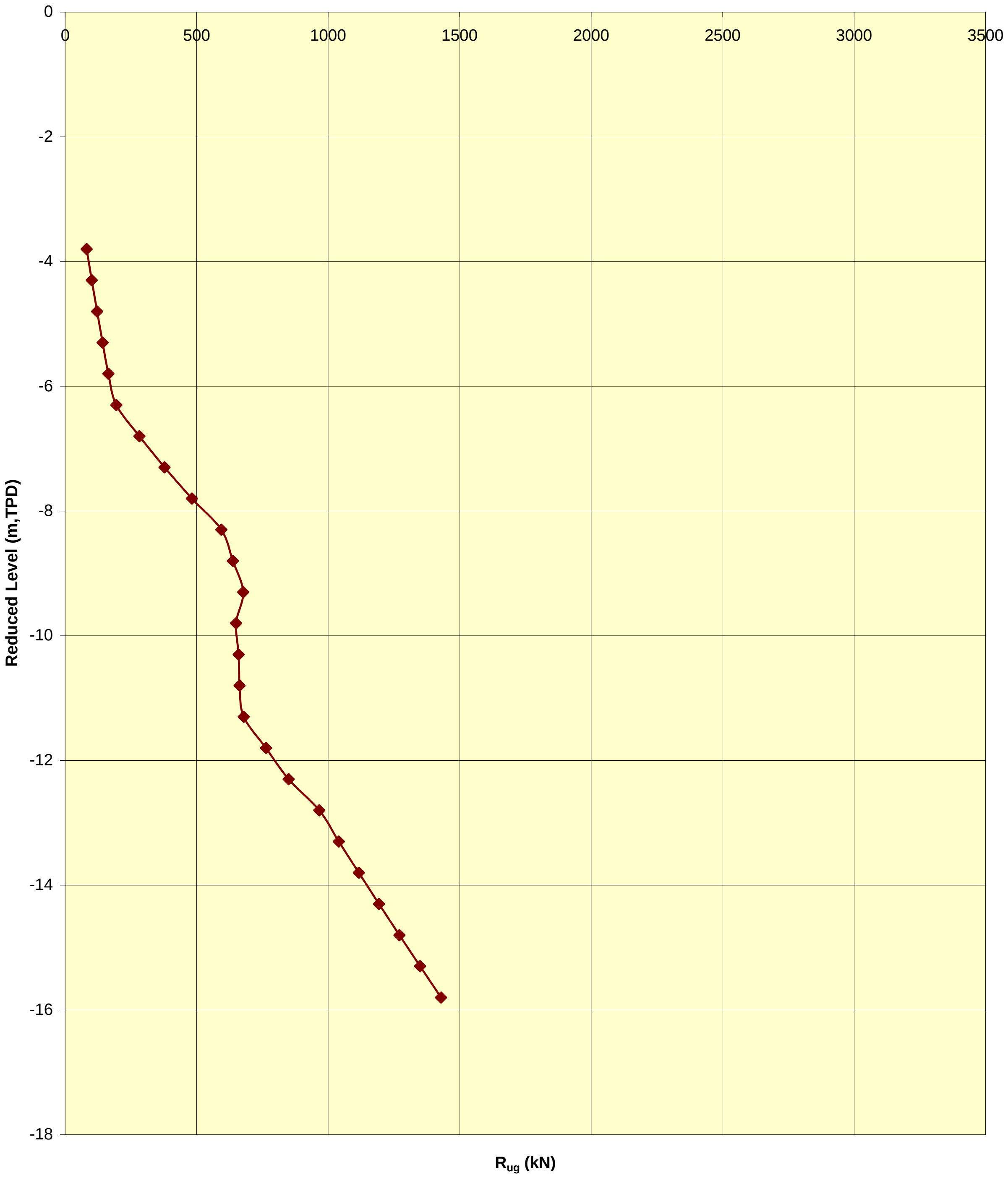
Appendix F
Ultimate Geotechnical Capacity Charts for Driven 600mm Diameter Piles

TPA-01 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



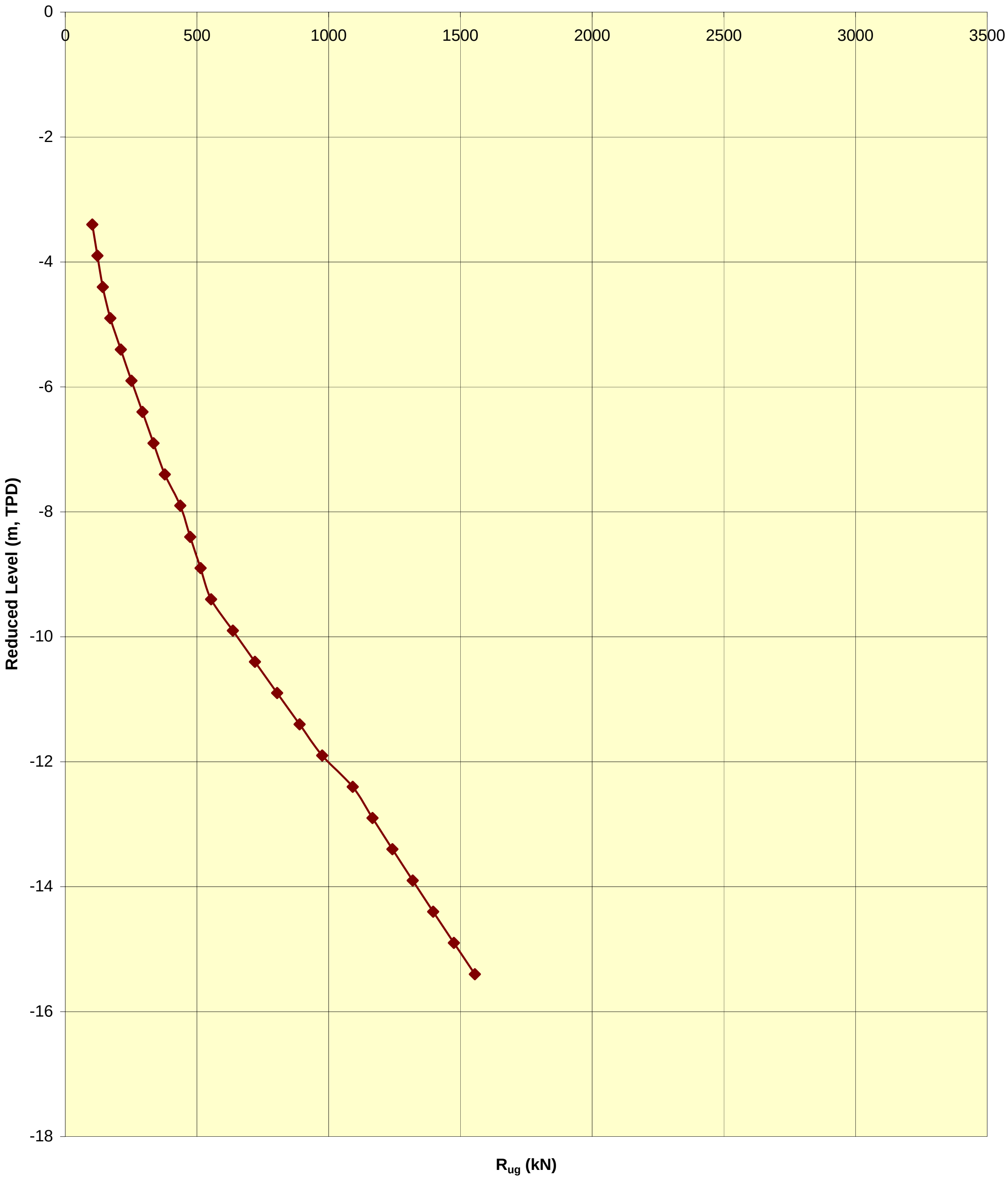
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-02 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



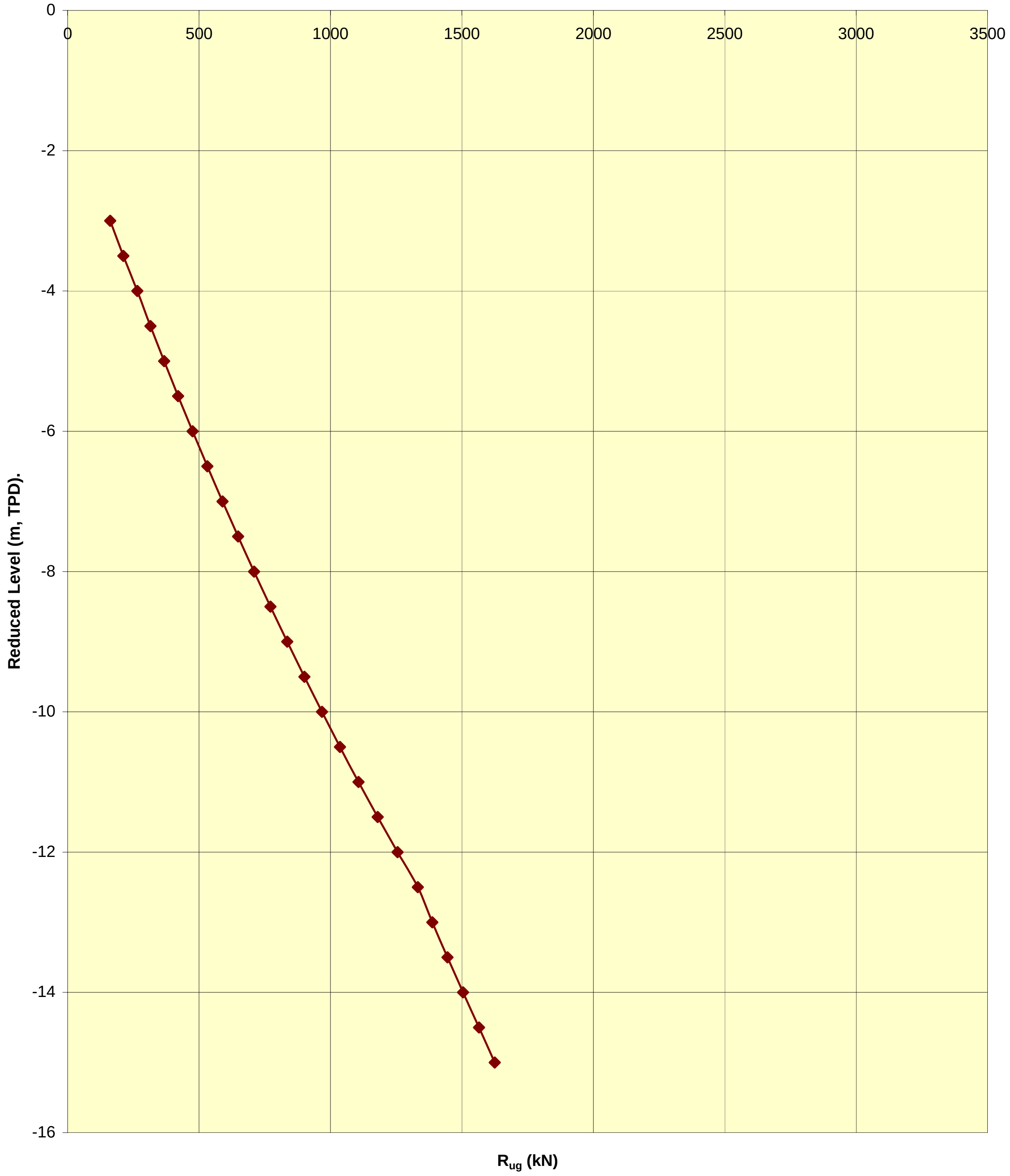
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-03 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-04 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



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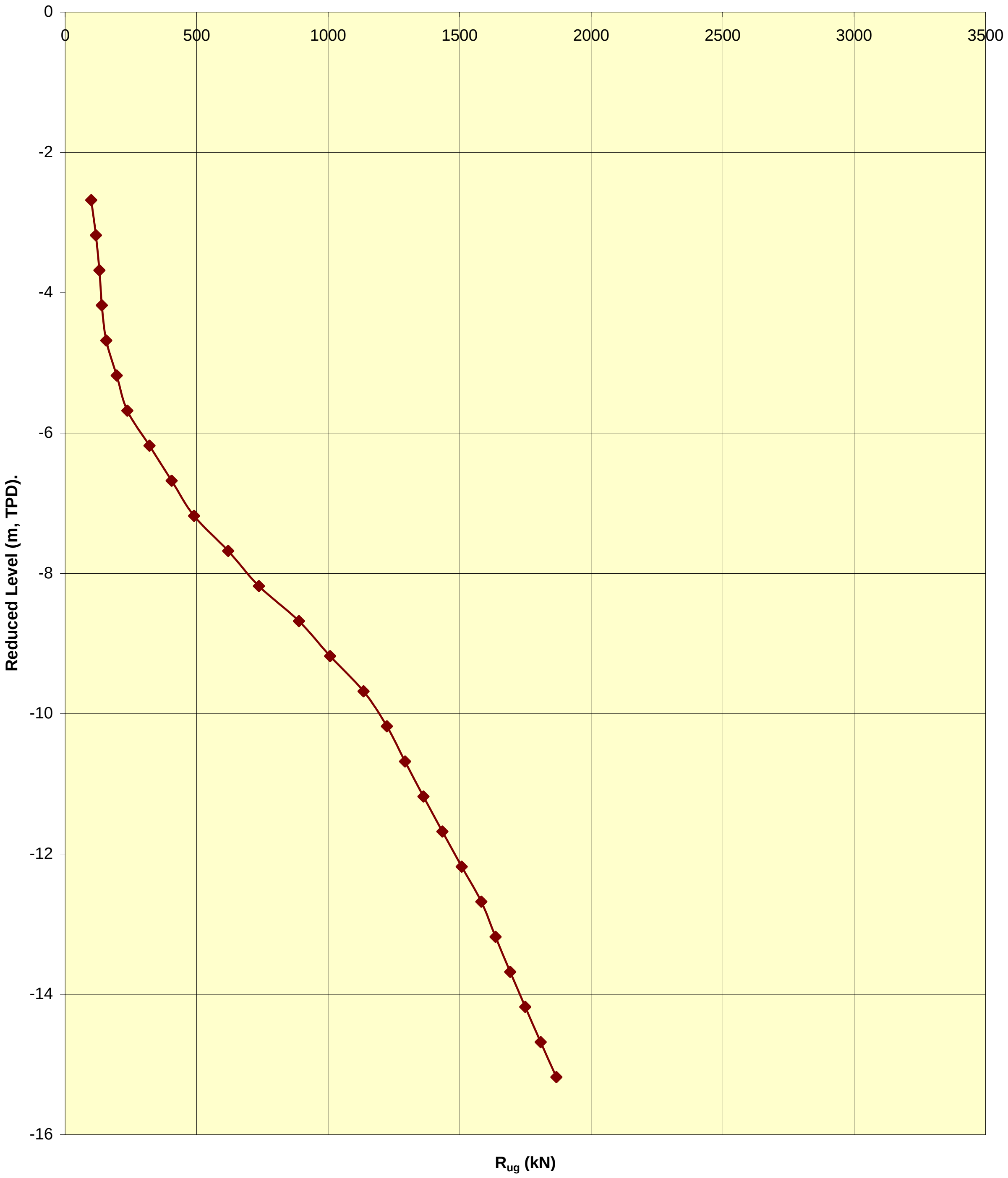
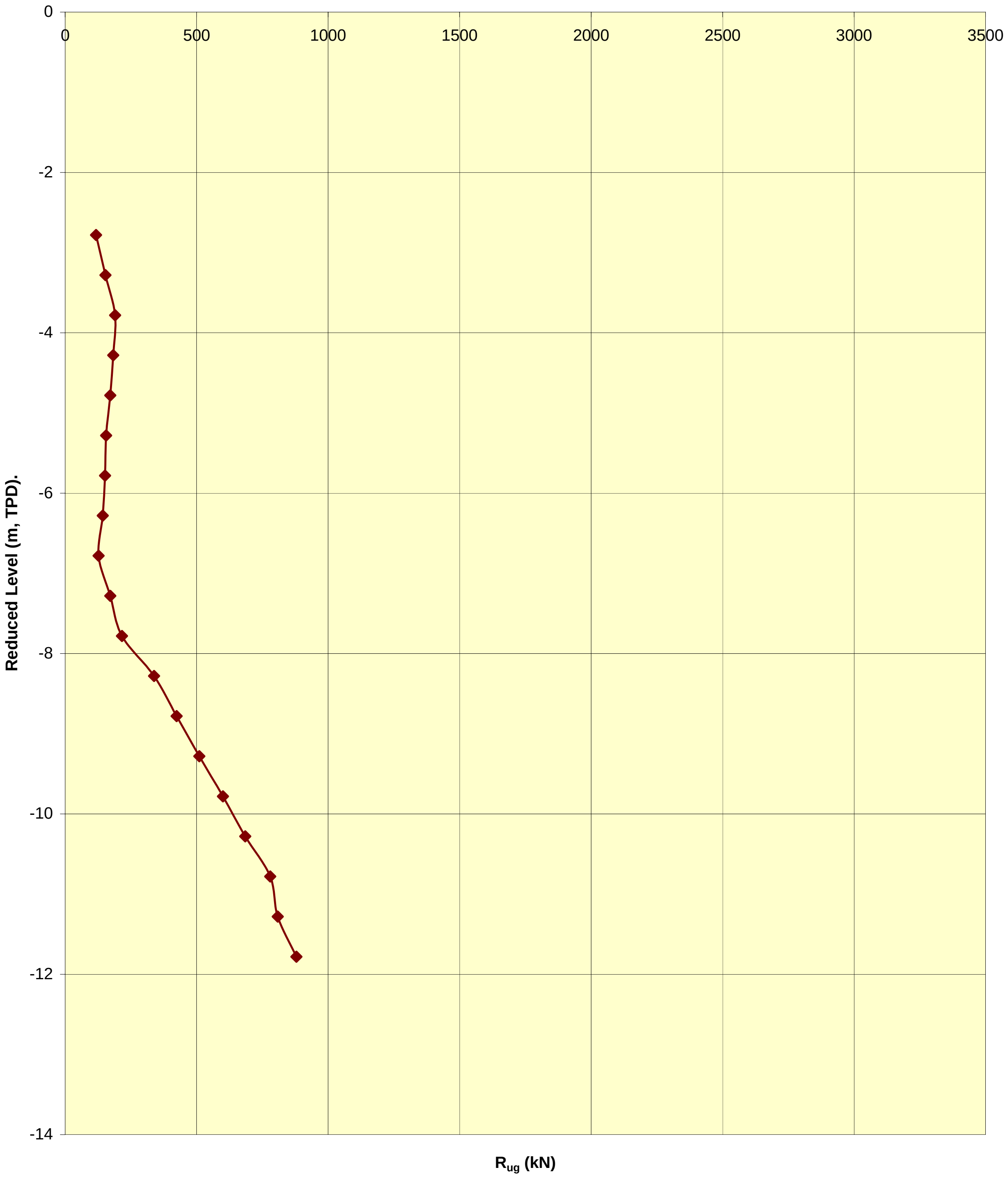
Checked by: WSB
Date: Feb 2008

TPA-05 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



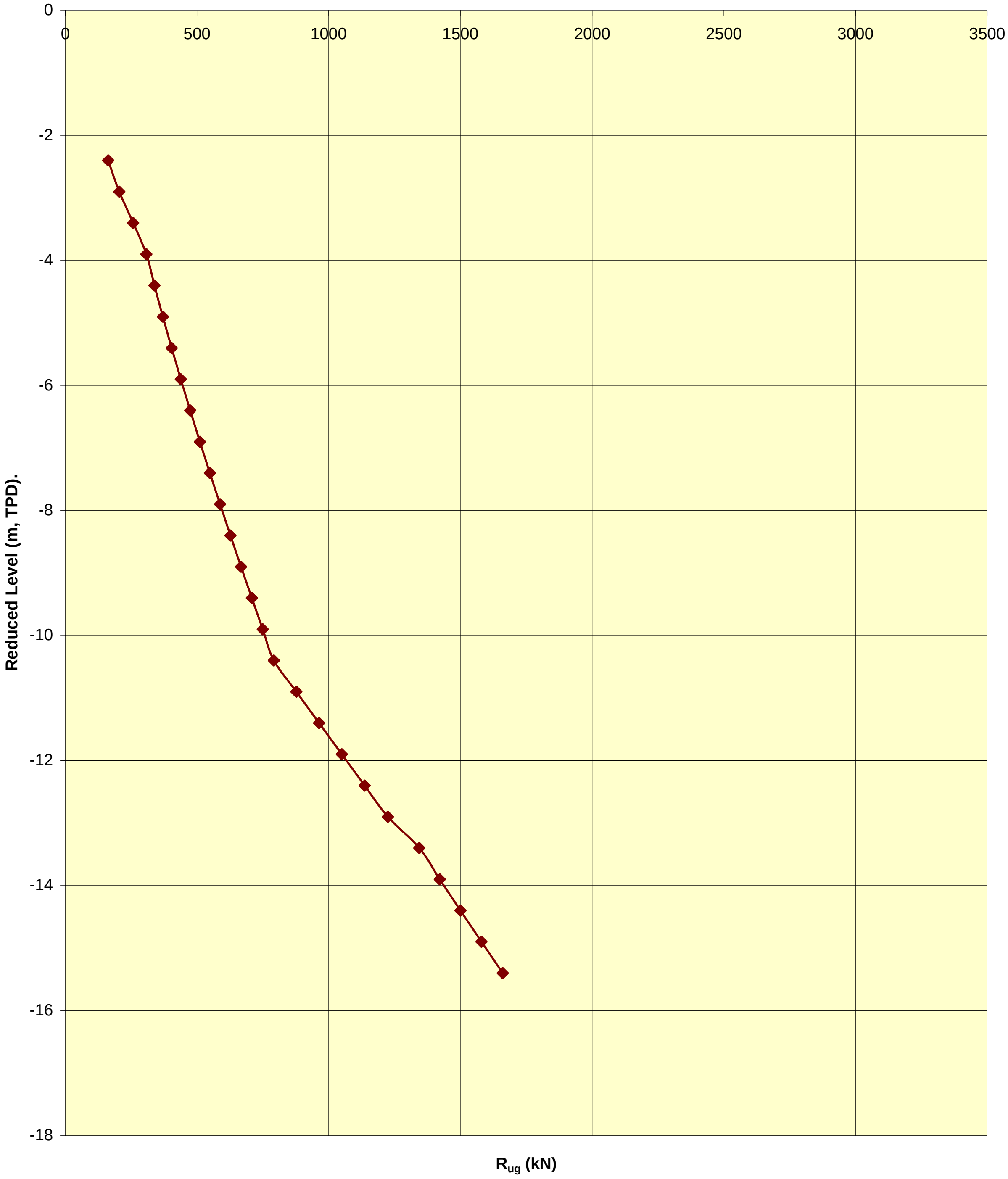
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-06 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



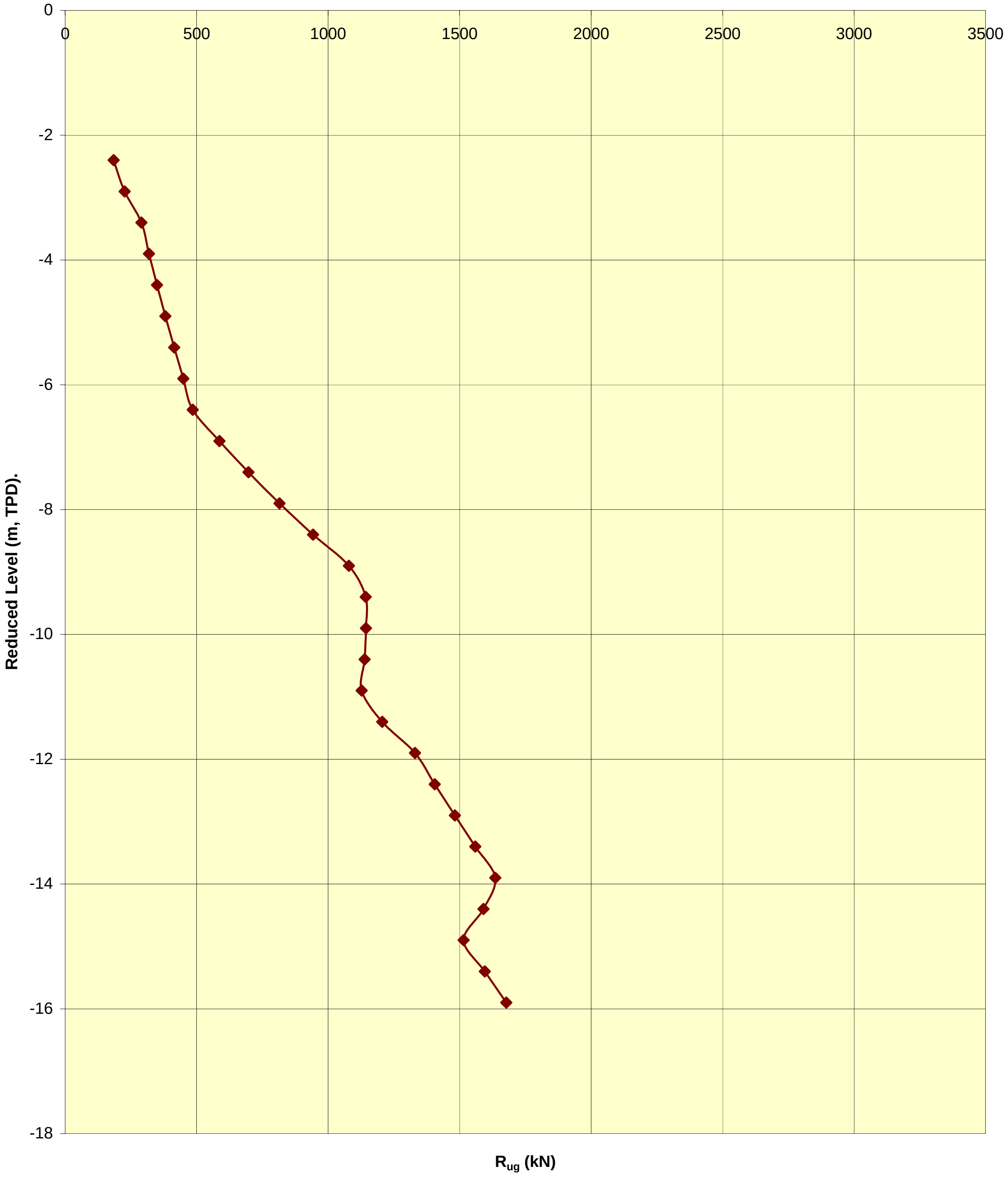
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-07 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



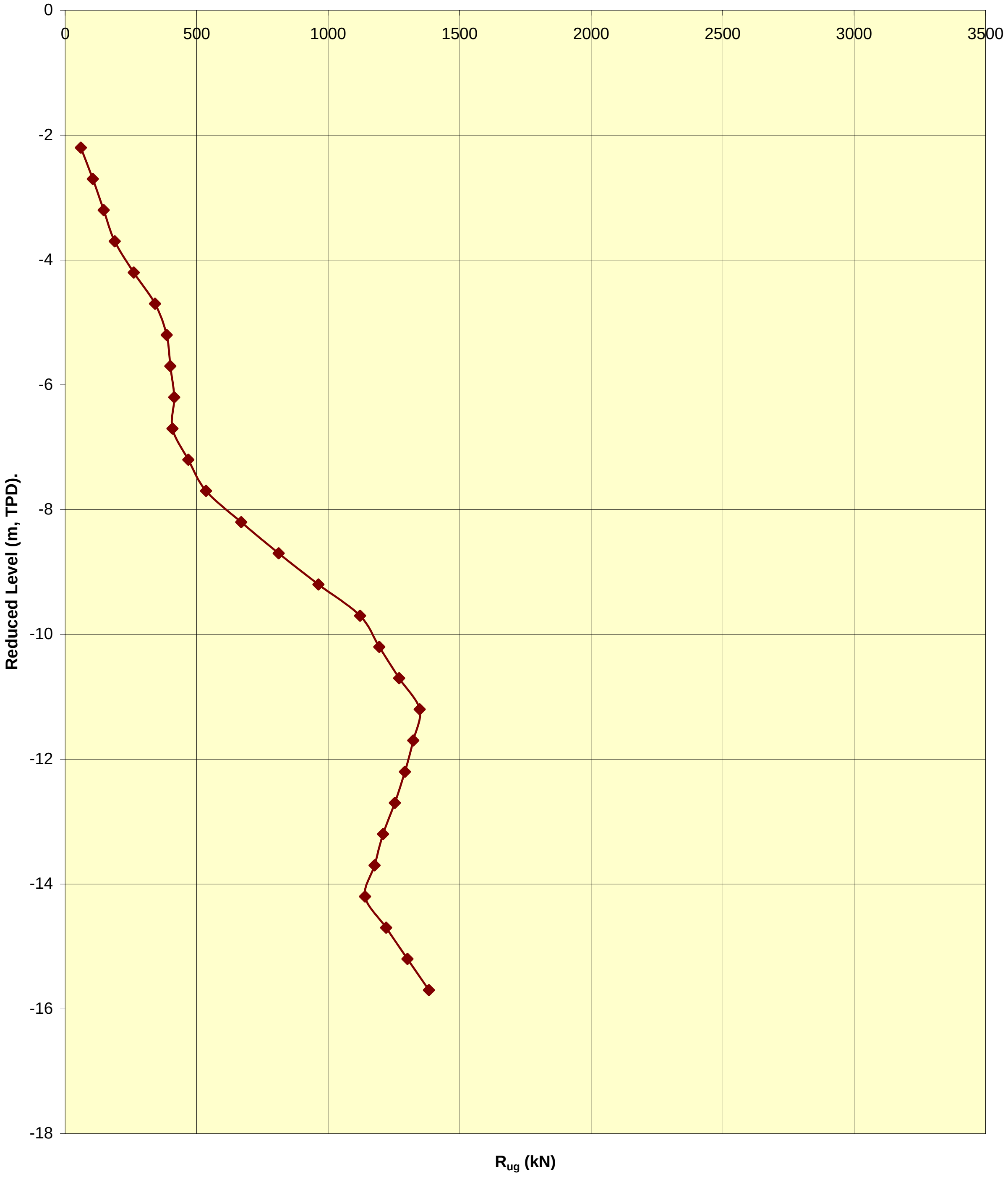
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-08 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-09 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



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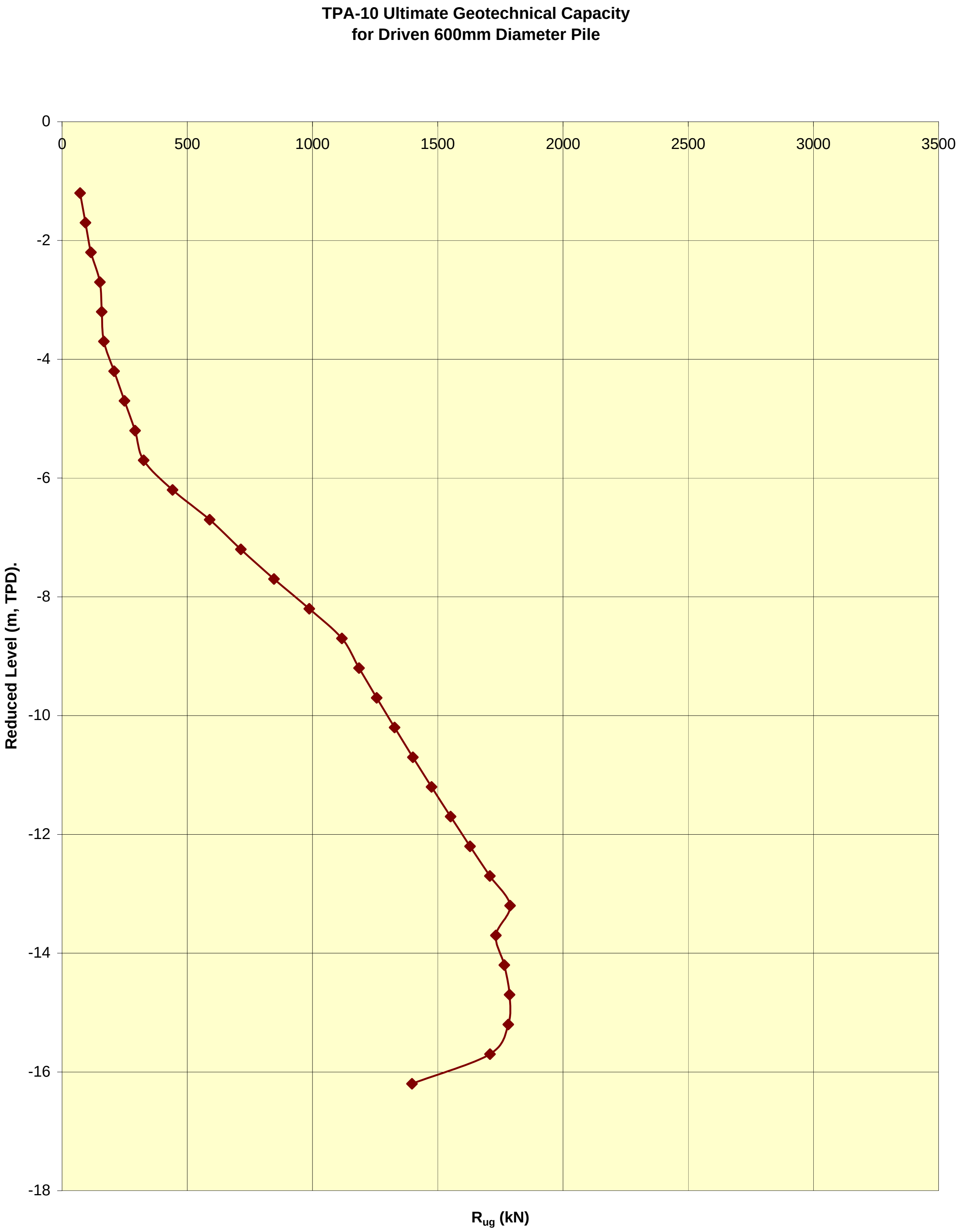
Date: Feb 2008



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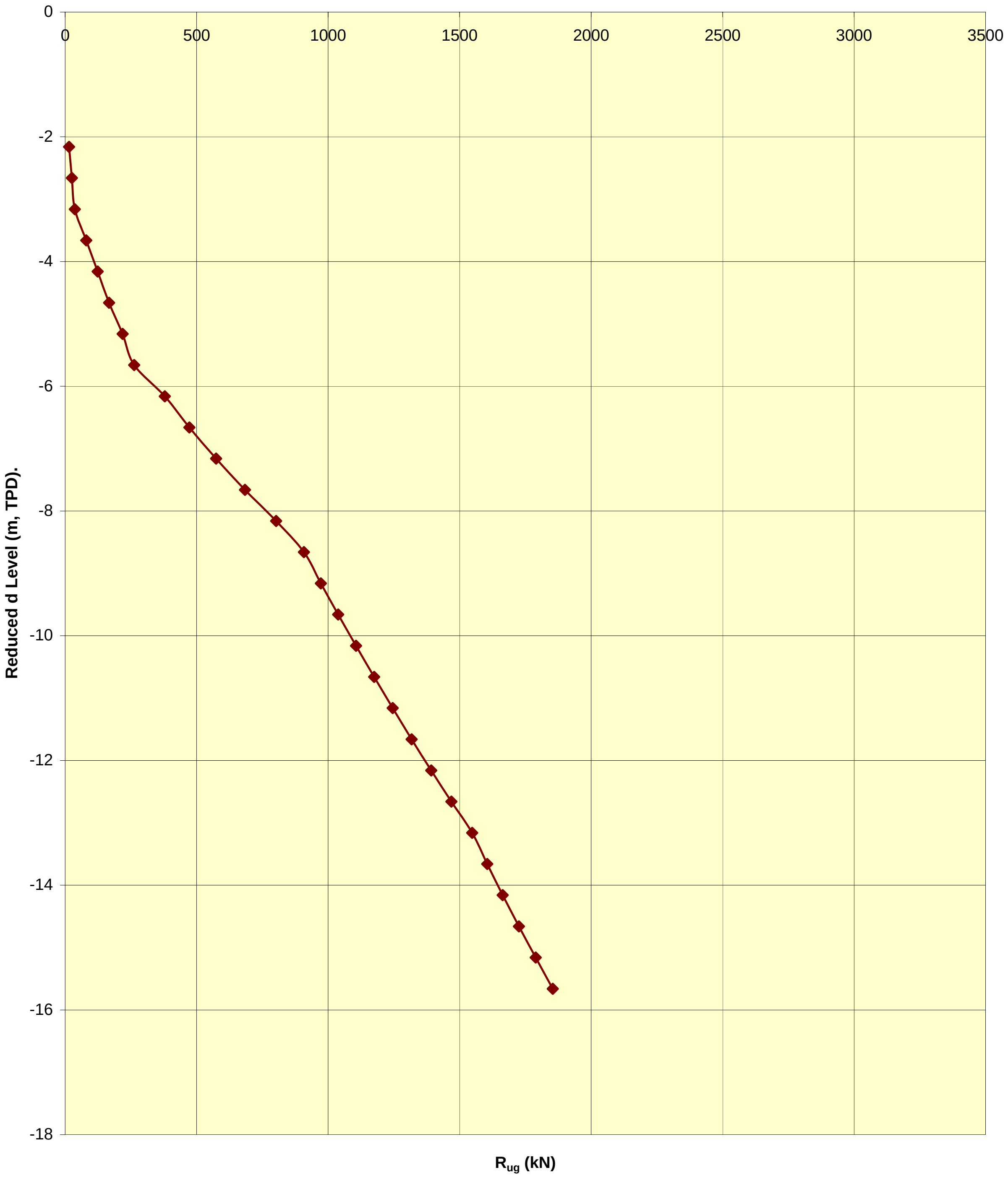
Checked by: WSB
Date: Feb 2008

TPA-11 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



Calculated by: JL
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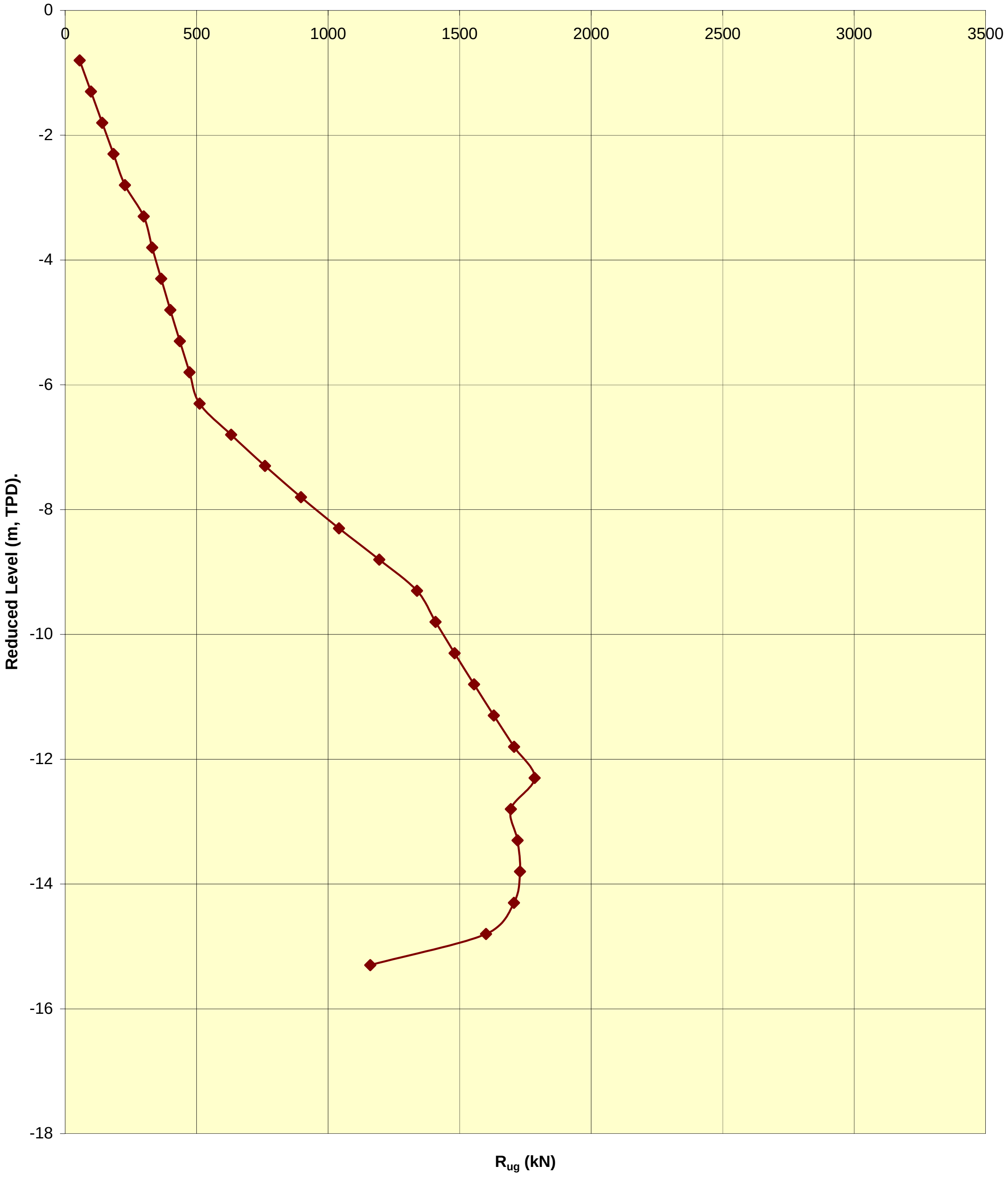
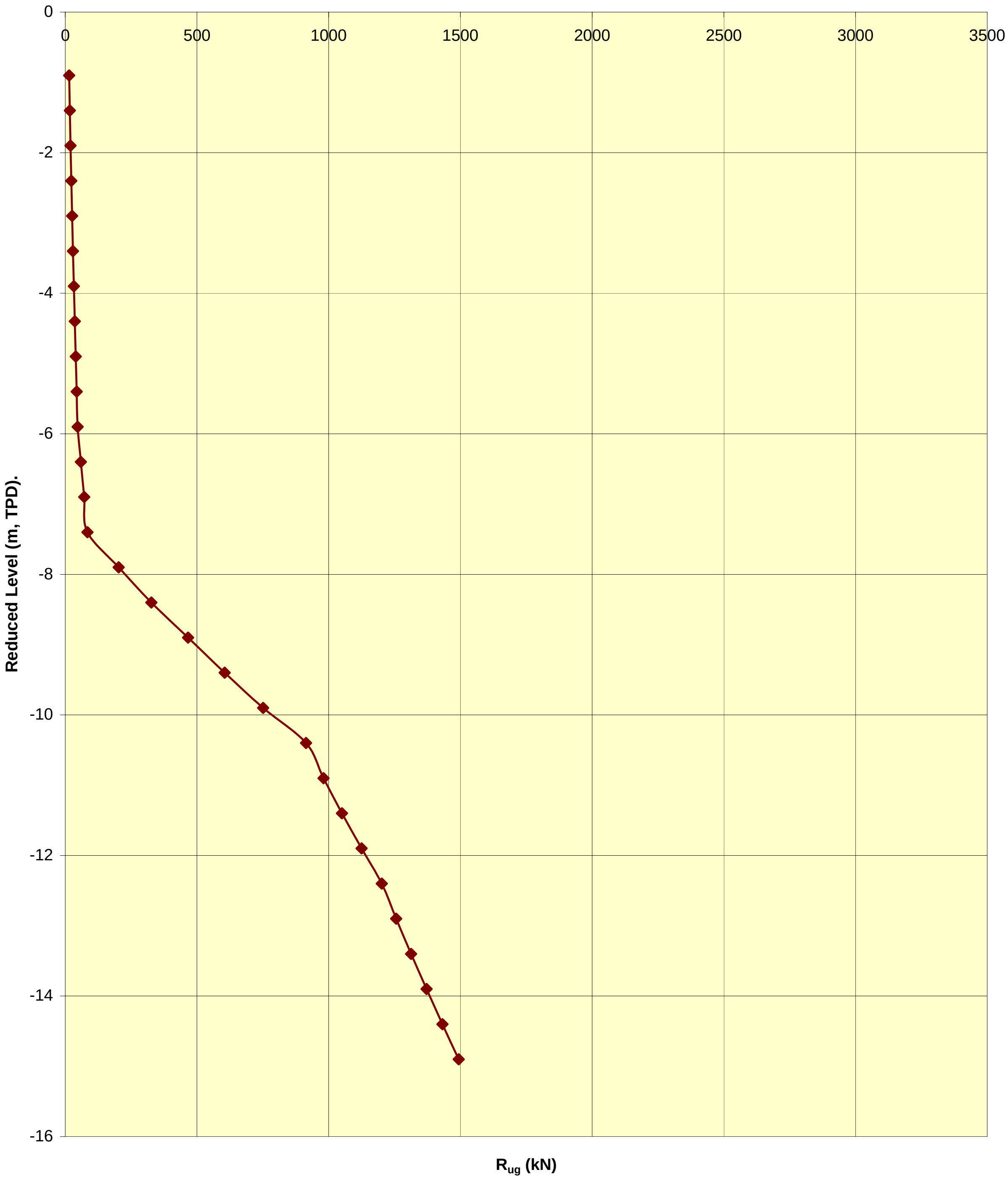
Checked by: WSB
Date: Feb 2008

TPA-12 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile

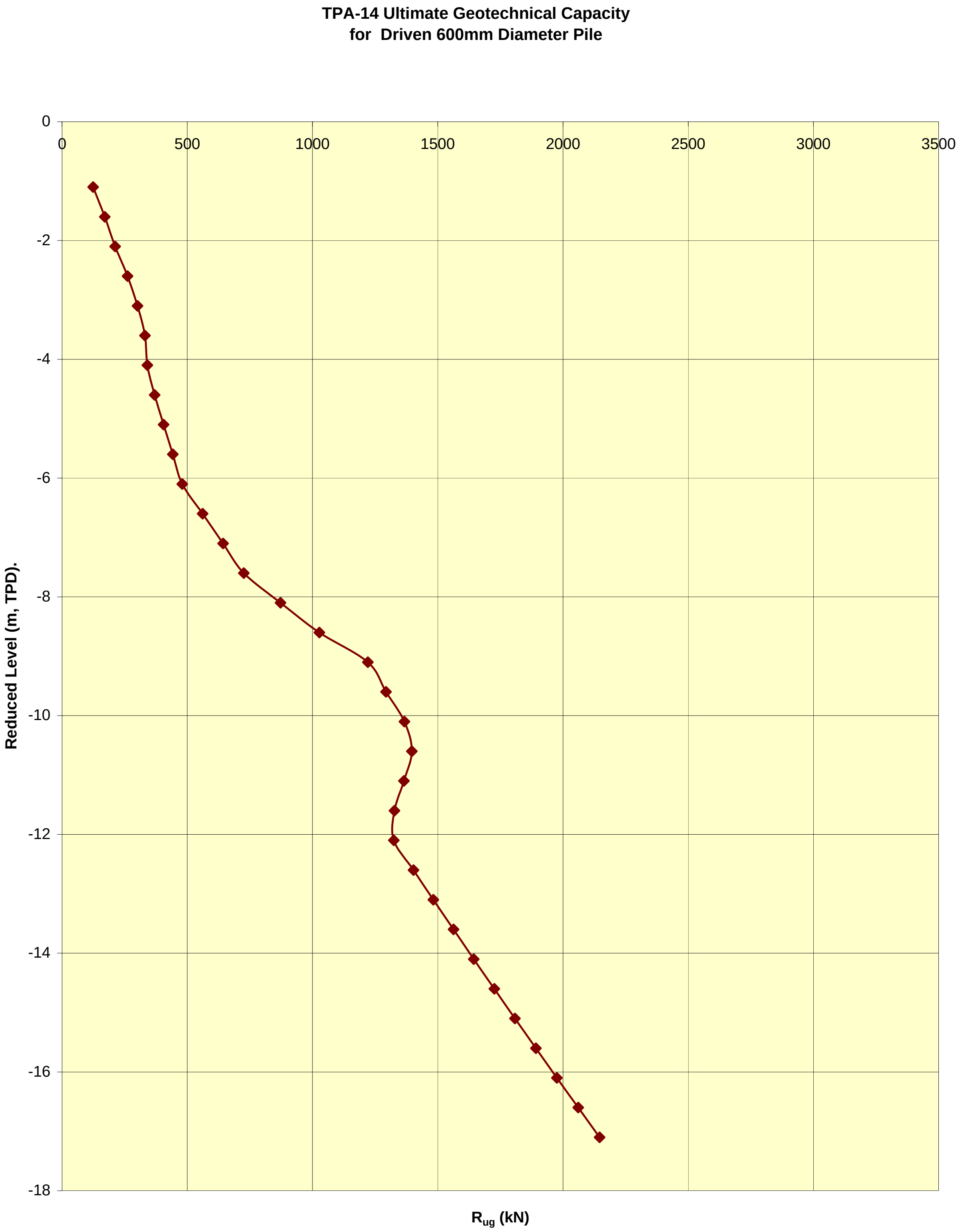


Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-13 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile

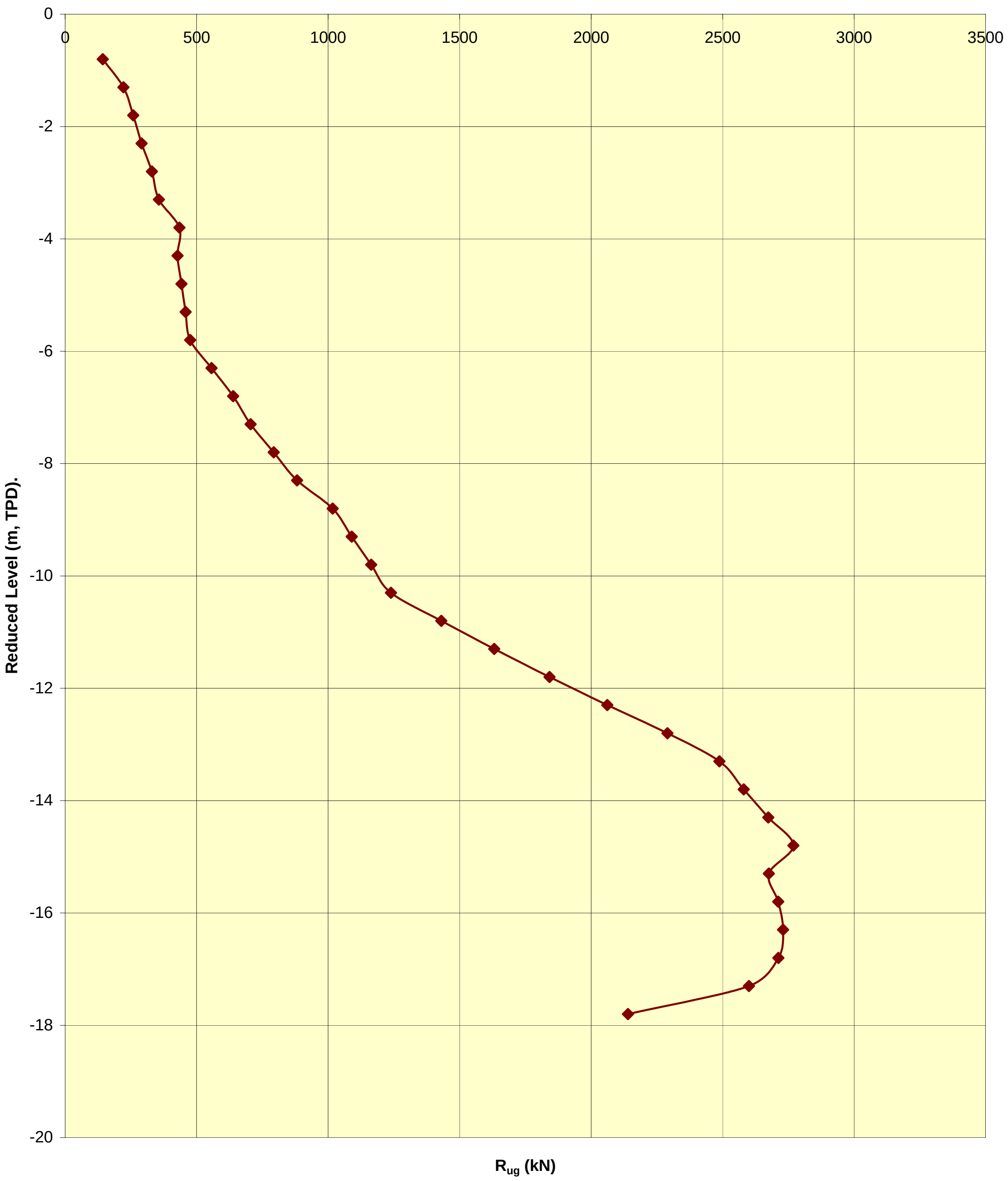


Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008



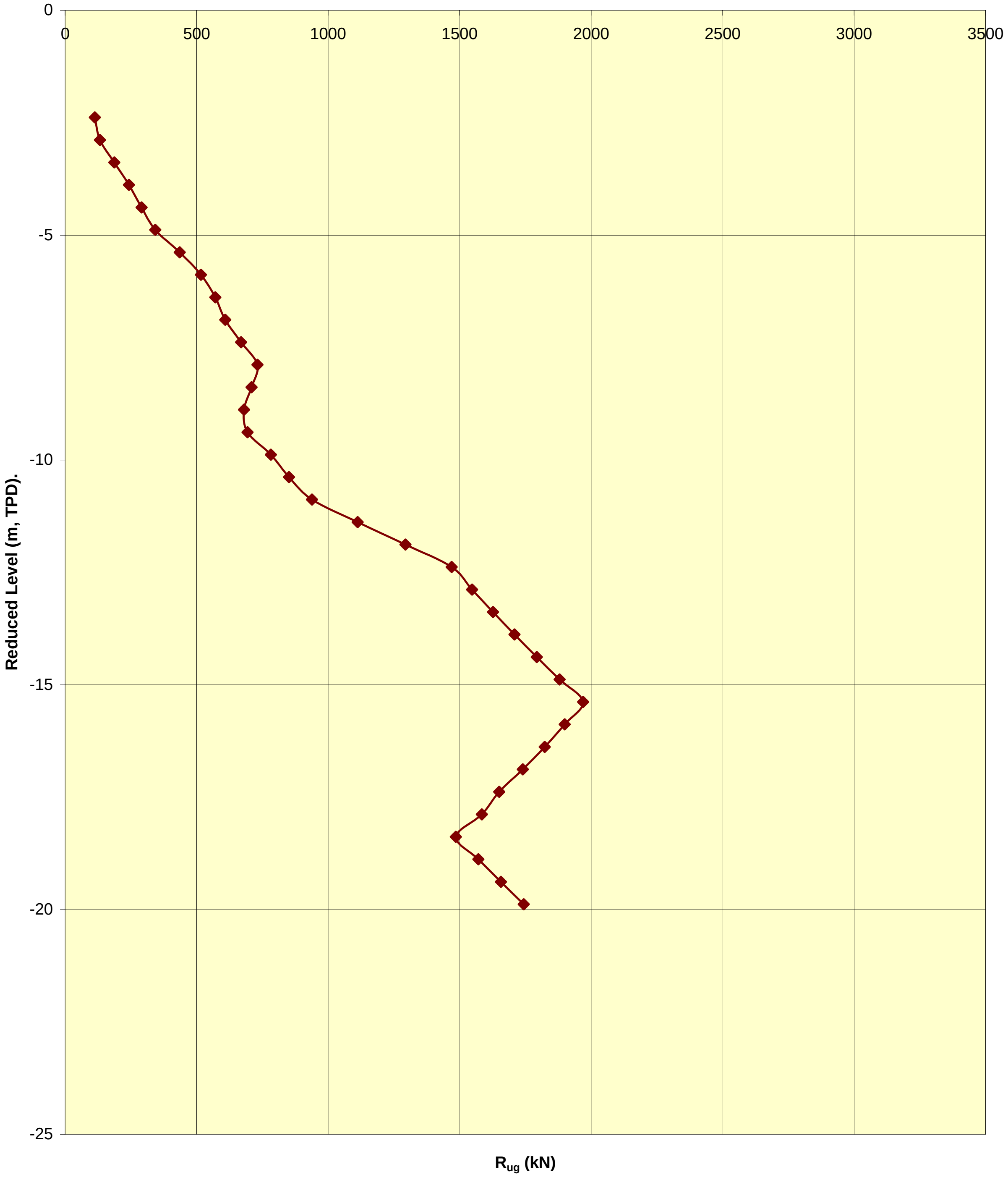
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-15 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



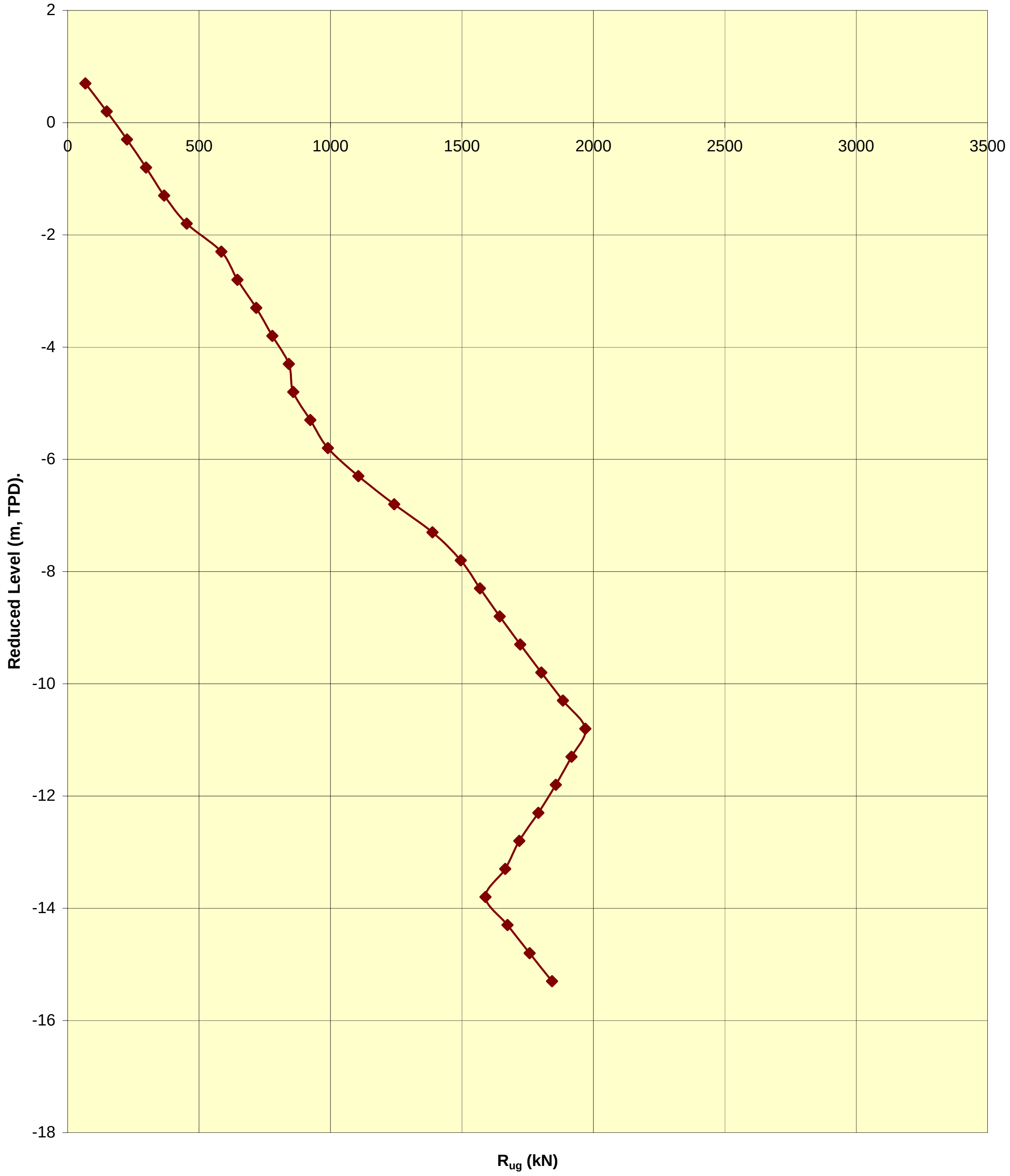
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-16 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



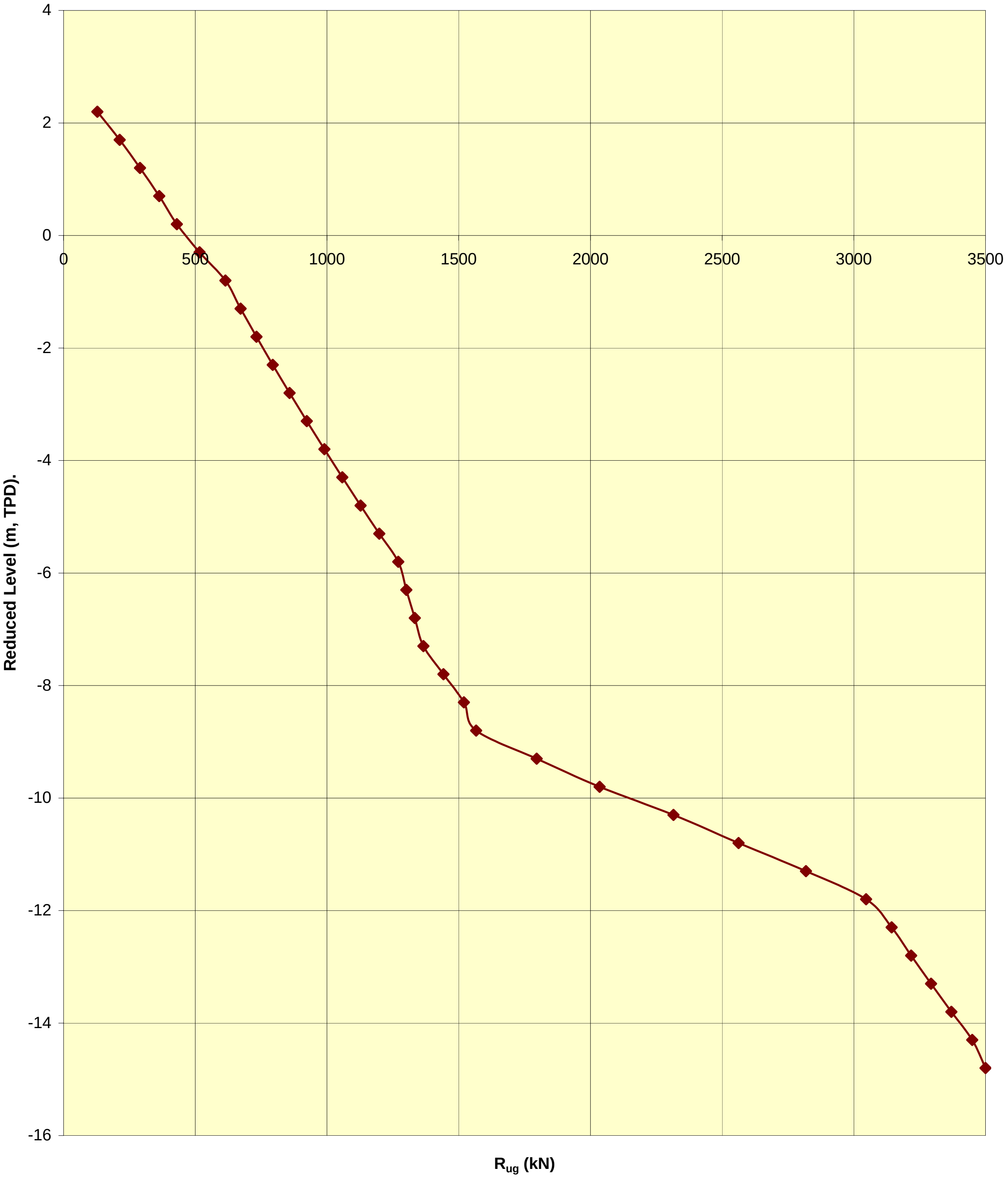
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-17 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



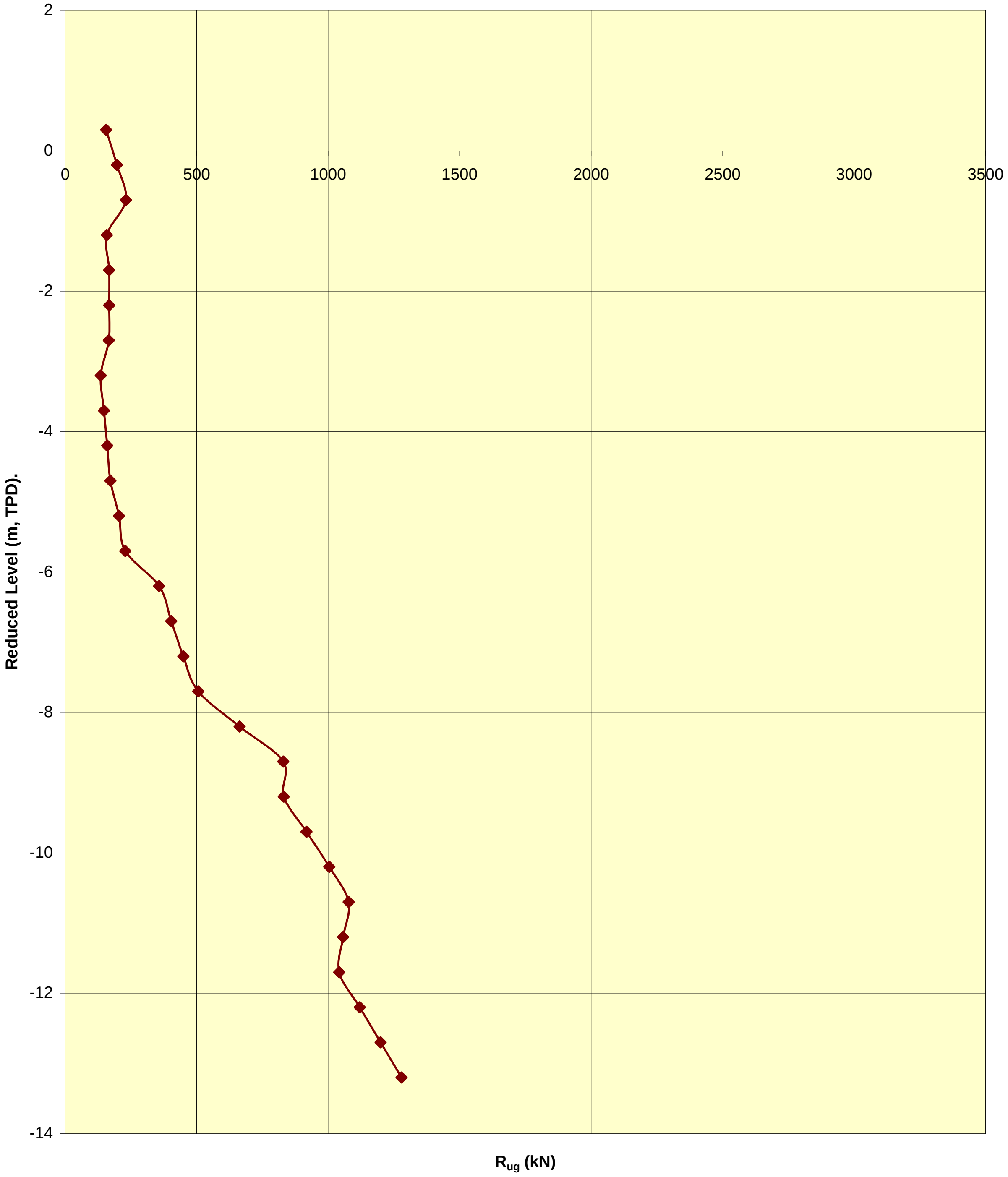
Calculated by: JL
Date: Jan 2008
Checked by:
Date:

TPA-18 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



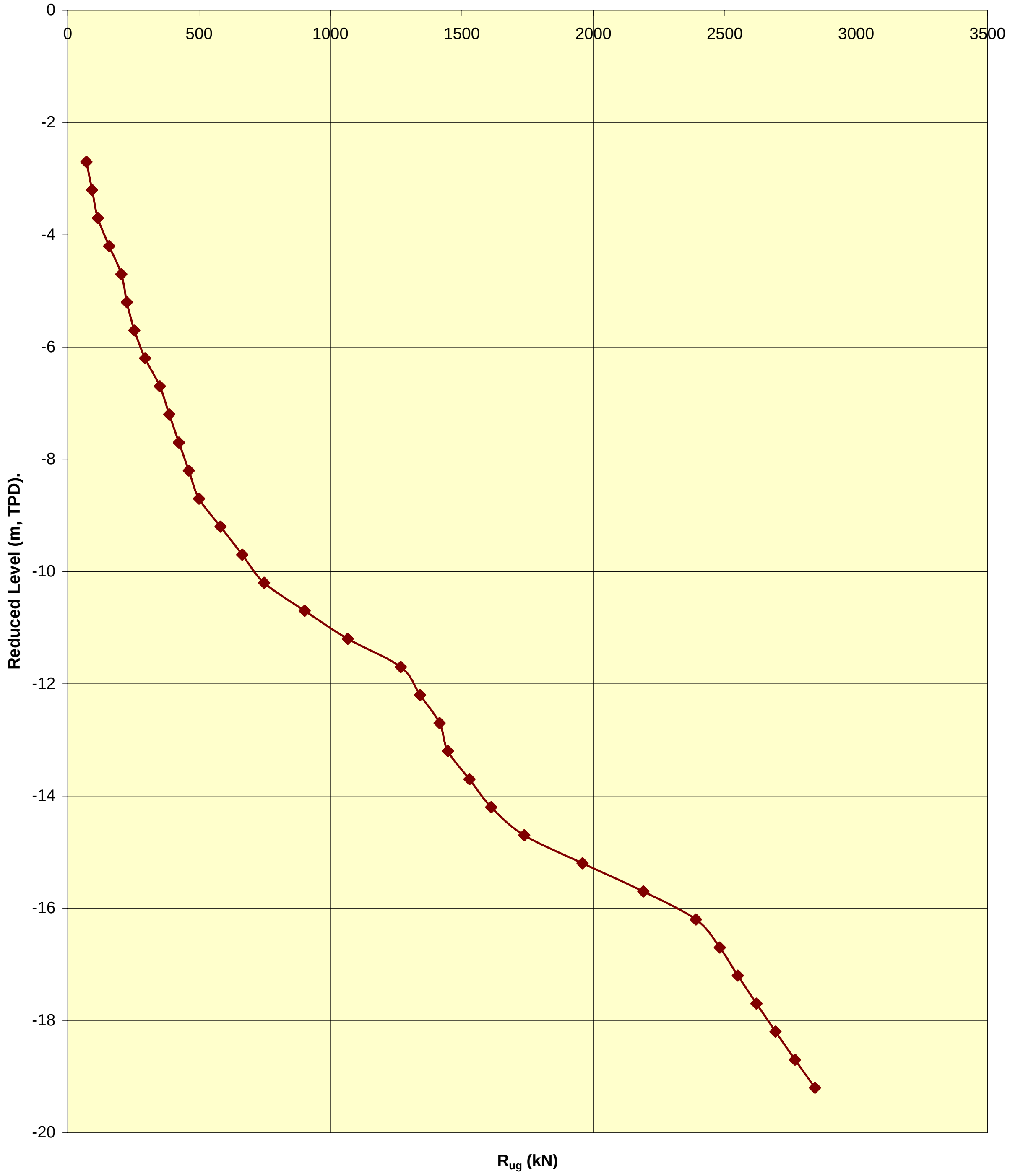
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-19 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



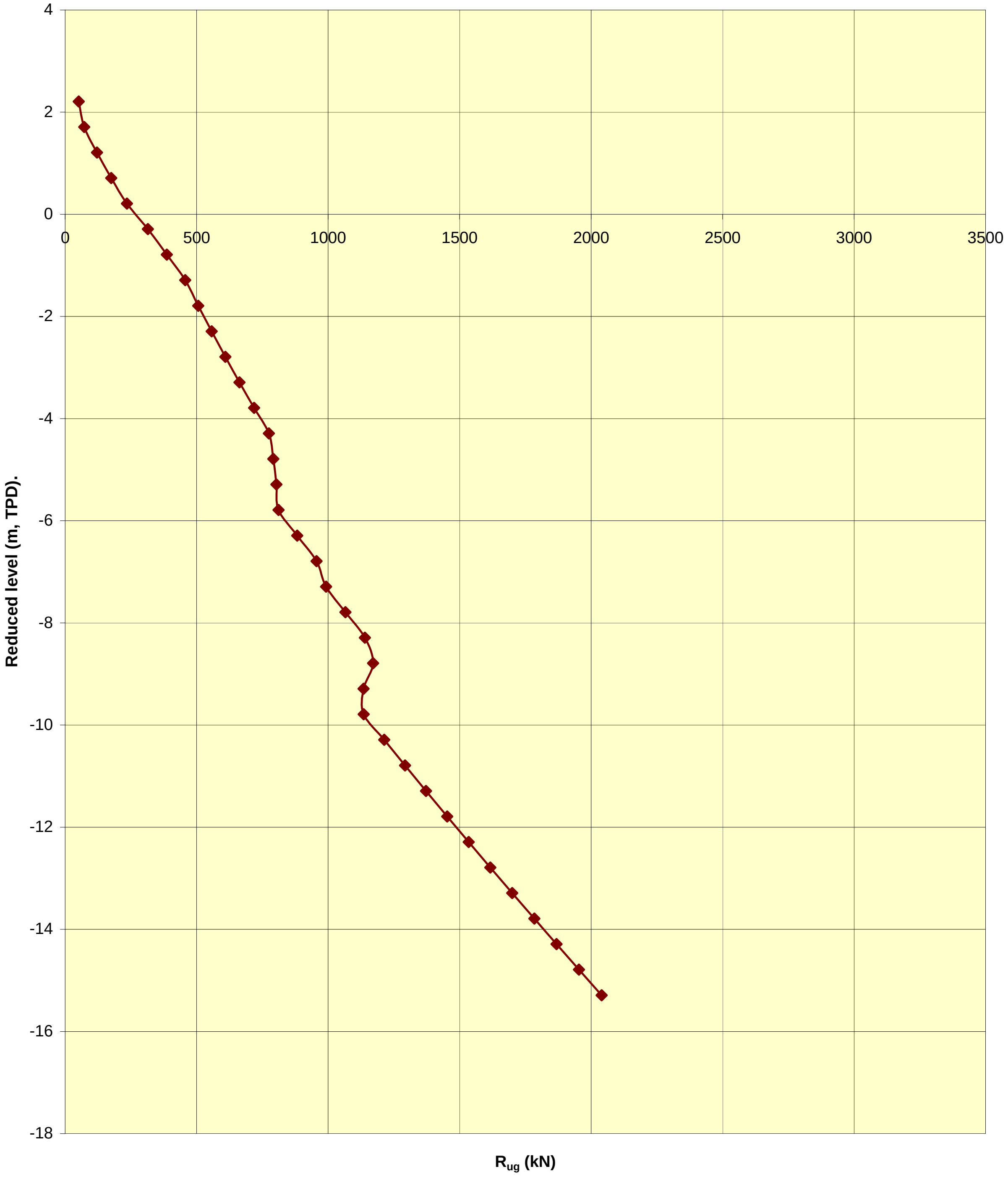
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-20 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



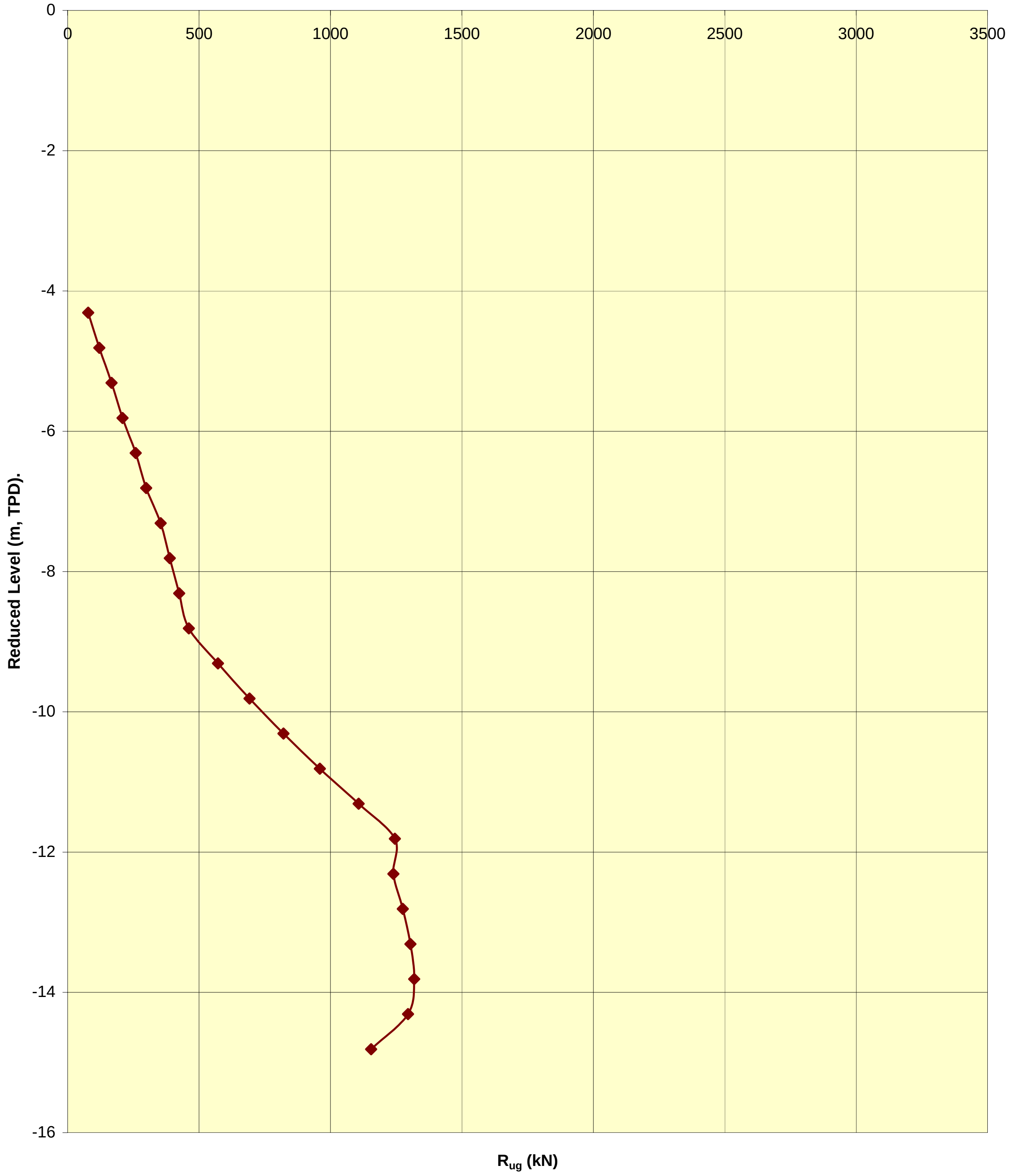
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-21 Ultimate Geotechnical Capacity
for Driven 600mm Diameter Pile



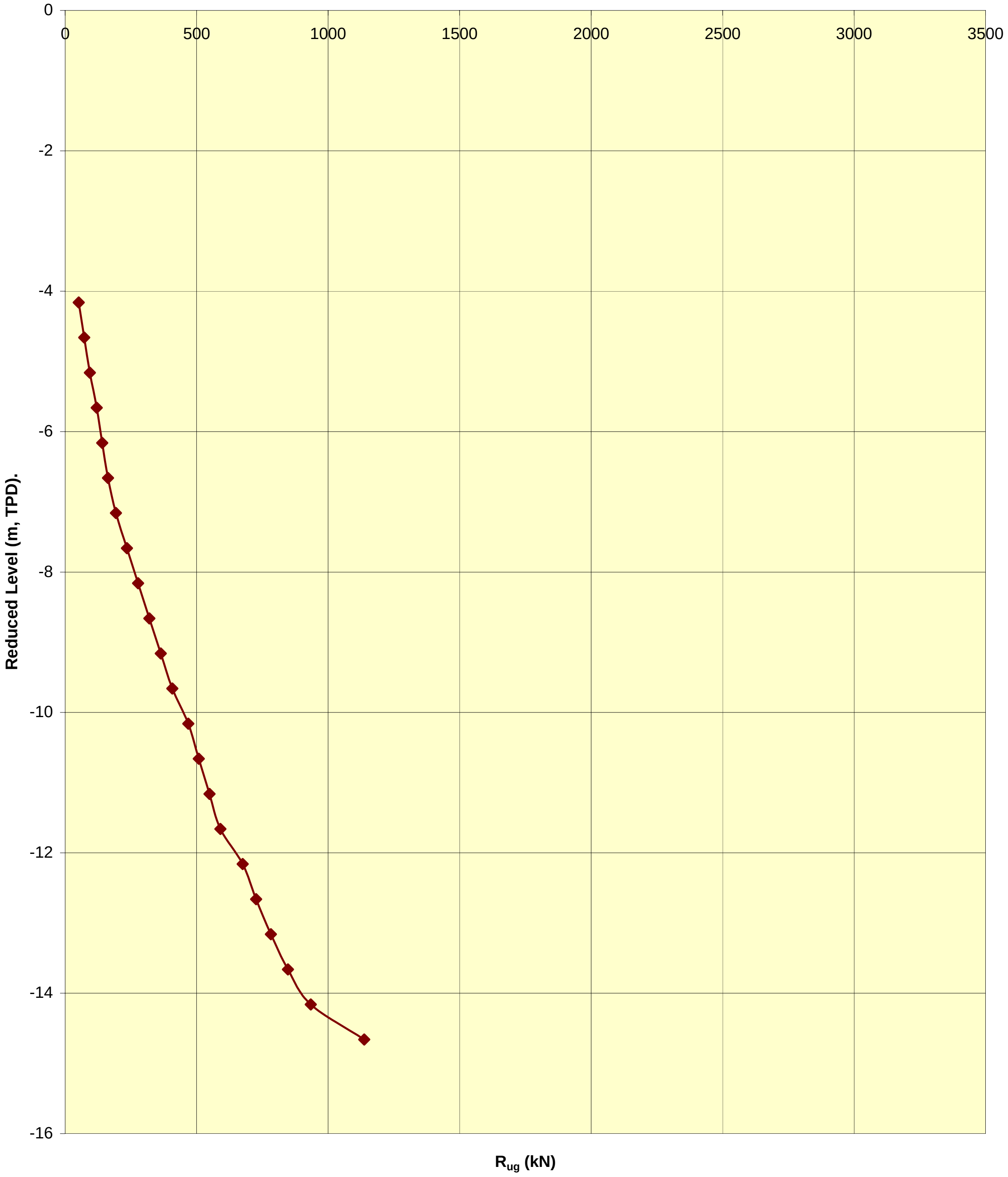
Calculated by: JL
Date: Jan 2008
Checked by: WSB
Date: Feb 2008

TPA-22 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



Calculated by: JL
Date: Jan 2008
Checked by:
Date:

TPA-23 Ultimate Geotechnical Capacity for Driven 600mm Diameter Pile



Calculated by: JL
Date: Jan 2008
Checked by:
Date:

Appendix G
Preliminary Settlement Assessment

Preliminary Settlement Assessment for Townsville Port Expansion

Borehole Location	Level		Thickness Highly Compressible Clay (m)	Without Dredging Sea Sediment and Filled With Compressible Sea Sediment (mm)	Dredging Sea Sediment and Filled With Engineered Fill Comprising Stiff to Very Stiff Dredged Sediment (mm)
	Surface (m)	Final (m)			
TPA 01	-4.00	5.5	2.5	900 - 1900	+/- 40
TPA 02	-3.80	5.5	2.5	900 - 1900	+/- 40
TPA 03	-3.40	5.5	1.5	500 - 1100	+/- 40
TPA 04	-3.00	5.5	1.2	400 - 900	+/- 40
TPA 05	-2.68	5.5	2.0	600 - 1400	+/- 40
TPA 06	-2.64	5.5	5.5	1700 - 4000	+/- 40
TPA 07	-2.78	5.5	0.9	250 - 600	+/- 40
TPA 08	-2.40	5.5	1.0	300 - 650	+/- 40
TPA 09	-2.20	5.5	3.0	900 - 1900	+/- 40
TPA 10	-1.20	5.5	1.2	300 - 700	+/- 40
TPA 11	-2.16	5.5	3.9	1100 - 2500	+/- 40
TPA 12	-0.80	5.5	2.5	600 - 1300	+/- 40
TPA 13	-0.90	5.5	9.5	2400 - 4500	+/- 40
TPA 14c	-1.10	5.5	1.5	350 - 800	+/- 40
TPA 14	-1.10	5.5	N/A	---	+/- 40
TPA 15c	-0.80	5.5	1.0	250 - 550	+/- 40
TPA 15	-0.80	5.5	N/A	---	+/- 40
TPA 16c	-2.38	5.5	1.6	500 - 1050	+/- 40
TPA 16	-2.38	5.5	N/A	---	+/- 40
TPA 17c	0.70	5.5	2.4	450 - 950	+/- 40
TPA 17	0.70	5.5	N/A	---	+/- 40
TPA 18c	2.20	5.5	0.6	50 - 200	+/- 40
TPA 18	2.20	5.5	N/A	---	+/- 40
TPA 19c	0.30	5.5	8.0	1650 - 3500	+/- 40
TPA 20c	-2.70	5.5	2.0	650 - 1350	+/- 40
TPA 20	-2.70	5.5	N/A	---	+/- 40
TPA 21c	2.21	5.5	2.5	300 - 700	+/- 40
TPA 21	2.21	5.5	N/A	---	+/- 40
TPA 22	-4.31	5.5	2.0	750 - 1600	+/- 40
TPA 23	-4.16	5.5	2.5	950 - 2000	+/- 40
TPA 101c	-3.22	5.5	4.5	1500 - 3500	+/- 40
TPA 101	-3.22	5.5	4.5	1500 - 3500	+/- 40
TPA 102c	-5.77	5.5	0.0	---	+/- 40
TPA 102	-5.77	5.5	0.0	---	+/- 40
TPA 103	-0.92	5.5	1.0	250 - 550	+/- 40
TPA 104	-9.72	5.5	2.0	1200 - 2500	+/- 40
TPA 105	-9.46	5.5	0.5	300 - 600	+/- 40
TPA 106	-12.00	5.5	0.8	550 - 1150	+/- 40

Appendix H
Important Information about your Geo-Environmental Report

Important Information About Your

Geo-environmental Report

These notes have been prepared by Golder Associates Pty Ltd using guidelines prepared by ASFE; The Association of Engineering Firms Practising in the Geosciences, of which Golder Associates Pty Ltd is a member. They are offered to help you in the interpretation of your Geo-environmental Report.

Geo-environmental studies are commissioned to gain information about environmental conditions on and beneath the surface of a site. The more comprehensive the study, the more reliable the assessment is likely to be. But remember, any such assessment is to a greater or lesser extent based on professional opinions about conditions that cannot be seen or tested. Accordingly, no matter how much data is accumulated, risks created by unanticipated conditions will always remain. *Have realistic expectations.* Work with your Geo-environmental consultant to manage known and unknown risks. Part of that process should already have been accomplished, through the risk allocation provisions you and your Geo-environmental professional discussed and included in your contract's general terms and conditions. This document is intended to explain some of the concepts that may be included in your agreement, and to pass along information and suggestions to help you manage your risk.

Beware of Change; Keep Your Geo-environmental Professional Advised

The design of a Geo-environmental study considers a variety of factors that are subject to change. Changes can undermine the applicability of a report's findings, conclusions, and recommendations. *Advise your Geo-environmental professional about any changes you become aware of them.* Geo-environmental professionals cannot accept responsibility or liability for problems that occur because a report fails to consider conditions that did not exist when the study was designed. Ask your Geo-environmental professional about the types of changes you should be particularly alert to. Some of the most common include:

- modification of the proposed development or ownership group,
- sale or other property transfer,
- replacement of or additions to the financing entity,
- amendment of existing regulations or introduction of new ones, or
- changes in the use or condition of adjacent property

Should you become aware of any change, *do not rely on an existing Geo-environmental report.* Advise your Geo-environmental professional immediately; follow the professional's advice.

Recognize the Impact of Time

A Geo-environmental professional's findings, recommendations, and conclusions cannot remain valid indefinitely. The more time that passes, the more likely it is that important latent changes may occur. *Do not rely on a Geo-environmental report if too much time has elapsed since it was completed.* Ask your environmental professional to define "too much time." In the case of Phase I Environmental Site Assessments (ESAs), for example, more than 180 days after submission is generally considered "too much."

Prepare To Deal with Unanticipated Conditions

The findings. recommendations, and conclusions of a Phase I ESA report typically are based on a review of historical information, interviews, a site "walkover," and other forms of noninvasive research. When site subsurface conditions are not sampled in any way, the risk of unanticipated conditions is higher than it would otherwise be.

While borings, installation of monitoring wells, and similar invasive test methods can help reduce the risk of unanticipated conditions, *do not overvalue the effectiveness of testing.* Testing provides information about actual conditions only at the precise locations where samples are taken, and only when they are taken. Your Geo-environmental professional has applied that specific information to develop a general opinion about environmental conditions. *Actual conditions in areas not sampled may differ (sometimes sharply) from those predicted in a report.* For example, a site may contain an unregistered underground storage tank that shows no surface trace of its existence. *Even conditions in areas that were tested can change,* sometimes suddenly, due to any number of events, not the least of which include occurrences at adjacent sites. Recognize, too, that *even some conditions in tested areas may go undiscovered,* because the tests or analytical methods used were designed to detect only those conditions assumed to exist.

Manage your risks by retaining your Geo-environmental professional to work with you as the project proceeds. Establish a contingency fund or other means to enable your Geo-environmental professional to respond rapidly, in order to limit the impact of unforeseen conditions. To help prevent any misunderstanding, identify those empowered to authorize changes and the administrative procedures that should be followed.

Do Not Permit Any Other Party To Rely on the Report

Geo-environmental professionals design their studies and prepare their reports to meet the specific needs of the clients who retain them, in light of the risk management methods that the client and Geo-environmental professional agree to, and the statutory, regulatory, or other requirements that apply. The study designed for a developer may differ sharply from one designed for a lender, insurer, public agency ... or even another developer. *Unless the report specifically states otherwise, it was developed for you and only you.* Do not unilaterally permit any other party to rely on it. The report and the study underlying it may not be adequate for another party's needs, and you could be held liable for shortcomings your Geo-environmental professional was powerless to prevent or anticipate. Inform your Geo-environmental professional when you know or expect that someone else - a third-party will want to use or rely on the report. *Do not permit third-party use or reliance until you first confer with the Geo-environmental professional who prepared the report.* Additional testing, analysis, or study may be required and, in any event, appropriate terms and conditions should be agreed to so both you and your Geo-environmental professional are protected from third-party risks. *Any party who relies on a Geo-environmental report without the express written permission of the professional who prepared it and the client for whom it was prepared may be solely liable for any problems that arise.*

Avoid Misinterpretation of the Report

Design professionals and other parties may want to rely on the report in developing plans and specifications. They need to be advised, in writing, that their needs may not have been considered when the study's scope was developed, and, even if their needs were considered, they might misinterpret Geo-environmental findings, conclusions, and recommendations. *Commission your Geo-environmental professional to explain pertinent elements of the report to others who are permitted to rely on it, and to review any plans, specifications or other instruments of professional service that incorporate any of the report's findings, conclusions, or recommendations.* Your Geo-environmental professional has the best understanding of the issues involved, including the fundamental assumptions that determined the study's scope.

Give Contractors Access to the Report

Reduce the risk of delays, claims, and disputes by giving contractors access to the full report, *providing that it is accompanied by a letter of transmittal that can protect you* by making it unquestionably clear that: 1) the study was not conducted and the report was not prepared for purposes of bid development, and 2) the findings, conclusions, and recommendations included in the report are based on a variety of opinions, inferences, and assumptions and are subject to interpretation. Use the letter to also advise contractors to consult with your Geo-environmental professional to obtain clarifications, interpretations, and guidance (a fee may be required for this service), and that-in any event-they should conduct additional studies to obtain the specific type and extent of information each prefers for preparing a bid or cost estimate. Providing access to the full report, with the appropriate caveats, helps prevent formation of adversarial attitudes and claims of concealed or differing conditions. If a contractor elects to ignore the warnings and advice in the letter of transmittal, it would do so at its own risk. Your Geo-environmental professional should be able to help you prepare an effective letter.

Do Not Separate Documentation from the Report

Geo-environmental reports often include supplementary documentation, such as maps and copies of regulatory files, permits, registrations, citations, and correspondence with regulatory agencies. If subsurface explorations were performed, the report may contain final boring logs and copies of laboratory data. If remediation activities occurred on site, the report may include: copies of daily field reports, waste manifests, and information about the disturbance of subsurface materials, the type and thickness of any fill placed on site, and fill placement practices, among other types of documentation. *Do not separate supplementary documentation from the report. Do not, and do not permit any other party to redraw or modify any of the supplementary documentation for incorporation into other professionals' instruments of service.*

Understand the Role of Standards

Unless they are incorporated into statutes or regulations, standard practices and standard guides developed by the American Society for Testing and Materials (ASTM) and other recognized standards-developing organizations (SDOs) are little more than aspirational methods agreed to by a consensus of a committee. The committees that develop standards may not comprise those best qualified to establish methods and, no matter what, no standard method can possibly consider the infinite client and project-specific variables that fly in the face of the theoretical "standard conditions" to which standard practices and standard guides apply. In fact, these variables can be so pronounced that Geo-environmental professionals who comply with every directive of an ASTM or other standard procedure could run foul of local custom and practice, thus violating the standard of care.

Accordingly, when Geo-environmental professionals indicate in their reports that they have performed a service "in general compliance" with one standard or another, it means they have applied professional judgement in creating and implementing a scope of service designed for the specific client and project involved, and which follows some of the general precepts laid out in the referenced standard. To the extent that a report indicates "general compliance" with a standard, you may wish to speak with your Geo-environmental professional to learn more about what was and was not done. *Do not assume a given standard was followed to the letter.* Research indicates that that seldom is the case.

Realize That Recommendations May Not Be Final

The technical recommendations included in a Geo-environmental report are based on assumptions about actual conditions, and so are preliminary or tentative. Final recommendations can be prepared only by observing actual conditions as they are exposed. For that reason, you should retain your Geo-environmental professional to observe construction and/or remediation activities on site, to permit rapid response to unanticipated conditions. *The Geo-environmental professional who prepared the report cannot assume responsibility or liability for the report's recommendations if that professional is not retained to observe relevant site operations.*

Understand That Geotechnical Issues Have Not Been Addressed

Unless geotechnical engineering was specifically included in the scope of professional service, a report is not likely to relate any findings, conclusions, or recommendations about the suitability of subsurface materials for construction purposes, especially when site remediation has been accomplished through the removal, replacement, encapsulation, or chemical treatment of on-site soils. The equipment, techniques, and testing used by geotechnical engineers differ markedly from those used by Geo-environmental professionals; their education, training, and experience are also significantly different. If you plan to build on the subject site, but have not yet had a geotechnical engineering study conducted, your Geo-environmental professional should be able to provide guidance about the next steps you should take. The same firm may provide the services you need.

Read Responsibility Provisions Closely

Geo-environmental studies cannot be exact; they are based on professional judgement and opinion. Nonetheless, some clients, contractors, and others assume Geo-environmental reports are or certainly should be unerringly precise. Such assumptions have created unrealistic expectations that have led to wholly unwarranted claims and disputes. To help prevent such problems, Geo-environmental professionals have developed a number of report provisions and contract terms that explain who is responsible for what, and how risks are to be allocated. Some people mistake these for "exculpatory clauses," that is, provisions whose purpose is to transfer one party's rightful responsibilities and liabilities to someone else. Read the responsibility provisions included in a report and in the contract you and your Geo-environmental professional agreed to. They are important.

Rely on Your Geo-environmental Professional for Additional Assistance

Membership in ASFE exposes Geo-environmental professionals to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a Geo-environmental project. Confer with your ASFE-member Geo-environmental professional for more information.

APPENDIX C

Seismic Survey From Mapping and Hydrographic Surveys Pty Ltd

Ducray, Noel

From:	Mapping & Hydrographic Surveys [mhs@mhshydro.com]
Sent:	Friday, 18 November 2011 9:22 AM
To:	O'Neill, Mark
Cc:	Ducray, Noel
Subject:	Port of Townsville Expansion Project EIS - Hydrographic Survey

Mark/Noel

I understand that MHS Cartographer Ben has now emailed the channel Geophysical plans sheets 2 to 6 to you.

You will note that the Single Channel High Resolution Seismic System has defined 2 reflectors and the 2D Multichannel Seismic has defined "Reflector 2" only and that there is a difference in the depth of approximately 5 metres between "Reflector 2" as defined by the Single Channel High Resolution Seismic and the 2D Multichannel Seismic techniques.

Although the same BOOMER sound source was used for each seismic system the hydrophone arrays, the energy level, the firing rate and recording systems were different and the interpretation for each system was carried out by different Geophysicists.

The sub seabed materials and their P-velocities are gradational and therefore the "Reflectors are not sharply defined however the use of the two different seismic systems confirms the absence of rock to the depth of interest.

Regards

John McCarthy

Mapping & Hydrographic Surveys Pty Ltd

Office 31 Byron Street, Bulimba, Brisbane, Queensland 4171, Australia
Postal P O Box 7144, East Brisbane, Queensland 4169, Australia
Web www.mhshydro.com

Phone 07 3399 8566
Fax 07 3899 1515
Mobile 0408 745 214

SEABED						-7.7	-11.5	-11.8	-12.0	-11.9	-12.0	-11.9	-12.1	-12.1	-12.2	-12.1	-12.3	-12.5	-12.6	-12.6	-12.6	-12.4	-12.6	-12.5	-12.6	-12.5	-12.5	-12.5	-12.5	-12.4	-12.5	-12.5	-12.4	-12.6	-12.6	-12.6	-12.6
REFLECTOR 1						-9.9	-12.8	-14.6	-18.3	-22.9	-22.0	-18.4	-18.8	-20.0	-19.6	-18.4	-17.9	-19.0	-21.7	-21.0	-19.7	-17.5	-16.5	-17.9	-16.6	-17.0	-16.5	-17.3	-17.5	-16.9	-18.1	-20.8	-20.0	-21.1	-17.3	-20.7	-18.9
REFLECTOR 2						-31.3	-35.1	-34.5	-34.7	-35.0	-34.1	-34.1	-34.6	-34.2	-34.6	-34.5	-35.6	-34.8	-35.4	-36.2	-36.0	-35.6	-36.3	-36.0	-36.0	-35.6	-35.1	-34.9	-36.0	-34.8	-34.9	-35.4	-35.0	-35.0	-34.9	-34.6	-34.2
Chainage	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800

PLATYPUS CHANNEL – 40m (Stbd) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

SEABED	-12.4	-12.3	-12.2	-12.3	-12.3	-12.1	-12.6	-12.9	-12.6	-12.2	-12.5	-12.4	-12.7	-12.6	-12.7	-12.6	-12.7	-12.7	-12.9	-12.9	-12.7	-12.8	-12.6	-12.7	-12.6	-12.8	-12.6	-12.7	-12.7	-12.7	-12.8	-12.6	-12.7	-12.7	-12.7	-12.9	-12.8
REFLECTOR 2		-28.5	-28.7	-28.8	-28.9	-27.5	-27.5	-27.0	-27.6	-26.9	-27.9	-27.9	-28.7	-29.4	-28.8	-28.5	-28.1	-27.5	-28.2	-28.7	-28.9	-29.0	-29.2	-28.5	-28.9	-29.4	-29.1	-28.7	-28.8	-28.7	-28.7	-29.2	-28.8	-29.5	-29.7	-29.6	-29.2
Chainage	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800

PLATYPUS CHANNEL – 20m (Stbd) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

SEABED	-12.8	-12.7	-12.5	-12.5	-12.7	-12.8	-12.9	-12.7	-12.4	-12.5	-12.4	-12.4	-12.6	-12.8	-12.6	-12.6	-12.8	-12.8	-12.8	-12.6	-12.8	-12.6	-12.6	-12.5	-12.6	-12.4	-12.4	-12.5	-12.5	-12.4	-12.2	-12.3	-12.4	-12.3	-12.3	-12.5	-12.2
REFLECTOR 1	-17.3	-17.9	-18.8	-19.3	-20.0	-18.6	-20.5	-21.9	-18.8	-17.0	-23.5	-20.2	-18.5	-19.1	-16.5	-16.7	-17.8	-19.0	-19.0	-18.2	-16.9	-16.6	-16.3	-16.2	-19.1	-24.0	-17.4	-17.0	-15.6	-15.0	-16.2	-16.1	-16.9	-18.2	-16.9	-17.3	-17.2
REFLECTOR 2	-35.8	-36.0	-34.9	-35.3	-36.4	-36.2	-36.7	-36.3	-35.9	-35.6	-34.8	-35.3	-36.4	-35.7	-36.4	-35.8	-35.9	-36.3	-36.5	-36.1	-35.5	-35.1	-35.6	-35.1	-35.7	-35.7	-35.2	-35.6	-35.7	-35.6	-35.0	-35.5	-34.9	-34.8	-35.1	-36.1	-34.6
Chainage	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800

PLATYPUS CHANNEL – CENTRLINE PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

PLATYPUS CHANNEL – BATHYMETRY DATA AT 1:5000

SCALE HORIZONTAL : 1:5000

SEABED	-13.1	-12.8	-12.8	-12.4	-12.7	-12.9	-13.1	-12.8	-12.6	-12.4	-12.3	-12.5	-12.7	-12.7	-12.7	-12.8	-13.0	-12.9	-12.9	-12.9	-12.8	-12.9	-12.8	-12.7	-12.7	-12.8	-12.7	-12.8	-12.8	-12.7	-12.5	-12.8	-12.6	-12.6	-12.8	-12.7	-12.7
REFLECTOR 2	-28.9	-28.8	-28.5	-27.9	-28.1	-28.3	-28.8	-28.7	-28.4	-27.9	-27.3	-28.1	-29.4	-29.6	-29.0	-28.5	-28.2	-28.7	-29.2	-29.0	-29.2	-29.3	-29.4	-29.7	-29.6	-29.3	-29.2	-29.1	-29.3	-29.3	-29.5	-29.5	-29.3	-29.4	-29.8	-29.2	-29.2
Chainage	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800

PLATYPUS CHANNEL – 20m (Port) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

SEABED	-13.1	-12.8	-12.7	-12.5	-12.8	-12.7	-12.7	-12.7	-12.4	-12.2	-12.3	-12.4	-12.5	-12.7	-12.7	-13.2	-12.8	-12.6	-12.4	-12.4	-12.6	-12.5	-12.5	-12.4	-12.3	-12.5	-12.6	-12.6	-12.5	-12.5	-12.5	-12.5	-12.5	-12.6	-12.4	-12.6	-12.4
REFLECTOR 1	-19.1	-18.5	-18.0	-19.2	-19.9	-20.3	-20.0	-19.7	-20.9	-23.0	-25.8	-26.0	-24.2	-18.2	-18.1	-18.6	-16.7	-17.8	-17.6	-19.1	-16.8	-18.0	-19.7	-20.9	-17.2	-18.0	-20.3	-18.2	-19.0	-18.7	-21.0	-18.8	-18.3	-20.9	-20.7	-20.8	-19.4
REFLECTOR 2	-36.5	-37.0	-36.4	-35.3	-35.9	-35.8	-35.5	-35.8	-35.9	-34.7	-35.0	-35.1	-36.0	-36.3	-36.3	-36.3	-35.2	-35.0	-34.7	-34.7	-36.1	-34.9	-35.4	-35.7	-36.0	-35.5	-35.8	-36.4	-35.1	-35.2	-35.8	-34.8	-36.0	-34.7	-34.7	-36.4	-36.2
Chainage	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800

PLATYPUS CHANNEL – 40m (Port) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

QUALIFICATION OF PERSONNEL

Field surveyor : Dylan Colson B Geomatics (Survey & Spatial Science)
Checking Surveyor : Andreas Guzek BSc (Surveying) MSSSI (CPHS1)
Field Geophysicist : Mel Proudlock BSc (Hon) Geology & Applied Geology
Processing Geophysicist : Bharat Kumar BSc; MSc Geophysics
Supervising Surveyor : John E McCarthy FSSSI (CPHS1)

MAPPING & HYDROGRAPHIC SURVEYS Pty Ltd

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Email : mhs@mhshydro.com
Fax : 61 (0)7 3899 1515

Approved John E McCarthy FSSSI (CPHS1)
Date March 2011
Our Ref MH1136

Notes

CONFIDENCE LEVEL

+/- 1.0m at Frequency of Boomer

PROCESSING

Survey software: Qinsy
CAD package: Terramodel
Seismic Processing: Coda Geosurvey
Digital Processing: Geokit

Commissioned by

TOWNSVILLE PORT AUTHORITY

Engineering Building
Benwell Road
Townsville Qld. 4810
Ph: 61(7) 4781 1605
Fax: 61(7) 4781 1601

Ref

Consultant

AECOM

Level 8, 540 Wickham Street
Fortitude Valley QLD 4006
PO Box 1307
Ph: 61(7) 3553 2000
Fax: 61(7) 3553 2050

Ref

Surveyed Dylan Colson
Checked Andy Guzek

VERTICAL MEASUREMENTS

SEISMIC EQUIPMENT :
APPLIED ACOUSTICS - BOOMER
HYDROPHONES - 11 ELEMENT SINGLE CHANNEL
ACQUISITION SOFTWARE - CHESAPEAKE SONARWIZ.MAP
2D HYDROPHONES - 24 CHANNEL

Vertical Datum

LAT

Based on: PM 10011 RL 9.025m LAT
Soundings reduced to datum by linear interpolation from reading at Townsville Storm Surge Gauge ATG 055003A and using a range ratio of 0.96 for Magnetic Island

HORIZONTAL POSITIONING

Equipment : Navcom DGPS
Specified Accuracy : +/- 0.5 m
Resolution : +/- 0.1 m
Differential Signal : Starfire

Horizontal Datum

GDA94 - MGA ZONE 55

Based on: Starfire DGPS Broadcast Service

SCALE 1: 5000

0 100 200 300 400 500 Metres

CLASS of SURVEY

N/A

NORTH

SURVEY VESSEL

Vessel : Anika - J
LOA : 14.6 metres
Beam : 4.3 metres
Power : 1 x 215kw
Draft : 1.9 metre
Transducer : Hull Mounted

DEFINITIONS

CLASS A - SURVEY ENSURES 100% BOTTOM ENSONIFICATION
CLASS B - SURVEY IS DESIGNED FOR CHECK SURVEYS WHERE A CLASS A SURVEY HAS BEEN CARRIED OUT - MINIMUM 20% BOTTOM ENSONIFICATION
CLASS C - INVESTIGATION SURVEY WHERE LESS THAN 100% BOTTOM ENSONIFICATION HAS BEEN ACHIEVED AND WHERE A CLASS A SURVEY HAS NOT BEEN CARRIED OUT

TOWNSVILLE
PORT EXPANSION PROJECT EIS
SEISMIC REFLECTION SURVEY PROFILES

MARCH 2011

Drawing No MH1136-S02
Sheet 2 of 6

PLATYPUS CHANNEL – 40m (Stbd) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

PLATYPUS CHANNEL – 20m (Stbd) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1100

PLATYPUS CHANNEL – CENTRLINE PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

PLATYPUS CHANNEL – BATHYMETRY DATA AT 1:5000 SCALE HORIZONTAL : 1:5000

PLATYPUS CHANNEL – 20m (Port) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1100

PLATYPUS CHANNEL – 40m (Port) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

QUALIFICATION OF PERSONNEL

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Field Geophysicist : Mel Proudlock BSc (Hon) Geology & Applied Geology
Processing Geophysicist : Bharat Kumar BSc; MSc Geophysics
Supervising Surveyor : John E McCarthy FSSSI (CPHS1)

Notes

CONFIDENCE LEVEL

+/- 1.0m at Frequency of Boomer

PROCESSING

Survey software: Qinsy
CAD package: Terramodel
Seismic Processing: Coda Geosurvey
Digital Processing: Geokit

VERTICAL MEASUREMENTS

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HYDROPHONES - 11 ELEMENT SINGLE CHANNEL
ACQUISITION SOFTWARE - CHESAPEAKE SONARWIZ.MAP
2D HYDROPHONES - 24 CHANNEL

HORIZONTAL POSITIONING

Equipment : Navcom DGPS
Specified Accuracy : +/- 0.5 m
Resolution : +/- 0.1 m
Differential Signal : Starfire

CLASS of SURVEY
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SURVEY VESSEL

Vessel : Anika - J
LOA : 14.6 metres
Beam : 4.3 metres
Power : 1 x 215kw
Draft : 1.9 metre
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Vertical Datum
LAT
Based on: PM 10011 RL 9.025m LAT
Soundings reduced to datum by linear interpolation from reading at Townsville Storm Surge Gauge ATG 055003A and using a range ratio of 0.96 for Magnetic Island

Horizontal Datum
GDA94 - MGA ZONE 55
Based on: Starfire DGPS Broadcast Service

NORTH

TOWNSVILLE
PORT EXPANSION PROJECT EIS
SEISMIC REFLECTION SURVEY PROFILES
MARCH 2011

Approved	Date	Our Ref	Ref	Ref	Surveyed	Checked
John E McCarthy FSSSI (CPHS1)	March 2011	MH1136			Dylan Colson	Andy Guzek

SCALE 1: 5000 0 100 200 300 400 500 Metres

Drawing No MH1136-S03
Sheet 3 of 6

-12.3	-12.3	-12.2	-12.2	-12.2	-12.2	-12.2	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.3
-17.7	-17.8	-16.9	-16.3	-17.6	-18.3	-18.2	-19.7	-19.9	-20.7	-18.2	-16.3	-17.7	-17.8	-22.2	-19.7	-17.4	-16.8	-18.1	-16.4
-34.1	-33.6	-33.1	-33.5	-34.0	-34.6	-34.3	-35.6	-34.8	-34.8	-34.3	-35.6	-35.4	-35.6	-35.7	-34.8	-34.8	-34.4	-35.3	-34.6
7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300

-12.3	-12.3	-12.3	-12.3	-12.3	-12.3	-12.4	-12.6	-12.6	-12.4	-12.5	-12.4	-12.3	-12.2	-12.4	-12.5	-12.5	-12.4	-12.4	-12.3
-16.6	-16.2	-19.4	-17.1	-17.8	-19.2	-19.6	-19.9	-18.5	-20.2	-22.4	-20.8	-19.5	-21.6	-21.6	-23.5	-21.7	-18.5	-18.3	-18.8
-35.0	-35.4	-35.0	-34.9	-34.4	-35.6	-34.7	-34.9	-34.8	-34.9	-36.1	-35.6	-36.2	-36.3	-36.2	-35.0	-35.4	-35.9	-36.0	-35.8
9400	9500	9600	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300

SEA CHANNEL – 40m (Stbd) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

-12.3	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.5	-12.4	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
-28.4	-28.5	-28.4	-28.9	-28.5	-28.9	-28.8	-28.4	-28.4	-28.8	-28.6	-28.9	-28.6	-28.6	-28.4	-29.0	-28.9	-29.2	-28.6	-28.5
7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300

-12.5	-12.5	-12.5	-12.4	-12.5	-12.5	-12.7	-12.7	-12.8	-12.6	-12.6	-12.5	-12.6	-12.5	-12.5	-12.6	-12.7	-12.6	-12.5	-12.5
-28.7	-28.7	-28.4	-28.2	-28.6	-28.6	-29.2	-29.1	-29.4	-29.3	-29.1	-29.0	-29.1	-28.9	-29.3	-29.6	-29.2	-28.6	-28.2	-28.3
9400	9500	9600	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300

SEA CHANNEL – 20m (Stbd) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

-12.6	-12.6	-12.2	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.5	-12.4	-12.4	-12.4	-12.4	-12.4	-12.5	-12.5	-12.4	-12.4	-12.4
-23.9	-18.9	-18.2	-18.5	-17.9	-22.5	-18.2	-20.0	-19.2	-19.6	-18.8	-17.9	-23.1	-19.9	-19.7	-17.3	-17.3	-17.0	-21.5	-27.1
-35.8	-36.2	-35.4	-35.8	-36.2	-35.9	-36.3	-35.4	-36.2	-35.4	-35.4	-35.3	-35.2	-35.9	-35.7	-35.0	-35.9	-35.8	-35.7	-35.6
7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300

-12.5	-12.4	-12.4	-12.4	-12.5	-12.5	-12.6	-12.7	-12.6	-12.7	-12.5	-12.5	-12.4	-12.4	-12.5	-12.5	-12.6	-12.5	-12.5	-12.4
-18.8	-18.4	-19.3	-18.6	-18.3	-16.6	-19.1	-23.5	-19.6	-19.7	-21.0	-18.6	-18.9	-18.6	-20.7	-24.3	-23.0	-19.9	-22.1	-23.0
-35.9	-35.5	-35.6	-34.6	-35.7	-35.0	-35.9	-36.6	-36.2	-36.2	-35.8	-35.6	-36.8	-36.2	-36.0	-36.2	-35.4	-36.2	-35.1	-35.2
9400	9500	9600	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300

SEA CHANNEL – CENTRLINE PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

SEA CHANNEL – BATHYMETRY DATA AT 1:5000 SCALE HORIZONTAL : 1:5000

-12.5	-12.5	-12.3	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.4	-12.5	-12.4	-12.4	-12.4	-12.5	-12.5	-12.4	-12.4	-12.4	-12.3
-27.4	-27.5	-26.8	-27.7	-27.6	-27.3	-27.2	-27.1	-28.1	-27.6	-27.6	-27.4	-27.7	-27.0	-27.3	-27.4	-27.8	-27.7	-27.3	-27.3
7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300

-12.4	-12.4	-12.4	-12.4	-12.4	-12.5	-12.6	-12.6	-12.7	-12.7	-12.6	-12.5	-12.5	-12.4	-12.6	-12.6	-12.6	-12.5	-12.4	-12.4
-27.0	-26.9	-26.9	-27.0	-27.0	-27.1	-27.3	-27.2	-27.4	-27.5	-27.6	-27.5	-27.5	-27.6	-27.5	-27.7	-27.5	-27.5	-27.3	-27.2
9400	9500	9600	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300

SEA CHANNEL – 20m (Port) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

-12.2	-12.3	-12.2	-12.2	-12.3	-12.2	-12.2	-12.3	-12.3	-12.3	-12.3	-12.3	-12.2	-12.2	-12.2	-12.3	-12.3	-12.4	-12.2	-12.3
-17.5	-20.2	-18.0	-18.0	-18.5	-18.4	-19.2	-19.8	-18.2	-17.9	-18.6	-17.9	-16.9	-18.1	-20.6	-17.0	-19.3	-19.0	-16.6	-15.1
-35.8	-35.6	-35.5	-35.5	-34.6	-35.3	-35.0	-35.8	-35.8	-34.6	-35.2	-35.2	-34.9	-34.8	-34.8	-34.9	-34.9	-35.0	-34.9	-34.5
7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300

-12.2	-12.3	-12.3	-12.3	-12.4	-12.4	-12.5	-12.5	-12.6	-12.4	-12.3	-12.6	-12.4	-12.4	-12.5	-12.5	-12.5	-12.5	-12.4	-12.4
-14.9	-13.8	-15.0	-15.9	-14.8	-15.2	-14.9	-15.6	-14.5	-15.0	-15.3	-15.4	-18.2	-16.2	-14.7	-17.3	-15.5	-14.2	-14.8	-14.2
-34.8	-34.4	-36.2	-36.3	-36.1	-36.2	-35.1	-36.0	-36.1	-35.1	-36.1	-36.2	-36.0	-36.1	-35.6	-36.3	-35.8	-35.9	-34.6	-34.9
9400	9500	9600	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300

SEA CHANNEL – 40m (Port) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA SCALE HORIZONTAL : 1:5000 VERTICAL : 1:1000

QUALIFICATION OF PERSONNEL

Field surveyor : Dylan Colson B Geomatics (Survey & Spatial Science)
Checking Surveyor : Andreas Guzek BSc (Surveying) MSSSI (CPHS1)
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Supervising Surveyor : John E McCarthy FSSSI (CPHS1)

Notes

CONFIDENCE LEVEL

+/- 1.0m at Frequency of Boomer

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Survey software: Qinsy
CAD package: Terramodel
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Specified Accuracy : +/- 0.5 m
Resolution : +/- 0.1 m
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CLASS of SURVEY

N/A

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Vessel : Anika - J
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Beam : 4.3 metres
Power : 1 x 215kw
Draft : 1.9 metre
Transducer : Hull Mounted

DEFINITIONS

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Soundings reduced to datum by linear interpolation from reading at Townsville Storm Surge Gauge ATG 055003A and using a range ratio of 0.96 for Magnetic Island

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GDA94 - MGA ZONE 55

Based on: Starfire DGPS Broadcast Service

NORTH

TOWNSVILLE
PORT EXPANSION PROJECT EIS
SEISMIC REFLECTION SURVEY PROFILES

MARCH 2011

Approved	Date	Our Ref	Ref	Ref	Surveyed	Checked
John E McCarthy FSSSI (CPHS1)	March 2011	MH1136			Dylan Colson	Andy Guzek

SCALE 1: 5000 — 0 100 200 300 400 500 Metres

Drawing No MH1136-S04 Sheet 4 of 6

-12.4	-12.4	-12.4	-12.5	-12.5	-12.5	-12.6	-12.6	-12.6	-12.7	-12.7	-12.6	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7	-12.8	-12.8
-17.4	-17.5	-18.5	-17.0	-17.7	-17.2	-17.6	-17.7	-20.0	-20.8	-18.9	-19.7	-19.5	-19.5	-20.7	-17.4	-17.3	-17.6	-17.5	-17.3
-35.3	-36.2	-36.0	-35.8	-36.0	-35.1	-35.4	-35.1	-35.6	-35.7	-35.4	-34.8	-35.6	-34.5	-35.4	-35.2	-36.1	-35.7	-36.2	-36.6
11400	11500	11600	11700	11800	11900	12000	12100	12200	12300	12400	12500	12600	12700	12800	12900	13000	13100	13200	13300

-12.7	-12.9	-12.7	-12.7	-12.6	-12.5	-12.6	-12.6	-12.7	-12.8	-12.9	-13.0	-13.1	-13.2	-13.3	-13.4	-13.5	-13.5	-13.5	-13.6
-17.7	-18.2	-17.6	-19.4	-18.6	-18.6	-18.2	-18.7	-18.7	-18.8	-18.7	-18.6	-16.7	-16.9	-19.3	-21.1	-20.2	-20.1	-19.7	-18.1
-36.3	-35.9	-36.1	-35.7	-36.5	-36.7	-37.0	-35.9	-36.8	-36.4	-36.6	-35.3	-35.7	-36.7	-37.1	-36.3	-36.0	-36.7	-36.3	-36.0
13400	13500	13600	13700	13800	13900	14000	14100	14200	14300	14400	14500	14600	14700	14800	14900	15000	15100	15200	15300

SEA CHANNEL – 40m (Stbd) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.6	-12.7	-12.7	-12.7	-12.7	-12.7	-12.8	-12.8	-12.8	-12.8	-12.7	-12.8	-12.8	-12.9
-28.2	-28.2	-28.1	-28.0	-28.2	-28.3	-28.6	-28.8	-28.9	-28.7	-28.7	-28.8	-29.1	-29.2	-29.1	-28.7	-28.5	-28.7	-29.2	-29.7
11400	11500	11600	11700	11800	11900	12000	12100	12200	12300	12400	12500	12600	12700	12800	12900	13000	13100	13200	13300

-12.8	-12.8	-12.8	-12.7	-12.7	-12.6	-12.6	-12.6	-12.7	-12.8	-12.9	-13.0	-13.1	-13.2	-13.3	-13.3	-13.4	-13.4	-13.5	-13.5
-30.1	-30.6	-30.3	-29.9	-30.3	-30.0	-30.0	-30.5	-30.2	-30.6	-30.9	-30.8	-30.8	-31.2	-32.1	-32.1	-31.6	-32.2	-32.2	-32.4
13400	13500	13600	13700	13800	13900	14000	14100	14200	14300	14400	14500	14600	14700	14800	14900	15000	15100	15200	15300

SEA CHANNEL – 20m (Stbd) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

-12.5	-12.4	-12.4	-12.5	-12.5	-12.5	-12.6	-12.7	-12.7	-12.7	-12.6	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7	-12.8
-21.9	-20.9	-17.7	-18.4	-18.9	-19.9	-19.5	-19.9	-23.7	-21.1	-21.4	-21.0	-20.8	-20.5	-22.8	-22.9	-23.9	-23.5	-25.0	-23.3
-35.4	-36.0	-34.9	-35.5	-36.3	-37.5	-35.3	-35.5	-36.1	-35.9	-35.7	-35.2	-35.8	-35.2	-35.8	-35.7	-35.5	-35.7	-36.9	-36.1
11400	11500	11600	11700	11800	11900	12000	12100	12200	12300	12400	12500	12600	12700	12800	12900	13000	13100	13200	13300

-12.8	-12.7	-12.7	-12.7	-12.6	-12.6	-12.6	-12.5	-12.6	-12.7	-12.9	-12.9	-13.0	-13.1	-13.1	-13.2	-13.3	-13.4	-13.3	-13.3
-26.2	-23.1	-23.6	-22.7	-24.4	-23.4	-22.5	-21.0	-22.4	-21.9	-21.1	-20.7	-20.2	-18.8	-16.5	-18.2	-18.8	-18.6	-18.1	-18.9
-36.0	-36.0	-35.8	-35.8	-36.8	-36.0	-37.5	-32.8	-33.4	-33.2	-35.9	-35.7	-36.2	-35.9	-36.3	-37.3	-35.7	-37.9	-36.4	-36.8
13400	13500	13600	13700	13800	13900	14000	14100	14200	14300	14400	14500	14600	14700	14800	14900	15000	15100	15200	15300

SEA CHANNEL – CENTRLINE PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

SEA CHANNEL – BATHYMETRY DATA AT 1:5000

SCALE HORIZONTAL : 1:5000

-12.5	-12.5	-12.3	-12.5	-12.4	-12.5	-12.5	-12.6	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7	-12.8	-12.7	-12.8	-12.8	-12.8
-26.9	-26.9	-26.6	-26.7	-26.7	-27.2	-27.4	-27.4	-27.3	-27.2	-27.3	-27.2	-27.3	-27.3	-27.3	-27.2	-26.6	-26.8	-26.9	-26.8
11400	11500	11600	11700	11800	11900	12000	12100	12200	12300	12400	12500	12600	12700	12800	12900	13000	13100	13200	13300

-12.8	-12.8	-12.7	-12.7	-12.7	-12.6	-12.6	-12.5	-12.6	-12.7	-12.8	-12.9	-13.0	-13.1	-13.2	-13.2	-13.1	-13.5	-13.3	-13.3
-28.0	-27.6	-27.7	-27.5	-27.7	-28.0	-28.3	-28.6	-28.7	-29.0	-29.1	-29.4	-29.6	-29.9	-30.3	-30.5	-30.6	-31.1	-31.4	-31.6
13400	13500	13600	13700	13800	13900	14000	14100	14200	14300	14400	14500	14600	14700	14800	14900	15000	15100	15200	15300

SEA CHANNEL – 20m (Port) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

-12.4	-12.4	-12.4	-12.4	-12.5	-12.5	-12.5	-12.6	-12.6	-12.6	-12.7	-12.5	-12.8	-12.6	-12.7	-12.6	-12.8	-12.7	-12.7	-12.7
-15.7	-15.5	-15.8	-14.6	-16.5	-15.7	-14.7	-14.4	-15.4	-14.7	-15.3	-14.9	-17.0	-16.5	-14.6	-15.7	-14.8	-16.2	-16.2	-16.6
-34.9	-35.2	-34.9	-35.0	-35.3	-34.9	-35.3	-34.8	-35.7	-34.9	-35.5	-34.9	-36.3	-35.4	-35.5	-35.9	-36.0	-35.6	-35.2	-35.5
11400	11500	11600	11700	11800	11900	12000	12100	12200	12300	12400	12500	12600	12700	12800	12900	13000	13100	13200	13300

-12.7	-12.7	-12.7	-12.6	-12.4	-12.4	-12.4	-12.5	-12.5	-12.6	-12.7	-12.8	-13.0	-13.0	-13.1	-13.2	-13.1	-13.2	-13.3	-13.3
-15.6	-17.0	-16.3	-16.3	-15.7	-15.8	-15.5	-17.1	-16.4	-15.8	-17.9	-16.8	-16.5	-17.5	-18.9	-16.7	-18.6	-17.6	-18.2	-19.7
-35.5	-36.0	-35.9	-35.7	-34.8	-34.5	-34.6	-34.9	-34.8	-35.5	-35.1	-35.4	-36.2	-35.5	-35.2	-36.0	-35.5	-36.2	-35.5	-36.0
13400	13500	13600	13700	13800	13900	14000	14100	14200	14300	14400	14500	14600	14700	14800	14900	15000	15100	15200	15300

SEA CHANNEL – 40m (Port) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

QUALIFICATION OF PERSONNEL

Field surveyor : Dylan Colson B Geomatics (Survey & Spatial Science)
Checking Surveyor : Andreas Guzek BSc (Surveying) MSSSI (CPHS1)
Field Geophysicist : Mel Proudlock BSc (Hon) Geology & Applied Geology
Processing Geophysicist : Bharat Kumar BSc; MSc Geophysics
Supervising Surveyor : John E McCarthy FSSSI (CPHS1)

Notes

CONFIDENCE LEVEL

+/- 1.0m at Frequency of Boomer

PROCESSING

Survey software: Qinsy
CAD package: Terramodel
Seismic Processing: Coda Geosurvey
Digital Processing: Geokit

VERTICAL MEASUREMENTS

SEISMIC EQUIPMENT :
APPLIED ACOUSTICS - BOOMER
HYDROPHONES - 11 ELEMENT SINGLE CHANNEL
ACQUISITION SOFTWARE - CHESAPEAKE SONARWIZ.MAP
2D HYDROPHONES - 24 CHANNEL

HORIZONTAL POSITIONING

Equipment : Navcom DGPS
Specified Accuracy : +/- 0.5 m
Resolution : +/- 0.1 m
Differential Signal : Starfire

CLASS of SURVEY
N/A

SURVEY VESSEL

Vessel : Anika - J
LOA : 14.6 metres
Beam : 4.3 metres
Power : 1 x 215kw
Draft : 1.9 metre
Transducer : Hull Mounted

DEFINITIONS

CLASS A - SURVEY ENSURES 100% BOTTOM ENSONIFICATION
CLASS B - SURVEY IS DESIGNED FOR CHECK SURVEYS WHERE A CLASS A SURVEY HAS BEEN CARRIED OUT - MINIMUM 20% BOTTOM ENSONIFICATION
CLASS C - INVESTIGATION SURVEY WHERE LESS THAN 100% BOTTOM ENSONIFICATION HAS BEEN ACHIEVED AND WHERE A CLASS A SURVEY HAS NOT BEEN CARRIED OUT

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Consultant
AECOM
Level 8, 540 Wickham Street
Fortitude Valley QLD 4006
PO Box 1307
Ph: 61(7) 3553 2000
Fax: 61(7) 3553 2050

Vertical Datum
LAT
Based on: PM 10011 RL 9.025m LAT
Soundings reduced to datum by linear interpolation from reading at Townsville Storm Surge Gauge ATG 055003A and using a range ratio of 0.96 for Magnetic Island

Horizontal Datum
GDA94 - MGA ZONE 55
Based on: Starfire DGPS Broadcast Service

NORTH

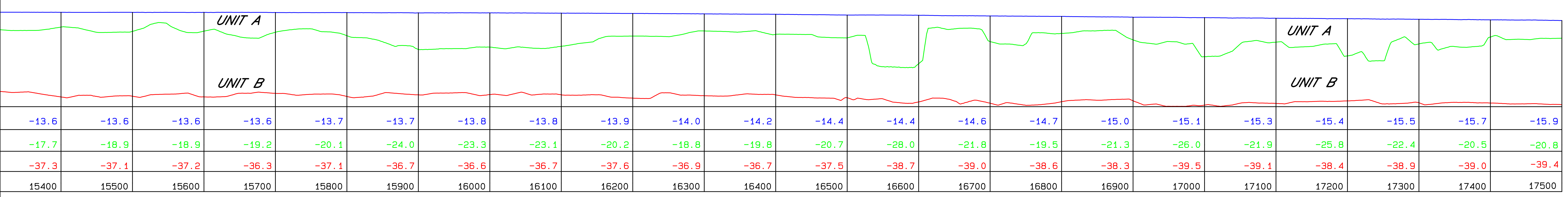
TOWNSVILLE
PORT EXPANSION PROJECT EIS
SEISMIC REFLECTION SURVEY PROFILES

MARCH 2011

Approved: John E McCarthy FSSSI (CPHS1)
Date: March 2011
Our Ref: MH1136
Ref:
Ref:
Surveyed: Dylan Colson
Checked: Andy Guzek

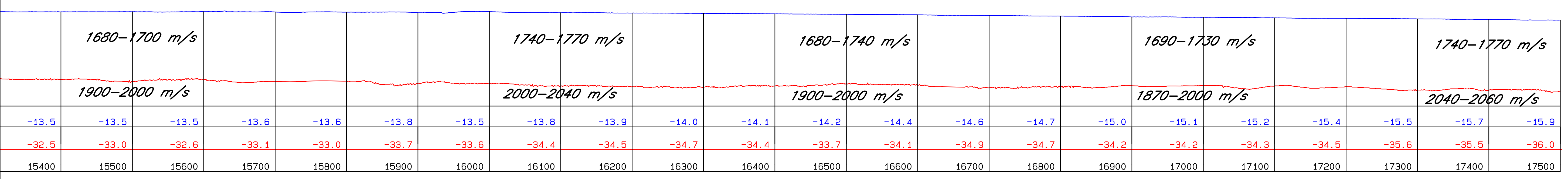
SCALE 1: 5000
0 100 200 300 400 500 Metres

Drawing No: MH1136-S05
Sheet 5 of 6



SEA CHANNEL – 40m (Stbd) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000



Shallow Geology Units

The generalised depositional sequence for the Platypus and Sea Channels survey is characterized by the following two stratigraphic units in the order of increasing depth:

Unit A: Consisting of fine to silty clay/clayey silt with intermittently occurring seams of sand

This unit is characterized by continuous medium amplitude parallel to sub parallel reflectors.
Absence of internal reflectors or the presence of reflector free areas suggests a clayey strata.
The presence of lateral continuity suggests that this unit is homogenously stratified.
Discontinuity occurred at a few places due to the occurrence of seams of sand

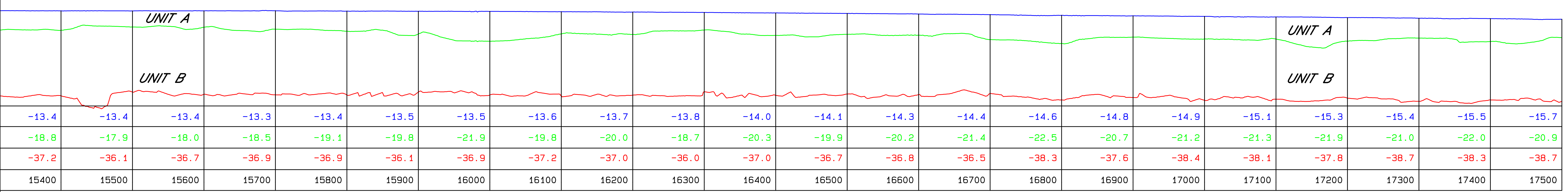
Underlain by

Unit B: Consisting predominantly of fine grained sandy clay/ clayey sand with intermittently occurring seams of sand

This unit is characterized by discontinuous low to medium amplitude parallel to sub parallel reflectors. The presence of lateral discontinuity suggests that this unit is heterogeneously stratified. This unit is mildly acoustically transparent up to the depth of the acoustic basement.

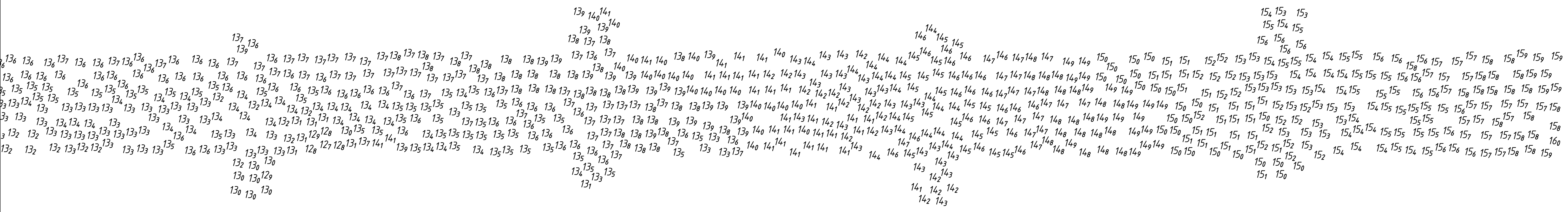
SEA CHANNEL – 20m (Stbd) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000



SEA CHANNEL – CENTRLINE PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000



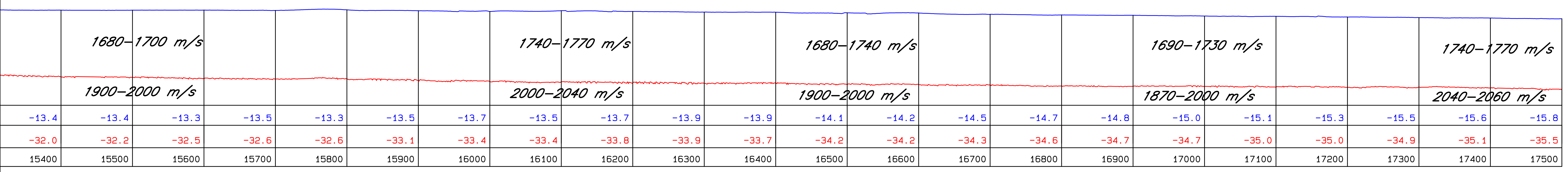
SUB-SEABED STRATA MATERIALS & ESTIMATED P-VELOCITIES

As a general guide, the table below is a summary of expected seismic velocities in the marine environment for a wide range of materials and geological settings that can be applied where other site–specific information is limited. The general correlation in the table identifies that softer and looser materials have generally low seismic velocities close to that of water (~1500 m/s) while denser and stronger materials are characterised by higher seismic velocities.

Material Description	Seismic Velocity (m/s)	Material Description	Seismic Velocity (m/s)
Gas–filled fine sediments	800–1400	Older limestone (reef)	2500–6000
Silts and soft clays	1500–1600	Calcarenite, siliceous calcarenite	2000–3700
Loose to dense sands	1600–1800	Boulders/broken rock in sand	1900–4000
Stiff clays	1700–1900	Weathered sandstone/shale	1900–2500
Cemented sands	1900–2400	Fresh sandstone/shale	2700–4300
Loose gravels, cemented gravels	1800–2400	Fresh Granite	4300–5800
Younger limestone (reef)	2200–3500	Fresh Basalt	3000–6500
		Fresh Metamorphics	3000–7000

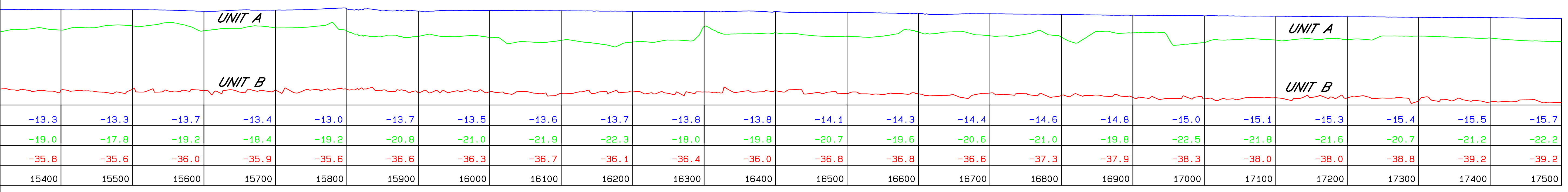
SEA CHANNEL – BATHYMETRY DATA AT 1:5000

SCALE HORIZONTAL : 1:5000



SEA CHANNEL – 20m (Port) PROFILE – 2D MULTICHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000



Declaration

These Geophysical Plans are compiled from two sets of independent seismic data sets namely Single–channel High Resolution Reflection Seismic and 2D Multi–channel Reflection Seismic acquired during the survey carried out in February and March 2011 using different instrumentation and equipment.

The penetration of acoustic waves through the seabed primarily depends upon the type of instruments, the frequency used and the geology of the surveyed area.

Analysis of the seismic data is interpretive and the interpretation of the two independent sets of Seismic data has been carried out by different Geophysicists.

Differences may occur in adjoining data due to differences in interpretation of horizons and/or due to the different equipment and different frequencies used for the surveys.

These Geophysical plans of survey have been prepared in good faith and with all due care and diligence. In the light of these facts, it must be clearly understood that Mapping and Hydrographic Surveys Pty Ltd, Geosence Surveys and Geo Survey Systems Inc, their proprietors and employees, cannot take responsibility for any consequences arising from the use of this plan.

SEA CHANNEL – 40m (Port) PROFILE – HIGH RESOLUTION SINGLE CHANNEL REFLECTION SEISMIC DATA

SCALE HORIZONTAL : 1:5000
VERTICAL : 1:1000

QUALIFICATION OF PERSONNEL

Field surveyor : Dylan Colson B Geomatics (Survey & Spatial Science)
Checking Surveyor : Andreas Guzek BSc (Surveying) MSSSI (CPHS1)
Field Geophysicist : Mel Proudlock BSc (Hon) Geology & Applied Geology
Processing Geophysicist : Bharat Kumar BSc; MSc Geophysics
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Approved: John E McCarthy FSSSI (CPHS1)
Date: March 2011
Our Ref: MH1136

Notes

CONFIDENCE LEVEL

+/- 1.0m at Frequency of Boomer

Commissioned by

TOWNSVILLE PORT AUTHORITY

Engineering Building
Benwell Road
Townsville Qld. 4810
Ph: 61(7) 4781 1605
Fax: 61(7) 4781 1601

Ref

PROCESSING

Survey software: Qinsy
CAD package: Terramodel
Seismic Processing: Coda Geosurvey
Digital Processing: Geokit

Consultant

AECOM

Level 8, 540 Wickham Street
Fortitude Valley QLD 4006
PO Box 1307
Ph: 61(7) 3553 2000
Fax: 61(7) 3553 2050

Ref

Surveyed: Dylan Colson

VERTICAL MEASUREMENTS

SEISMIC EQUIPMENT :
APPLIED ACOUSTICS - BOOMER
HYDROPHONES - 11 ELEMENT SINGLE CHANNEL
ACQUISITION SOFTWARE - CHESAPEAKE SONARWIZ.MAP
2D HYDROPHONES - 24 CHANNEL

Vertical Datum: LAT
Based on: PM 10011 RL 9.025m LAT
Soundings reduced to datum by linear interpolation from reading at Townsville Storm Surge Gauge ATG 055003A and using a range ratio of 0.96 for Magnetic Island

Checked: Andy Guzek

HORIZONTAL POSITIONING

Equipment : Navcom DGPS
Specified Accuracy : +/- 0.5 m
Resolution : +/- 0.1 m
Differential Signal : Starfire

Horizontal Datum: GDA94 - MGA ZONE 55
Based on: Starfire DGPS Broadcast Service

CLASS of SURVEY
N/A

NORTH

SURVEY VESSEL

Vessel : Anika - J
LOA : 14.6 metres
Beam : 4.3 metres
Power : 1 x 215kw
Draft : 1.9 metre
Transducer : Hull Mounted

DEFINITIONS

CLASS A - SURVEY ENSURES 100% BOTTOM ENSONIFICATION
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TOWNSVILLE
PORT EXPANSION PROJECT EIS
SEISMIC REFLECTION SURVEY PROFILES

MARCH 2011

SCALE 1: 5000

0 100 200 300 400 500 Metres

Drawing No MH1136-S06
Sheet 6 of 6

APPENDIX D

Limitations

LIMITATIONS

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