FLANAGAN CONSULTING GROUP
Trusted Advisor to Northern Australia

Ports North

CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX K: Soil Values and Constraints Assessment, Northern Sands Report (2016)

29 September 2016

BASELINE SOILS REPORT - NORTHERN SANDS

Cairns Shipping Development Project

REPORT

Report Number. 1546223-005-R-Rev3

Distribution:

1 PDF Electronic copy

Golder Associates

Executive Summary

Approximately 1.9 M m^3 of dredged material (subject to further investigation) is proposed to be pumped into the existing sand pit at Northern Sands. The existing pit may be able to accommodate all of the dredged spoil in a single stage of dredging or several stages of dredging. If this is not the case the pit could be expanded to the north-west and/or containment bund wall could be constructed to increase capacity.

The Northern Sands site and potential delivery pipeline routes are located in an area dominated by Holocene aged alluvial deposits of sand, silt and mud sediments. Some of these sediments are ASS.

Ground surface levels across the Northern Sand site typically range from about 5.5m to 2m AHD. The existing sand pit has been excavated to levels typically in the range of -1.5m to -4.5m AHD across the majority of the pit and to levels in the range from -6.5m to -14.5m AHD in the southern and eastern portions of the pit.

Placement of PASS dredged materials in the pit, below the permanent water table and covered by self-neutralising dredged materials will negate the need for treatment of PASS dredged materials. Insitu ASS materials are unlikely to be disturbed by placement of dredged materials in the existing pit. Excavations to depths greater than 1m in the areas south and east of the sand pit and to depths of more than about 4m to the north of the sand pit may disturb/encounter ASS materials. Excavations in ASS materials will need to be managed appropriately.

Construction of containment bunds and/or ponds/channels to manage tailwater quality will need to be carried out using clayey materials. Some of the near surface soils around the existing pit are expected to be generally clayey in nature, however they may not be suitable for construction of bunds or channels and liners may be required. The size and/or location of containment bunds around the existing pit may be constrained by stability issues. Parts of the site surrounding the sand pit may be needed for ponds/channels to manage tailwater quality. Suitable land areas may not be available.

Potential delivery pipeline routes traverse across low lying areas at levels between 1m and 2m AHD near the shoreline, before rising to traverse across cane fields with surface levels at about 4m AHD to the north of the Captain Cook Highway. If no significant excavations are carried out along the pipeline route, ASS materials are unlikely to be disturbed. Confirmation sampling would be required to confirm ASS conditions at staging ponds or excavations proposed near Thomatis Creek or Barr Creek.

Some areas along the proposed alignments of the delivery pipeline comprise soft clays at or near the surface. The presence of these soils may make access difficult for heavy machinery if required.

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FIGURES:

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Acronyms

AHD: Australian Height Datum

ASS: Acid Sulfate Soil

AASS: Actual Acid Sulfate Soil .

PASS: Potential Acid Sulfate Soil

1.0 INTRODUCTION

Flanagan Consulting Group (FCG) commissioned Golder Associates Pty Ltd (Golder) to provide advice and assessment of soil issues as part of the Revised Draft Environmental Impact Statement for the Cairns Shipping Development (CSD) project.

The revised CSD project involves the following:

- Reduced channel widening and deepening plus dredging of the swing basin and berth pockets in the inner port area (capital dredging). This will result in a total capital dredging volume of about 860 000m^3. This is an in-situ material volume calculated as occurring between current maintenance dredging depths and the enlarged channel target depths including insurance depth and appropriate minimal over-dredging allowances.
- Land placement of capital dredge material at the following sites:
  - Northern Sands (an existing void in the Barron River delta created by sand extraction and now used for burial of 'inert' construction and demolition fill and a limited quantity of PASS).
  - East Trinity (a new bunded site or sites within the general East Trinity area).

Other aspects of the CSD Project described in the Draft EIS remain unchanged.

This report is based on a desktop review of available information and addresses the placement of capital dredged material at "Northern Sands" – an existing void in the Barron Delta, see Figure 1. Conceptual placement of dredged materials at Northern Sands would have the following requirements:

- A pumping delivery line along one of the route options shown on Figure 1 including:
  - A pump-out facility.
  - The conceptual design for the pipeline includes 1 m diameter welded steel pipe on the seabed and creek bed where appropriate, and flanged steel section above ground on temporary earth pads. Booster stations will be positioned along the pipeline at various locations (possible locations shown on Figure 1).
- Approximately 1.9 M m^3 of dredged material (subject to further investigation) will be pumped into the existing sand pit (and/or possible extension) at Northern Sands with identified PASS spoil placed in the deeper portion of the pit and covered by self-neutralising spoil. PASS will be placed to achieve a final surface at least 1m below the permanent water table. Other self-neutralising spoil will be placed over the PASS and may extend above the permanent water table (subject to final design and approvals). A bund wall may be constructed around the existing sand pit to increase capacity or provide flood immunity.
- Provision for tailwater treatment – subject to preliminary concept design.

The aims of this report are to describe the existing soil conditions associated with Northern Sands and to identify:

- Key soils related constraints (and opportunities) to design and construction of the facilities required for placement of the dredged material.
- Potential soils related environmental impacts and mitigation/management measures (to be subject to a future detailed impact assessment).

2.0 DESKTOP ASSESSMENT

2.1 Site Background Information

The Northern Sands site covers an area of about 84 hectares and is located on the Barron River floodplain. The site contains an operating sand pit and is licenced to receive 'inert wastes' and potential acid sulfate soils (PASS), both of which are placed into the excavated pit below the water table. The current sand pit covers an area of about 25 hectares. A possible extension area is located north west of the pits (see Figure 1).

2.2 Topography

Ground surface levels across the Northern Sand site typically range from about 5.5m AHD to 2m AHD. Recent hydrographic survey (July 2016, see Figure 2) of the pit indicates excavation levels typically in the range of -1.5m to -4.5m AHD across the majority of the pit, apart from the southern and eastern portions of the pit where excavation levels range from -6.5m to -14.5m AHD. The Barron River is present immediately south and west of the Northern Sands site.

Pipeline route options are shown on Figure 1 and traverse largely across cane fields, with surface levels at about 4m AHD north of the Captain Cook Highway and then depending upon the route, traverse areas with surface levels dropping to between 1m and 2m AHD before the shoreline.

2.3 Geology

Erosion of the bedrock within the Macalister Ranges has resulted in the formation of the Barron River floodplain that stretches from Trinity Beach in the north to Cairns Airport in the south. The Barron River floodplain is underlain by unconsolidated Quaternary age alluvial deposits of sands, gravels, silts and clays.

Published geological information from *Queensland Digital Geological Map Data 1:100,000 Cairns 8064 series Department of Natural Resources and Mines* indicates the Northern Sands site and pipeline route options are dominated by Holocene aged alluvial deposits of silt, mud and sand sediments. The surficial deposits are underlain varying sequences of older sand and clay deposits, underlain by bedrock comprising Silurian/Devonian meta-sediments.

A surficial geological map of the Northern Sands area and the pipeline alignment is shown on Figure 3.

2.4 Soils

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) *Soils of Babinda -Cairns Area, North QLD* 1996 (1:50,000 scale) soils map indicates the presence of one soil unit (Liverpool) across the North Sands site. Soil units along the pipeline routes are summarised below:

Route Identifier	Route Section	Soil Units Present
Aquis	Northern Sands to Thomatis Creek	Liverpool, Brosnan, Hull, then Mangrove
	Thomatis Creek to mouth of Thomatis/Richters Creek	Mangrove, Liverpool, Hull, with additional zones of Mangrove and Hull neat the mouth of Thomatis/Richters Creek
Yorkeys	Northern Sands to Thomatis Creek	Liverpool, Brosnan, Hull, then Mangrove
	Thomatis Creek to the mouth of Thomatis/Richters Creek	Mangrove
Machans Beach	North Sands to about half way to mouth of Barr Creek	Predominantly Liverpool traversing a small section of Mangrove
	Remainder of the route to mouth of Barr Creek	Hull

The soil units are shown on Figure 4 and described below:

Unit Name	Typical Origin	Description
Hull	Beach Dune	Deep sandy soils – Tenosols;
Mangrove	Swamps and Intertidal Zone	Saline soils of the intertidal zone.
Liverpool	Alluvium	Well drained soils formed on alluvium, Orthic Tenosol: Dark grey brown silty loams over yellow brown silty loam and silty clay loam to about 0.6m overlying fine sands.
Brosnan	Alluvium	Soils formed on beach ridges, Red Kandosol: Brown sandy loam over yellowish red or red sandy loam to sandy light clay.

2.5 Acid Sulfate Soils

Acid Sulfate Soil (ASS) is a general term applying to both a soil horizon that contains sulfides (i.e. Potential Acid Sulfate Soil - PASS) and an acid soil horizon affected by oxidation of sulfides (i.e. Actual Acid Sulfate Soil - AASS).

The Department of Environment and Resource Management 2009 *Acid Sulfate Soils of Cairns North Queensland* shows the Project area as being mapped at a 1:50,000 scale. An extract of the DERM 2009 soil map covering the project area and showing the interpreted distribution of PASS is reproduced as Figure 5.

Across the Northern Sands site the following conditions are indicated:

- The existing sand pit is mapped as “Disturbed Land – likely to contain ASS”.
- Surrounding the pit, strongly acidic soil conditions (pH >4.0 to ≤5.0) are indicated from the surface (this does not indicate the presence of ASS). A PASS layer is generally indicated within 4 to 5m of the surface and within 1m to 2m of the surface around the southern and eastern margins of the pit.

Along the pipeline route the following conditions are indicated:

Route Identifier	Route Section
Aquis	■ Between the Captain Cook Highway and Thomatis Creek, strongly acidic soil conditions (pH >4.0 to ≤5.0) are generally indicated from the surface. A PASS layer is generally indicated within 1m to 5m along this section. PASS is present at depths between 1m and the surface at the Thomatis Creek crossing point. ■ West of Thomatis Creek, PASS is again present at depths between 1m and the surface near the bank and then there are strongly acidic soil conditions (pH >4.0 to ≤5.0) are generally indicated from the surface over the majority of the route with a PASS layer is generally indicated within 2m to 4m over most of this route. The last 400-500m of the route prior to the mouth of Thomatis/Richters Creek has PASS present at depths between 1m and the surface.
Yorkeys	■ Between the Captain Cook Highway and Thomatis Creek, strongly acidic soil conditions (pH >4.0 to ≤5.0) are generally indicated from the surface. A PASS layer is generally indicated within 1m to 5m along this section. ■ To the mouth of Thomatis/Richters Creek PASS is typically indicated from the surface in the banks and is expected to be present in the creek bed.
Machans Beach	■ For the first 800m north of the Captain Cook Highway has strongly acidic soil conditions (pH >4.0 to ≤5.0) are generally indicated from the surface. A PASS layer is generally indicated within 0.5m to 2m along this section. ■ The remainder of the route traverses areas where PASS is indicated within 2.5m to 4 m of the surface until the mouth of Barrs Creek where PASS is indicated within 0.5m of the surface.

2.6 Groundwater

A review of existing groundwater bores (DNRM groundwater database) within 2 km of the sand pit suggests that groundwater is present in two aquifers:

- A shallow, unconfined aquifer with groundwater levels typically between about 1.5m and 4m below the ground surface; and
- A deeper aquifer which is confined/semi-confined by a clay layer. Groundwater levels are typically between 1.2m and 6m below the ground surface (about 4m AHD to -0.8m AHD).

At the Northern Sands site, water levels in the sand pit and groundwater levels (shallow aquifer) in monitoring bores (see Figure 6) is understood to have been collected since about 2005. Water level in the sand pit during the July 2016 hydrographic survey was recorded at 0.5m AHD.

The potential tidal influence from the Barron River is not known at this time.

Water quality data provided by Landline Consulting indicates that water quality within the sand pit is typically:

- Freshwater conditions with electrical conductivity within about 200 to 1000 mS/cm.
- Neutral to alkaline with pH ranging from about 6.3 to 8.

Water quality data provided by Landline Consulting indicates that groundwater quality (shallow aquifer) surrounding the sand pit is typically:

- Freshwater conditions to saline conditions with electrical conductivity within about 200 to 20,000 mS/cm. This large variation in electrical conductivity may be related to seasonal interaction with the Barron River.
- Acidic to neutral with pH ranging from about 5 to 7.5.

A more detailed assessment of groundwater is presented in Golder report 1546233-012-R-Rev0.

2.7 Geotechnical Conditions

Previous subsurface investigations have occurred across the Northern Sands site specifically, and include:

- Borehole investigation carried out by Probin Pty Ltd in 2007, comprising 21 No. boreholes to depths ranging between approximately 15 to 24 m below ground level.
- Borehole investigation carried out by GEO Investigate in 2013, comprising 10 No. boreholes within the extent of the existing dredged area (i.e. ‘lake’). The boreholes were drilled to depths ranging from 18 to 30 m below water level.
- Cone Penetration Testing (CPT) carried out by GEO Investigate/GEO Design in July 2016 comprising 30 No. CPT’s to depths ranging from approximately 8 to 24 m below ground level.

Cross sections of inferred subsurface conditions (locations shown on Figure 6) are presented in Figures 7A and 7B. Interpreted logs from the Queensland Government Registered Groundwater Bores Database have also been included to provide information on conditions in proximity to the site. Interpreted logs utilised in the cross sections are presented in Appendix A.

The identified soil conditions within the site were broadly consistent with published geology and soil units and the typical profile encountered includes:

- Sandy silty clay (typically above 0 m AHD): medium plasticity, approximately 0.5 to 3 m thick, brown to brown-grey; overlying
- Upper sand/gravelly sand (broadly between 3 m AHD to -5 m AHD): inferred loose to medium dense, fine to coarse grained, grey and brown; overlying
- Silty clay (broadly between -5 m AHD to -15 m AHD): medium to high plasticity, brown, grey and dark grey; overlying

- Lower sand/ gravelly sand (broadly between -10 m AHD to -25 m AHD): inferred loose to medium dense, grey and brown, with occasional coarse gravel and cobbles.

Variations occur in the thickness and sequence of each unit across the area and minor layers of sand/clay commonly occur within each unit, characteristic of an alluvial floodplain deposit. The sand/clay sequence tends to be shallower towards the south of the site.

Groundwater bore RN139211 located immediately north-west of the site on the opposite side of the Barron River extends to 66 m depth. This borehole record indicates a continuation of interbedded sand and clay layers to a depth of 62 m where weathered rock was encountered.

3.0 CONSTRAINTS AND OPPORTUNITIES

3.1 Opportunities

Opportunities related to the disposal of dredged spoil at Northern Sands are as follows:

- The existing pit may be able to accommodate all of the dredged spoil in a single stage of dredging or several stages of dredging. Failing this, expansion to the north-west may be feasible.
- Placement of dredged spoil in the sand pit, below the permanent water table and covered by self-neutralising spoil, negates the need for treatment of PASS in the dredged spoil.

3.2 Constraints

3.2.1 Construction

Constraints related to construction that may be required for the dredged spoil disposal are as follows:

- Some of the near surface soils around the existing sand pit are expected to be generally clayey in nature, however they may not be suitable for construction of embankments/bunds or channels for management of tailwaters, if required.
- The size and/or location of bunding around the existing sand pit may be constrained by stability issues.
- Some areas along the alignment of the delivery pipeline comprise soft clays at or near the surface. The presence of these soils may make access difficult for heavy machinery if required

3.2.2 Insitu ASS Materials

Constraints related to insitu ASS materials are as follows:

- Unless the sand pit is significantly expanded to accommodate dredge spoil, insitu ASS materials are unlikely to be disturbed. Any excavations to depths greater than 1m in the areas south and east of the sand pit may disturb/encounter ASS materials that have the potential to generate acid if not managed appropriately via lime treatment, or immediate placement back below the water table (PASS only). Confirmation sampling of these areas will be required.
- In the possible pit expansion area (northwest of existing pit) PASS may be present in sands below about 4m to 5m from the surface. Deeper soft dark grey clay deposits exhibit characteristics typically expected to be PASS.
- If no significant excavations are carried out along the pipeline route, ASS materials are unlikely to be disturbed. If staging ponds or excavations are proposed near Thomatis Creek or Barr Creek, confirmation sampling of these areas will be required.
- Booster Pump #2 under the Yorkeys and Aquis pipeline route options are located in or close to areas mapped with PASS present within 0.5m of the surface. The locations may need to be reviewed.
- Dewatering of excavations may expose in-situ PASS materials and result in release of acid. If required, such dewatering activities would need to be managed.
- Although unlikely, lowering of the sand pit water level may expose in-situ PASS materials and result in release of acid. Lowering of water levels within the sand pit to such levels would need to be avoided.

3.2.3 Dredge Spoil Materials

Constraints related to dredged spoil materials are as follows:

- The proposed dredging operation will use a combination of mechanical and hydraulic excavation processes, with the end result being that the dredged material is a slurry mixture of soil and saltwater. Some of the materials to be dredged have been confirmed as PASS. If terrestrial spills occur during the pumping of slurry this will need to be assumed to be PASS and will need to be contained, collected and treated as such.
- Parts of the site surrounding the sand pit may be needed for construction of ponds/channels to manage tailwater quality prior to discharge from the site. Suitable land areas may not be available.

4.0 POTENTIAL IMPACTS

4.1 ASS Material

4.1.1 Potential Level of Risk

Given the volume of dredged spoil to be placed, management of existing and potential acidity would be classified as XH (extra high level) treatment as per the Soil Management Guidelines V4 (Dear et al. 2014) - Table 4.2. As such, the Guidelines require that a comprehensive environmental management plan must be formulated including detailed closure reporting and handover testing procedures. This plan should also provide for ongoing management and monitoring of the effects of the disturbance/placement of ASS during and after disposal of dredged spoil into the sand pit.

4.1.2 Potential Impacts Associated with ASS

4.1.2.1 General

When ASS is exposed to oxygen as a result of disturbance (via excavation or displacement) or drainage (via dewatering or other means), pyrite can oxidise and forms sulfuric acid ASS when combined with water. Sulfuric acid can leach out of these affected soils and strip metals (including iron, aluminum and heavy metals) from the surrounding soils. Acidic and metals impacted water can migrate into surface waters and groundwater.

These processes can lead to degradation of terrestrial vegetation through:

- Stunting of root growth;
- Increased toxicity from higher concentrations of aluminum, iron and manganese;
- Reduced plant minerals and nutrients; and
- Reduced resistance to pathogen attack.

Longer term impacts may include species die off and changes to vegetation cover (domination by more acid tolerant species).

The discharge of acidic water to aquatic environments (especially estuarine) may cause the following impacts:

- Increased acidity and increased iron and aluminum concentrations may be toxic to some aquatic organisms and may cause fish diseases (eg. Red spot).
- Iron and aluminum precipitates can affect water quality and coat stream banks, benthic (sediment-dwelling) organisms and aquatic vegetation.
- Aquatic vegetation communities may change to become dominated by acid tolerant species.
- Deoxygenated water may also result from the secondary oxidation of the Fe2+ consuming oxygen and lowering the level of dissolved oxygen in surface waters.

Acidified waters can also weaken concrete and steel infrastructure such as culverts, pipes and piles.

4.1.2.2 Oxygenation of Dredged Spoil

When left undisturbed and submerged in an anoxic environment, pyrite (in acid sulfate soil) is chemically inert. Pyrite oxidizes in the presence of oxygen and hydrogen to form sulfuric acid. There are a number of variables affecting the oxidation of pyrite, and the reactions are complex although the rate at which pyrite is oxidised tends to be closely linked with pH, with oxidation increasing as pH decreases, and is usually only limited by the rate of supply of oxygen.

There is a potential for aeration (introduction of oxygen) into dredged PASS materials during pumping and discharge into the sand pit. Whilst PASS remains saturated, the available supply of oxygen is significantly lower (typically 9 ppm) compared to PASS excavated and allowed to dry, where an almost infinite supply of atmospheric oxygen at relatively high concentrations (21%) is available.

In dynamic conditions such as dredging and pumping, the oxygen is principally delivered via advection to suspended soil particles. The risk of acid generation is variable and dependent upon the rate and duration of suspension. The relatively stable pH of seawater results in a slow rate of pyrite oxidation and the greatest risk of acid generation is associated with suspended or resuspended sediments. Seawater contains the major buffering constituents - bicarbonate and carbonate in solution so minor acid generated is neutralised almost instantaneously. At the sand pit, the majority of the dredged spoil will settle to the floor of the pit and return to an anoxic, reducing stable state presenting minimal risk to the environment.

Where identified PASS spoils are placed in deeper sections of the pit and covered by self-neutralising spoil the risk of remobilising and re-oxygenating is very low.

4.2 Geotechnical

Potential geotechnical impacts resulting from construction and operation of the dredged material deposition process include the following:

- Settlement and/or failure of pipeline support foundations, possibly resulting in burst or leaking pipelines.
- Seepage through containment bund walls (if proposed) or tailwater pond channel walls as a result of dispersive soil properties, possibly resulting in a breach of these walls.
- Instability of bund walls (if proposed for additional containment) surrounding the sand pit as a result of siting too close to the pit or over-steep profiles, possibly resulting in release of water and spoil.
- Instability of tailwater pond channel walls as a result of over-steep profiles, possibly resulting in overtopping of channels and release of water.

It is noted that all of the above impacts are likely to be able mitigated by appropriate geotechnical investigation and design.

5.0 REFERENCES

Queensland Digital *Geological Map Data 1:100,000 Cairns 8064 series* Department of Natural Resources and Mines

Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2013 *Soils of Babinda -Cairns Area, North QLD 1996 (1:50,000 scale)*. Sourced from QGIS 9/2013 (DP_QLD_LAN_BBC_50K)

Manders J.A. O'Brien L.E. Morrison DW (2009). *Acid Sulfate Soils of Cairns, North Queensland* Department of Environment and Resource Management, Indooroopilly, Queensland, Australia.

Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. (2014). *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines*. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.

Landline Consulting (2016). *Northern Sands Lake and Bore Stats*. Letter Report dated 26/7/2016

Probin Pty Ltd (2007). *Sand Resource Evaluation*. Letter Report dated 27/4/07.

GEO Investigate (2013). *Sand Resource Drilling, Northern Sands*. Letter Report Ref. 12109AA-I-R-V1, dated 13 May 2013.

GEO Design (2016). *Sand Resource Evaluation, Northern Sands*. Report No. 16056AA-D-R01-v1 - Tom Hedley.docx, dated 29 August 2016.

6.0 IMPORTANT INFORMATION

Your attention is drawn to the document - "Important Information", which is included as an attachment to this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. 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.

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CAPTAIN COOK HIGHWAY
Avondale Creek
WISTARIA STREET
HOLLOWAY BEACH ROAD
Barr Creek
MACHANS STREET
MACHANS BEACH ROAD
Machans Beach
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Booster #2
Booster #3
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Booster #3
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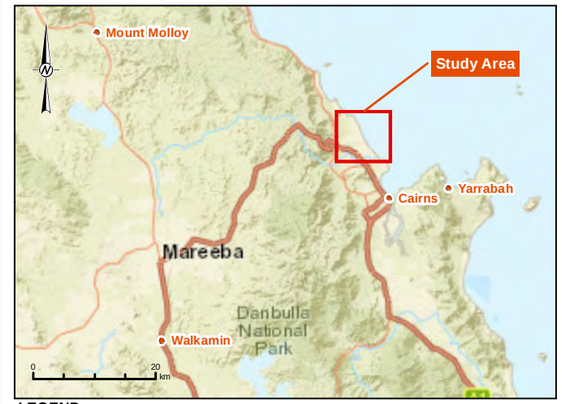
Booster #2

LOCATION MAP



LEGEND

- Localities
- Roads and Tracks
- Drainage (25k)

Pipeline Route Options

Inbound Aquis

- Booster Locations (with Marine Booster)
- Booster Locations (no Marine Booster)
- Inbound Pipeline

Inbound Yorkeys

- Booster Locations
- Inbound Pipeline

Inbound Machans Beach

- Booster Locations
- Inbound Pipeline
- Dredge Pumpout and Marine Booster Areas
- Storage and Laydown Areas
- Northern Sands Placement Area
- Pit Expansion Area

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Kilometres
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PROJECTION: GDA 1994 MGA Zone 55

CLIENT
FLANAGAN CONSULTING GROUP

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS: BASELINE SOILS REPORT NORTHERN SANDS

TITLE
LOCALITY: NORTHERN SANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-29
PREPARED	DP
DESIGNED	DP
REVIEWED	DS
APPROVED	DS

PROJECT NO.	CONTROL	REV.	FIGURE
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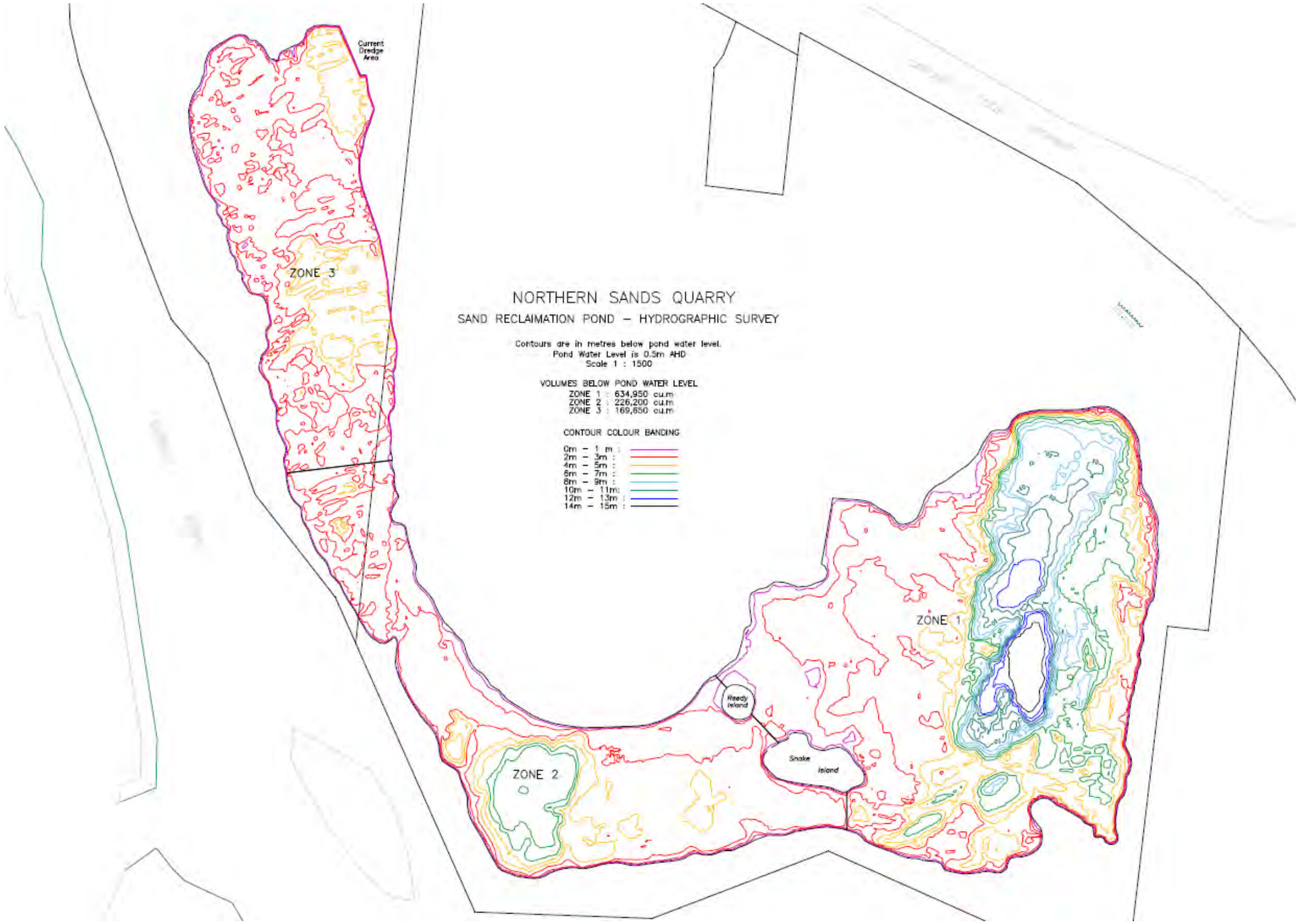
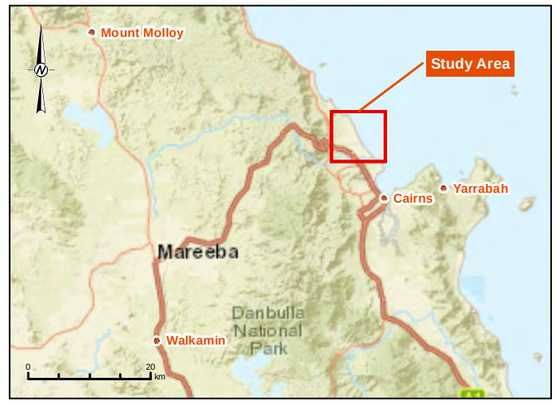


LOCATION MAP



CLIENT
FLANAGAN CONSULTING GROUP

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS: BASLINE SOILS REPORT NORTHERN SANDS

TITLE
HYDROGRAPHIC SURVEY OF SAND PIT

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-02
PREPARED	DP
DESIGNED	DP
REVIEWED	DS
APPROVED	DS

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Detailed Geology

- **Dgf:** Muscovite-biotite granite, strongly foliated and sheared.
- **Dh/h:** Hornfelsed/metasomatised arenite and mudstone.
- **Dh/m:** Mainly dark grey, thin bedded, mudstone, subordinate thin to thick bedded arenite beds, minor chert and basalt.
- **Qha/1:** Younger creek alluvium, lowest terraces and channel deposits - silt, clay, sand and gravel.
- **Qha/2:** Younger creek alluvium, intermediate terraces - silt, clay, sand and gravel.
- **Qha:** Sand, gravel, silt and clay; active stream channels and low terraces.
- **Qhcb:** Moderately well-sorted, fine to coarse-grained quartzose to shelley sand and some gravel: beach ridges and cheniers.
- **Qhct:** Coastal tidal flats, mangrove flats, supratidal flats, saltpans and grasslands - silt, mud and sand, minor salt.
- **Qhmd:** Deltaic sand.
- **Qhmp:** Prodelta mud, sandy mud, muddy sand.
- **Qhms:** Shoreface/fringing coral reef: lithofeldspathic sublabile sand, muddy sand, sandy mud.
- **Qpcb:** Silty and loamy quartz sand in degraded beach ridges.
- **Qpfc:** Steep alluvial and colluvial fans, cones and aprons - coarse boulder deposits (on granites), silty and clayey gravel (on metasediments).
- **W:** Water body, unspecified.

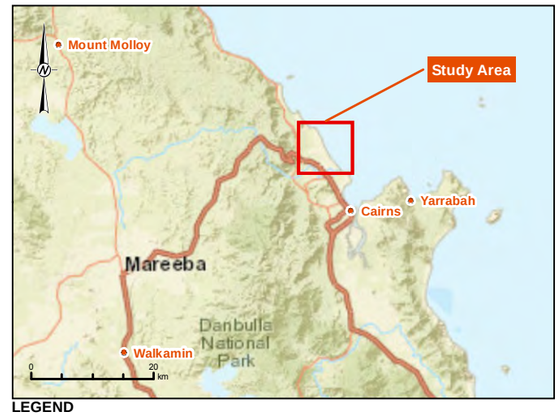
Booster #1
Booster #1
Booster #1
Booster #1
Booster #2
Booster #2
Booster #2
Booster #3
Booster #3
Booster #3

Qhms
Qhmp
Qhcb
Qhmd
Qha/2
Qha/1
W

YORKEYS KNOB ROAD
CAPTAIN COOK HIGHWAY
WISTARIA STREET
HOLLOWAY BEACH ROAD
MACHANS STREET
MACHANS BEACH ROAD

Avondale Creek
Barr Creek
Machans Beach

LOCATION MAP



LEGEND

- Localities
- Roads and Tracks
- Drainage (25k)

Pipeline Route Options

Inbound Aquis
- Booster Locations (with Marine Booster)
- Booster Locations (no Marine Booster)
- Inbound Pipeline

Inbound Yorkeys
- Booster Locations
- Inbound Pipeline

Inbound Machans Beach
- Booster Locations
- Inbound Pipeline

- Dredge Pumpout and Marine Booster Areas
- Storage and Laydown Areas
- Northern Sands Placement Area
- Pit Expansion Area

0 1 2
1:30,000 at A3 Kilometres
PROJECTION: GDA 1994 MGA Zone 55

CLIENT
FLANAGAN CONSULTING GROUP

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS
STAGE 1B – NORTHERN SANDS

TITLE
SURFACE GEOLOGY: NORTHERN SANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-29
PREPARED	DP
DESIGNED	DP
REVIEWED	DS
APPROVED	DS

PROJECT NO.	CONTROL	REV.	FIGURE
1546223	005	3	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: A3
0 25mm

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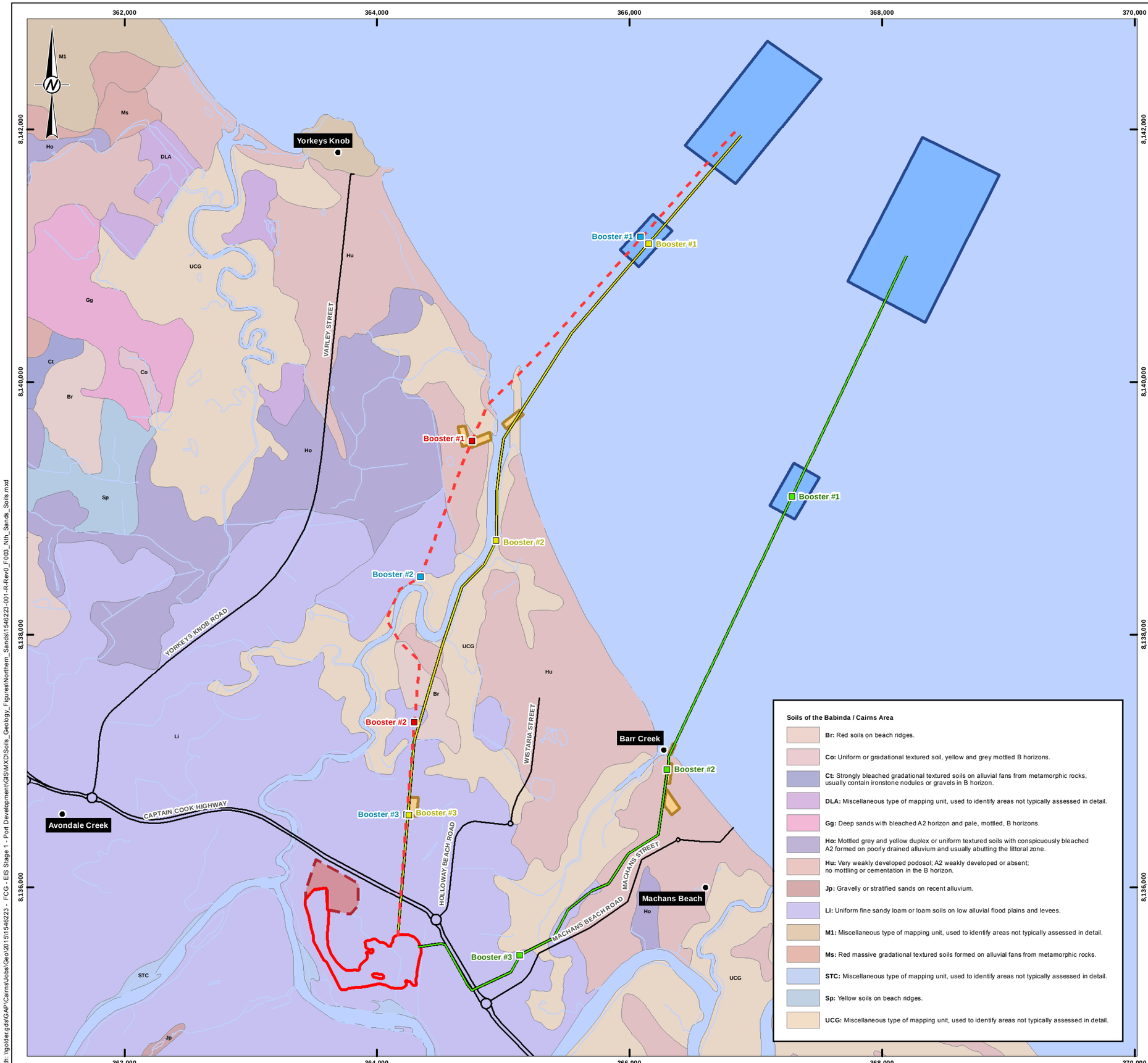

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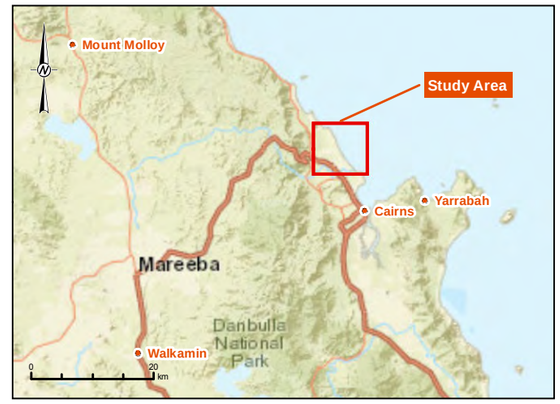

LEGEND

- Localities
- Roads and Tracks
- Drainage (25k)

Pipeline Route Options

Inbound Aquis

- Booster Locations (with Marine Booster)
- Booster Locations (no Marine Booster)
- Inbound Pipeline

Inbound Yorkeys

- Booster Locations
- Inbound Pipeline

Inbound Machans Beach

- Booster Locations
- Inbound Pipeline
- Dredge Pumpout and Marine Booster Areas
- Storage and Laydown Areas
- Northern Sands Placement Area
- Pit Expansion Area

0 1 2
Kilometres

1:30,000 at A3
PROJECTION: GDA 1994 MGA Zone 55

CLIENT
FLANAGAN CONSULTING GROUP

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS
STAGE 1B – NORTHERN SANDS

TITLE
SOILS MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-29
PREPARED	DP
DESIGNED	DP
REVIEWED	DS
APPROVED	DS

PROJECT NO.	CONTROL	REV.	FIGURE
1546223	005	3	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: A3

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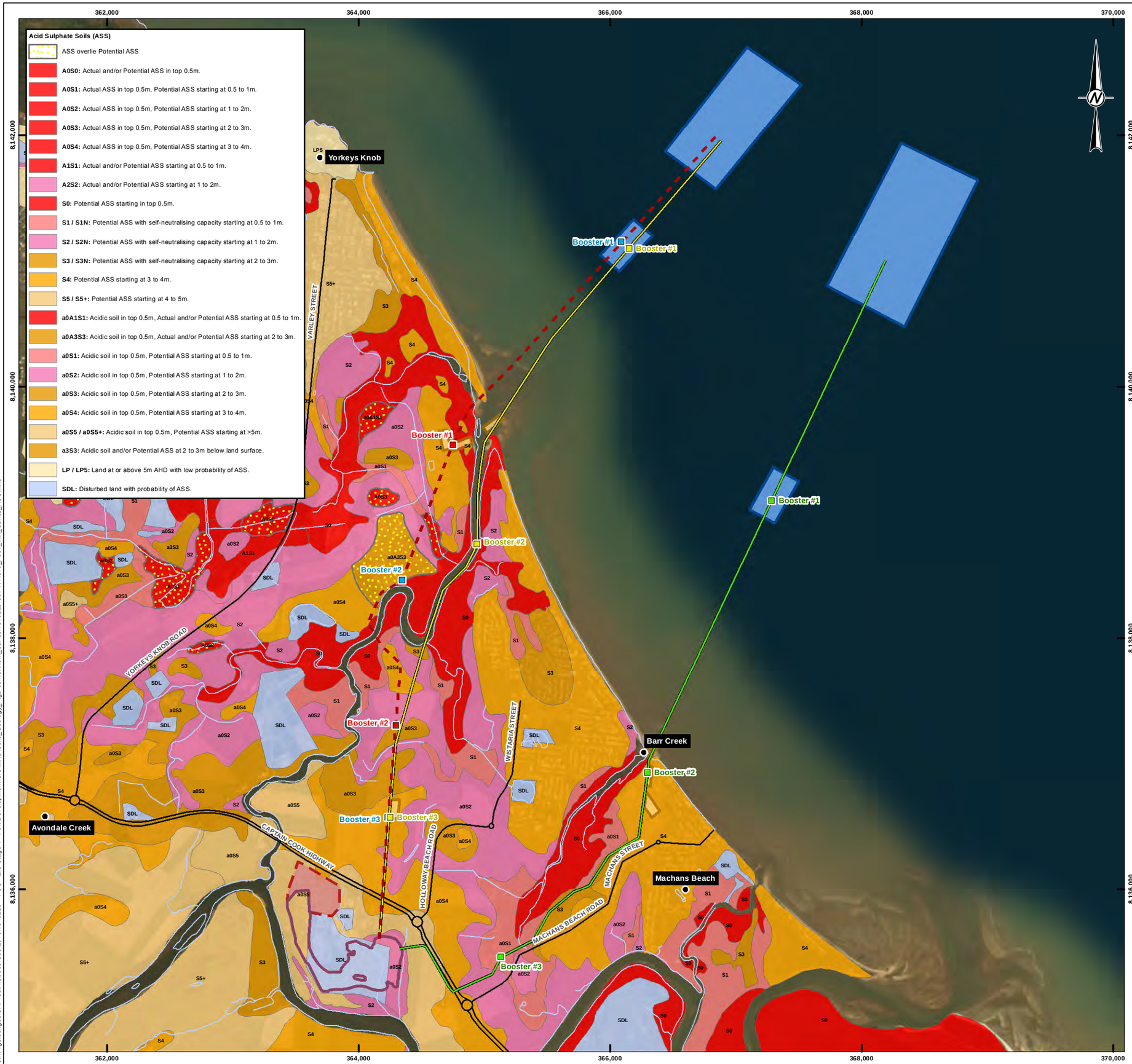
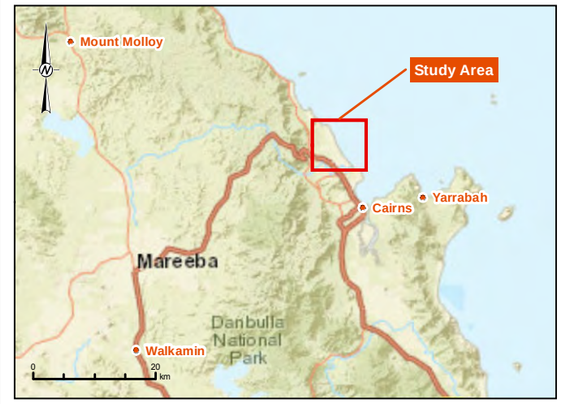


LOCATION MAP



LEGEND

- Localities
- Roads and Tracks
- Drainage (25k)

Pipeline Route Options

Inbound Aquis

- Booster Locations (with Marine Booster)
- Booster Locations (no Marine Booster)
- Inbound Pipeline

Inbound Yorkeys

- Booster Locations
- Inbound Pipeline

Inbound Machans Beach

- Booster Locations
- Inbound Pipeline
- Dredge Pumpout and Marine Booster Areas
- Storage and Laydown Areas
- Northern Sands Placement Area
- Pit Expansion Area

0 1 2
Kilometres

1:30,000 at A3
PROJECTION: GDA 1994 MGA Zone 55

CLIENT
FLANAGAN CONSULTING GROUP

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS
STAGE 1B – NORTHERN SANDS

TITLE
ASS MAP: NORTHERN SANDS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-29
PREPARED	DP
DESIGNED	DP
REVIEWED	DS
APPROVED	DS

PROJECT NO.	CONTROL	REV.	FIGURE
1546223	005	3	5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: A3

25mm

0

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363,000 363,500 364,000 364,500 365,000 365,500

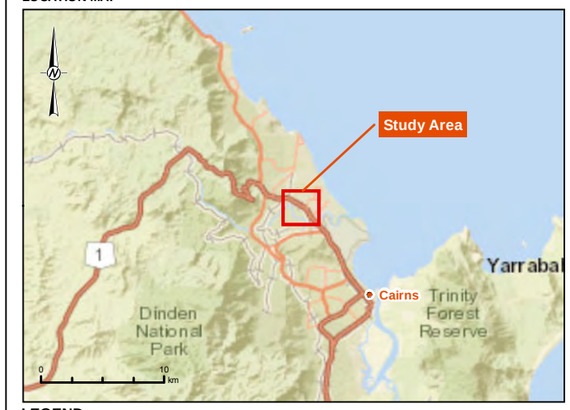
8,137,000 8,136,500 8,136,000 8,135,500 8,135,000 8,134,500

11000024 11000024 B 11000024 A
72509 72509
11000156 11000156
11000030 11000030
139211 139211
11000025 11000025
Booster #3 Booster #3
11000031 11000031
11000049 11000049
11000032 11000032
11000033 11000033
11000053 A 11000053 B 11000053 11000039 11000039
72350 72350
Booster #3

WISTARIA STREET
WISTERIA STREET
HOLLOWAY BEACH ROAD
CAPTAIN COOK HIGHWAY
MACHANS BEACH ROAD

UG1 UG2
BH1 BH2 BH3 BH4 BH5 BH6 BH7 BH8 BH9 BH10 BH11 BH12 BH13 BH14 BH16 BH17 BH18 BH19 BH20 BH21
BH2 BH3a BH4 BH5a
CPT1 CPT2 CPT3 CPT4 CPT5 CPT6 CPT7 CPT8 CPT9 CPT10 CPT11 CPT12 CPT13 CPT14 CPT15 CPT16 CPT17 CPT18 CPT19 CPT20 CPT21 CPT22 CPT23 CPT24 CPT25 CPT26 CPT27 CPT28 CPT29 CPT30
NS1 NS2 NS3 NS4 NS5 NS6 NS7 NS8 NS9 NS10
Lake
River

LOCATION MAP



LEGEND

- Localities
- Sections
- Roads and Tracks
- Watercourses (25k)

Investigation Locations

- GW Monitoring Bore
- Probin Boreholes
- GEO Investigate
- Well Locations

Pipeline Route Options

Inbound Aquis

- Booster Locations (with Marine Booster)
- Inbound Pipeline

Inbound Yorkeys

- Booster Locations
- Inbound Pipeline

Inbound Machans Beach

- Booster Locations
- Inbound Pipeline

- Storage and Laydown Areas
- Northern Sands Placement Area
- Pit Expansion Area

0 0.25 0.5
1:10,000 at A3 Kilometres
PROJECTION: GDA 1994 MGA Zone 55

CLIENT
FLANAGAN CONSULTING GROUP

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS
STAGE 1B – NORTHERN SANDS

TITLE
INVESTIGATION AND WELL LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-29
PREPARED	DP
DESIGNED	DP
REVIEWED	DS
APPROVED	DS

PROJECT NO.	CONTROL	REV.	FIGURE
1546223	005	3	6

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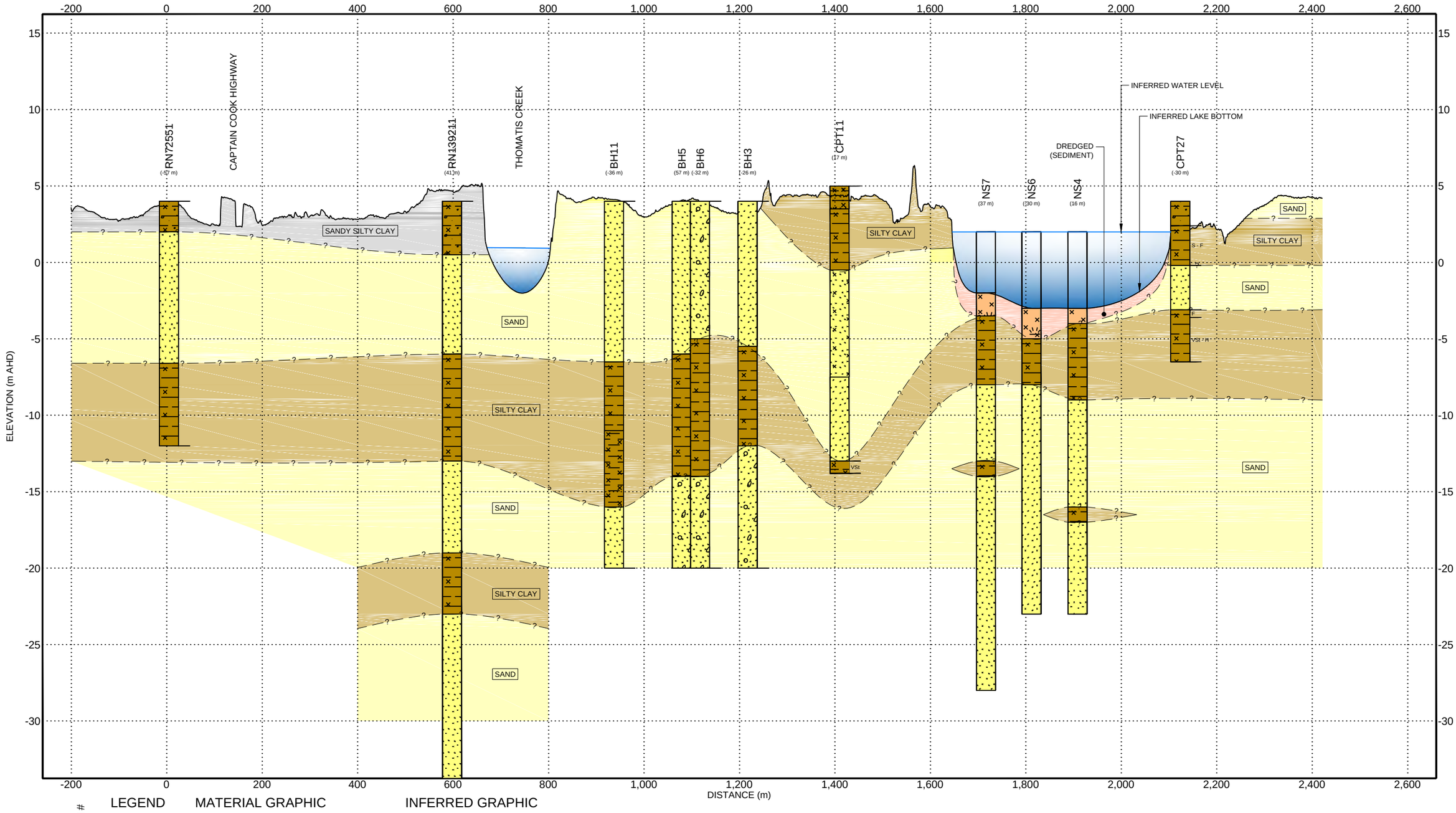


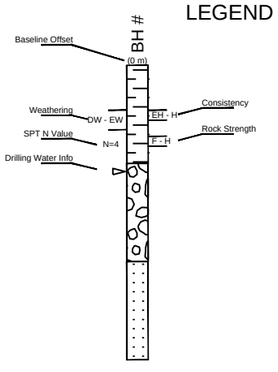
LEGEND

MATERIAL GRAPHIC

- Silty CLAY
- Sandy Silty CLAY
- SEDIMENT
- SAND
- Silty SAND
- Gravelly SAND

INFERRED GRAPHIC

- SAND/GRAVELLY SAND
- SILTY CLAY
- DREDGED SEDIMENT
- SANDY SILTY CLAY



H 1:8000
0 90 180 270 360 450m

V 1:250
0 2 4 6 8 10m

CLIENT
FLANAGAN CONSULTING GROUP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-08-25
DESIGNED	SB
PREPARED	GPG
REVIEWED	MC
APPROVED	MC

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS
BASELINE SOILS - NORTHERN SANDS

TITLE
NW-SE INFERRED GEOTECHNICAL LONGSECTION

PROJECT NO.	DOCUMENT No	REV.	FIGURE
1546223	005	3	F07A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
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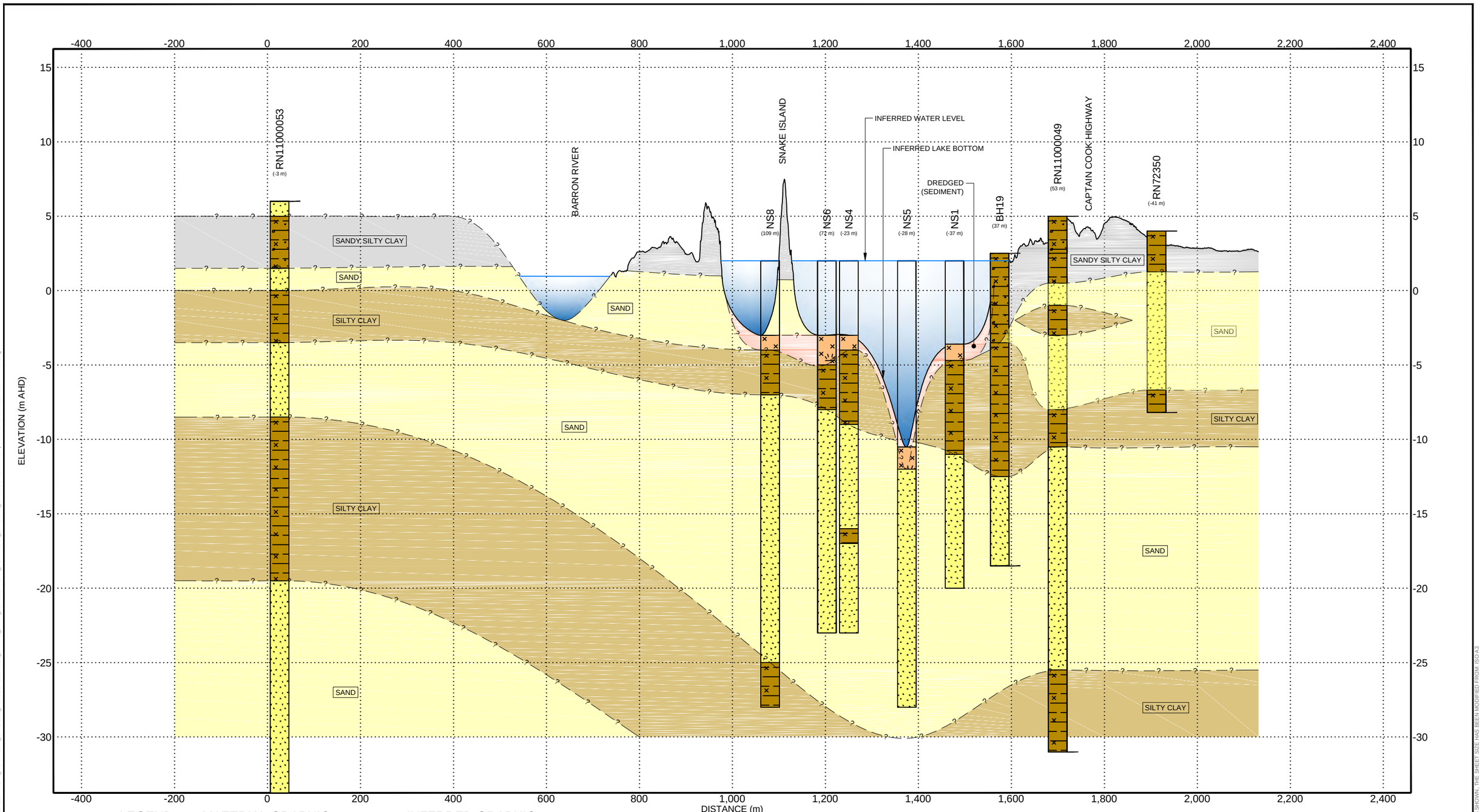

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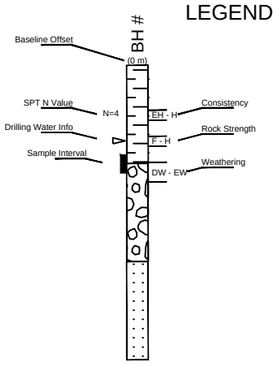

MATERIAL GRAPHIC

- Silty CLAY
- Sandy Silty CLAY
- SEDIMENT
- SAND

INFERRED GRAPHIC

- SAND/GRAVELLY SAND
- SILTY CLAY
- DREDGED SEDIMENT
- SANDY SILTY CLAY

H 1:8000

0 90 180 270 360 450m

V 1:250

0 2 4 6 8 10m

CLIENT
FLANAGAN CONSULTING GROUP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-08-25
DESIGNED	SB
PREPARED	GPG
REVIEWED	MC
APPROVED	MC

PROJECT
CAIRNS SHIPPING DEVELOPMENT EIS
BASELINE SOILS - NORTHERN SANDS

TITLE
SW-NE INFERRED GEOTECHNICAL LONGSECTION

PROJECT NO.	DOCUMENT No	REV.	FIGURE
1546223	005	3	F07B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

25 mm
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APPENDIX A

Historical Borelogs and QLD Registered Groundwater Bores

REPORT OF BOREHOLE: BH3

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363593.0 m E 8135841.0 m N MGA94 56
SURFACE RL: 5.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 24.00 m

DRILL RIG:
CONTRACTOR: Probin Pty Ltd 2007
LOGGED: SRF DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	5.00				SW	SAND fine to coarse grained, brown/grey			
			5									
				9.50 -4.50				CH	Silty CLAY medium to high plasticity, brown/grey			
			10									
			15									
				16.00 -11.00				SW	Gravelly SAND fine to coarse grained, grey			
			20									
				-19.00					END OF BOREHOLE @ 24.00 m			
			25									

REPORT OF BOREHOLE: BH5

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363556.0 m E 8135998.0 m N MGA94 56
SURFACE RL: 5.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 24.00 m

DRILL RIG:
CONTRACTOR: Probin Pty Ltd 2007
LOGGED: SRF DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	5.00				SW	SAND fine to coarse grained, brown/grey			
			5									
				10.00								
			10	-5.00				CH	Silty CLAY high plasticity, brown/grey, some sand			
			15									
				18.00								
				-13.00				SW	Gravelly SAND fine to coarse grained, grey			
			20									
				-19.00					END OF BOREHOLE @ 24.00 m			
			25									

REPORT OF BOREHOLE: BH6

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363519.0 m E 8135908.0 m N MGA94 56
SURFACE RL: 5.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 24.00 m

DRILL RIG:
CONTRACTOR: Probin Pty Ltd 2007
LOGGED: SRF DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	5.00				SW	Gravelly SAND fine to coarse grained, brown/grey			
				9.00								
				-4.00				CH	Silty CLAY high plasticity, grey			
			5									
			10									
			15									
				18.00								
				-13.00				SP	Gravelly SAND medium to coarse grained, grey			
			20									
				-19.00					END OF BOREHOLE @ 24.00 m			
			25									

REPORT OF BOREHOLE: BH11

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363390.0 m E 8136034.0 m N MGA94 56
SURFACE RL: 5.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 24.00 m

DRILL RIG:
CONTRACTOR: Probin Pty Ltd 2007
LOGGED: SRF DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	5.00				SP	SAND medium to coarse grained, brown/grey			
			5									
			10	*10.50* -5.50				CH	Silty CLAY high plasticity, grey/brown, with some organic material			
			15	*15.00* -10.00				MH	Clayey SILT grey, high liquid limit			
			20	*20.00* -15.00				SP	SAND coarse grained, grey			
			25	-19.00					END OF BOREHOLE @ 24.00 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.

GAP gINT FN. F01a
RL3

REPORT OF BOREHOLE: BH19

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364301.0 m E 8135644.0 m N MGA94 56
SURFACE RL: 2.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 21.00 m

DRILL RIG:
CONTRACTOR: Probin Pty Ltd 2007
LOGGED: SRF DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.50					Sandy Silty CLAY medium plasticity, brown/grey			
			2									
			4									
			6	*6.00* -3.50					Silty CLAY medium to high plasticity, brown			
			8									
			10									
			12									
			14									
				15.00 -12.50					SAND fine to coarse grained, grey, cemented layer encounted at 21.0m. Refusal of drilling method			
			16									
			18									
			20									

REPORT OF BOREHOLE: BH19

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364301.0 m E 8135644.0 m N MGA94 56
SURFACE RL: 2.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 21.00 m

DRILL RIG:
CONTRACTOR: Probin Pty Ltd 2007
LOGGED: SRF DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND fine to coarse grained, grey, cemented layer encounted at 21.0m. Refusal of drilling method			
				-18.50					END OF BOREHOLE @ 21.00 m			
			22									
			24									
			26									
			28									
			30									
			32									
			34									
			36									
			38									
			40									

REPORT OF BOREHOLE: RN72509

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 362864.0 m E 8136717.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 11.00 m

DRILL RIG: Rotary/Mud
CONTRACTOR: Ingham Drilling
LOGGED: DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	0.30					TOPSOIL			
			2						Clayey SILT brown			
				3.00								
				3.50					SAND & GRAVEL			
			4						MUD			
			6									
			8									
				8.50					SAND course			
			10	10.00					MUD			
									END OF BOREHOLE @ 11.00 m			
			12									
			14									
			16									
			18									
			20									

REPORT OF BOREHOLE: RN72551

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 362722.0 m E 8136685.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 16.00 m

DRILL RIG: Rotary/Mud
CONTRACTOR: Ingham Drilling
LOGGED: DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	0.40					TOPSOIL			
									Clayey SAND fine (LOAM)			
			2	2.00					GRAVEL fine to coase sand			
			4	4.50					SAND & GRAVEL fine to coarse grey sand, with layers of mud			
			6									
			8									
			10	10.60					MUD			
			12									
			14									
			16						END OF BOREHOLE @ 16.00 m			
			18									
			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
RL3

REPORT OF BOREHOLE: RN139211

SHEET: 1 OF 4

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363207.0 m E 8136330.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 66.00 m

DRILL RIG: Rotary/Mud
CONTRACTOR: Ingham Drilling
LOGGED: DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0						Clayey SILT brown			
			2									
				3.50								
			4						SAND & GRAVEL grey/brown, 1-6mm			
			6									
				7.00								
			8						SAND & GRAVEL grey, 1-8mm			
				10.00								
			10						MUD dark grey			
			12									
			14									
			16									
				17.00								
			18						SAND & GRAVEL grey			
			20									

REPORT OF BOREHOLE: RN139211

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363207.0 m E 8136330.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 66.00 m

DRILL RIG: Rotary/Mud
CONTRACTOR: Ingham Drilling
LOGGED: DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND & GRAVEL grey			
			22									
				23.00								
			24						MUD dark grey			
			26									
				27.00								
			28						SAND & GRAVEL grey			
			30									
			32									
				33.00								
			34						Clayed SAND & GRAVEL yellow			
			36									
			38									
			40									

REPORT OF BOREHOLE: RN139211

SHEET: 3 OF 4

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363207.0 m E 8136330.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 66.00 m

DRILL RIG: Rotary/Mud
CONTRACTOR: Ingham Drilling
LOGGED: DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			40						Clayed SAND & GRAVEL yellow			
			42									
			44									
			46									
				47.00								
			48						MUD dark grey			
				48.90								
			50						grey and yellow claybound SAND & GRAVEL			
			52									
			54									
				56.00								
			56						Silty CLAY grey/yellow			
			58									
			60									

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REPORT OF BOREHOLE: RN72350

SHEET: 1 OF 1

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364600.0 m E 8135819.0 m N MGA94 56
SURFACE RL: 4.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 12.19 m

DRILL RIG: Rotary Rig
CONTRACTOR:
LOGGED: DATE: 18/3/86
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	4.00					Sandy Silty CLAY brown			
				1.83								
			2	2.17					Sandy CLAY brown			
				2.74								
				1.26					SAND yellow, fine			
			4	*4.27*								
				-0.27					SAND white, fine			
				4.88								
				-0.88					SAND course, sand & wash			
			6									
			8									
			10									
				10.67								
				10.97					MUD Mangrove mud			
				-6.97								
				11.58					CLAY grey, hard			
				-7.58								
			12						CLAY SHALE hard			
				-8.19					END OF BOREHOLE @ 12.19 m			
			14									
			16									
			18									
			20									

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GAP gINT FN. F01a
RL3

REPORT OF BOREHOLE: RN139211

SHEET: 4 OF 4

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363207.0 m E 8136330.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 66.00 m

DRILL RIG: Rotary/Mud
CONTRACTOR: Ingham Drilling
LOGGED: DATE:
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			60						Silty CLAY grey/yellow			
				62.00								
			62						SLATE dark grey			
			64									
			66						END OF BOREHOLE @ 66.00 m			
			68									
			70									
			72									
			74									
			76									
			78									
			80									

REPORT OF BOREHOLE: RN11000049

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364381.0 m E 8135741.0 m N MGA94 56
SURFACE RL: 5.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 36.00 m

DRILL RIG: Bourne 1500R Rotary Rig
CONTRACTOR:
LOGGED: DATE: 21/10/81
CHECKED: DATE:

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	5.00					Sandy Silty CLAY dark brown		
				2.50							
				2.50					Sandy CLAY yellow/brown		
				4.50							
				0.50					Clayey SAND fine grained		
				6.00							
				-1.00					Sandy CLAY multi-coloured		
				8.00							
				-3.00					SAND fine to coarse grained		
				10.00							
				-5.00					Gravelly SAND medium to coarse grained		
				13.00							
				-8.00					CLAY mid grey		
				15.50							
				-10.50					GRAVEL fine to medium, sandy, some clay layers		

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: RN11000049

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364381.0 m E 8135741.0 m N MGA94 56
SURFACE RL: 5.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 36.00 m

DRILL RIG: Bourne 1500R Rotary Rig
CONTRACTOR:
LOGGED: DATE: 21/10/81
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						GRAVEL fine to medium, sandy, some clay layers			
			22									
			24									
			26									
			28									
			30	*30.50* -25.50					CLAY yellow/brown			
			32									
			34									
			36	-31.00					END OF BOREHOLE @ 36.00 m			
			38									
			40									

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
RL3

REPORT OF BOREHOLE: RN11000053

SHEET: 1 OF 3

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363204.0 m E 8134550.0 m N MGA94 56
SURFACE RL: 6.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 42.00 m

DRILL RIG: Bourne 1500R Rotary Rig
CONTRACTOR:
LOGGED: DATE: 30/10/81
CHECKED: DATE:

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	6.00					SAND fine to coarse grained		
				1.00							
				5.00					Sandy Silty CLAY very sandy in part, dark brown & grey		
			2								
			4	*4.50*							
				1.50					SAND fine to coarse grained		
			6	*6.00*							
				0.00					Sandy CLAY grey/brown		
			8								
				9.50							
				-3.50					Gravelly SAND fine to coarse grained		
			10								
			12								
			14	*14.50*							
				-8.50					Sandy CLAY grey/brown		
			16								
				18.00							
			18	-12.00					CLAY dark & light grey & brown		
			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
RL3

REPORT OF BOREHOLE: RN11000053

SHEET: 2 OF 3

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363204.0 m E 8134550.0 m N MGA94 56
SURFACE RL: 6.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 42.00 m

DRILL RIG: Bourne 1500R Rotary Rig
CONTRACTOR:
LOGGED: DATE: 30/10/81
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						CLAY dark & light grey & brown			
			22	22.50 -16.50					Sandy CLAY grey/brown			
			24									
				25.50 -19.50					Sandy GRAVEL fine to medium grained			
			26									
			28									
			30									
			32									
			34									
			36									
			38									
			40									

REPORT OF BOREHOLE: RN11000053

SHEET: 3 OF 3

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363204.0 m E 8134550.0 m N MGA94 56
SURFACE RL: 6.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 42.00 m

DRILL RIG: Bourne 1500R Rotary Rig
CONTRACTOR:
LOGGED: DATE: 30/10/81
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			40						Sandy GRAVEL fine to medium grained			
			42	-36.00					END OF BOREHOLE @ 42.00 m			
			44									
			46									
			48									
			50									
			52									
			54									
			56									
			58									
			60									

REPORT OF BOREHOLE: NS1

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
COORDS: 364282.0 m E 8135523.0 m N MGA94 56
DRILL RIG:

PROJECT: EIS Stage 1- Port Development
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: GEO Investigate

LOCATION: Northern Sands
INCLINATION: -90°
LOGGED: SRF DATE: 13/5/13

JOB NO: 1546223
HOLE DEPTH: 22.00 m
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00								
				5.60 -3.60					SEDIMENT (dredged)			
				6.70 -4.70					Silty CLAY			
				13.00 -11.00					SAND/ GRAVELLY SAND			

REPORT OF BOREHOLE: NS1

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364282.0 m E 8135523.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 22.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND/ GRAVELLY SAND			
			22	-20.00					END OF BOREHOLE @ 22.00 m			
			24									
			26									
			28									
			30									
			32									
			34									
			36									
			38									
			40									

REPORT OF BOREHOLE: NS4

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364107.0 m E 8135377.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 25.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00								
				5.00 -3.00					SEDIMENT (dredged)			
				6.00 -4.00					Silty CLAY			
				11.00 -9.00					SAND/ GRAVELLY SAND			
				18.00 -16.00					Silty CLAY			
				19.00 -17.00					SAND/ GRAVELLY SAND			

REPORT OF BOREHOLE: NS4

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364107.0 m E 8135377.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 25.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND/ GRAVELLY SAND			
			22									
			24									
				-23.00					END OF BOREHOLE @ 25.00 m			
			26									
			28									
			30									
			32									
			34									
			36									
			38									
			40									

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GAP gINT FN. F01a
RL3

REPORT OF BOREHOLE: NS5

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364201.0 m E 8135459.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 30.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00								
			2									
			4									
			6									
			8									
			10									
			12	*12.50* -10.50					SEDIMENT (dredged)			
			14	*14.00* -12.00					SAND/ GRAVELLY SAND			
			16									
			18									
			20									

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GAP gINT FN. F01a
RL3

REPORT OF BOREHOLE: NS5

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
COORDS: 364201.0 m E 8135459.0 m N MGA94 56
DRILL RIG:

PROJECT: EIS Stage 1- Port Development
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: GEO Investigate

LOCATION: Northern Sands
INCLINATION: -90°
LOGGED: SRF DATE: 13/5/13

JOB NO: 1546223
HOLE DEPTH: 30.00 m
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND/ GRAVELLY SAND			
			22									
			24									
			26									
			28									
			30	-28.00					END OF BOREHOLE @ 30.00 m			
			32									
			34									
			36									
			38									
			40									

REPORT OF BOREHOLE: NS6

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364007.0 m E 8135414.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 25.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00								
				5.00 -3.00					SEDIMENT (dredged)			
				7.00 -5.00					Silty CLAY			
				10.00 -8.00					SAND/ GRAVELLY SAND			

REPORT OF BOREHOLE: NS6

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364007.0 m E 8135414.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 25.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND/ GRAVELLY SAND			
			22									
			24									
				-23.00					END OF BOREHOLE @ 25.00 m			
			26									
			28									
			30									
			32									
			34									
			36									
			38									
			40									

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GAP gINT FN. F01a
RL3

REPORT OF BOREHOLE: NS7

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
COORDS: 363988.0 m E 8135529.0 m N MGA94 56
DRILL RIG:

PROJECT: EIS Stage 1- Port Development
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: GEO Investigate

LOCATION: Northern Sands
INCLINATION: -90°
LOGGED: SRF DATE: 13/5/13

JOB NO: 1546223
HOLE DEPTH: 30.00 m
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00								
			2									
			4	4.00 -2.00					SEDIMENT (dredged)			
				5.50 -3.50					Silty CLAY			
			6									
			8									
			10	10.00 -8.00					SAND/ GRAVELLY SAND			
			12									
			14									
				15.00 -13.00					Silty CLAY			
			16	16.00 -14.00					SAND/ GRAVELLY SAND			
			18									
			20									

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GAP gINT FN. F01a
RL3

REPORT OF BOREHOLE: NS7

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363988.0 m E 8135529.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 30.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND/ GRAVELLY SAND			
			22									
			24									
			26									
			28									
			30	-28.00					END OF BOREHOLE @ 30.00 m			
			32									
			34									
			36									
			38									
			40									

REPORT OF BOREHOLE: NS8

SHEET: 1 OF 2

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1- Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363893.0 m E 8135357.0 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 30.00 m

DRILL RIG:
CONTRACTOR: GEO Investigate
LOGGED: SRF DATE: 13/5/13
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	2.00								
				5.00								
				-3.00					SEDIMENT (dredged)			
				6.00								
			6	-4.00					Silty CLAY			
				9.00								
				-7.00					SAND/ GRAVELLY SAND			

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: NS8

SHEET: 2 OF 2

CLIENT: Flanagan Consulting Group
COORDS: 363893.0 m E 8135357.0 m N MGA94 56
DRILL RIG:

PROJECT: EIS Stage 1- Port Development
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: GEO Investigate

LOCATION: Northern Sands
INCLINATION: -90°
LOGGED: SRF DATE: 13/5/13

JOB NO: 1546223
HOLE DEPTH: 30.00 m
CHECKED: DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			20						SAND/ GRAVELLY SAND			
			22									
			24									
			26									
				27.00 -25.00					Silty CLAY			
			28									
			30	-28.00					END OF BOREHOLE @ 30.00 m			
			32									
			34									
			36									
			38									
			40									

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
RL3

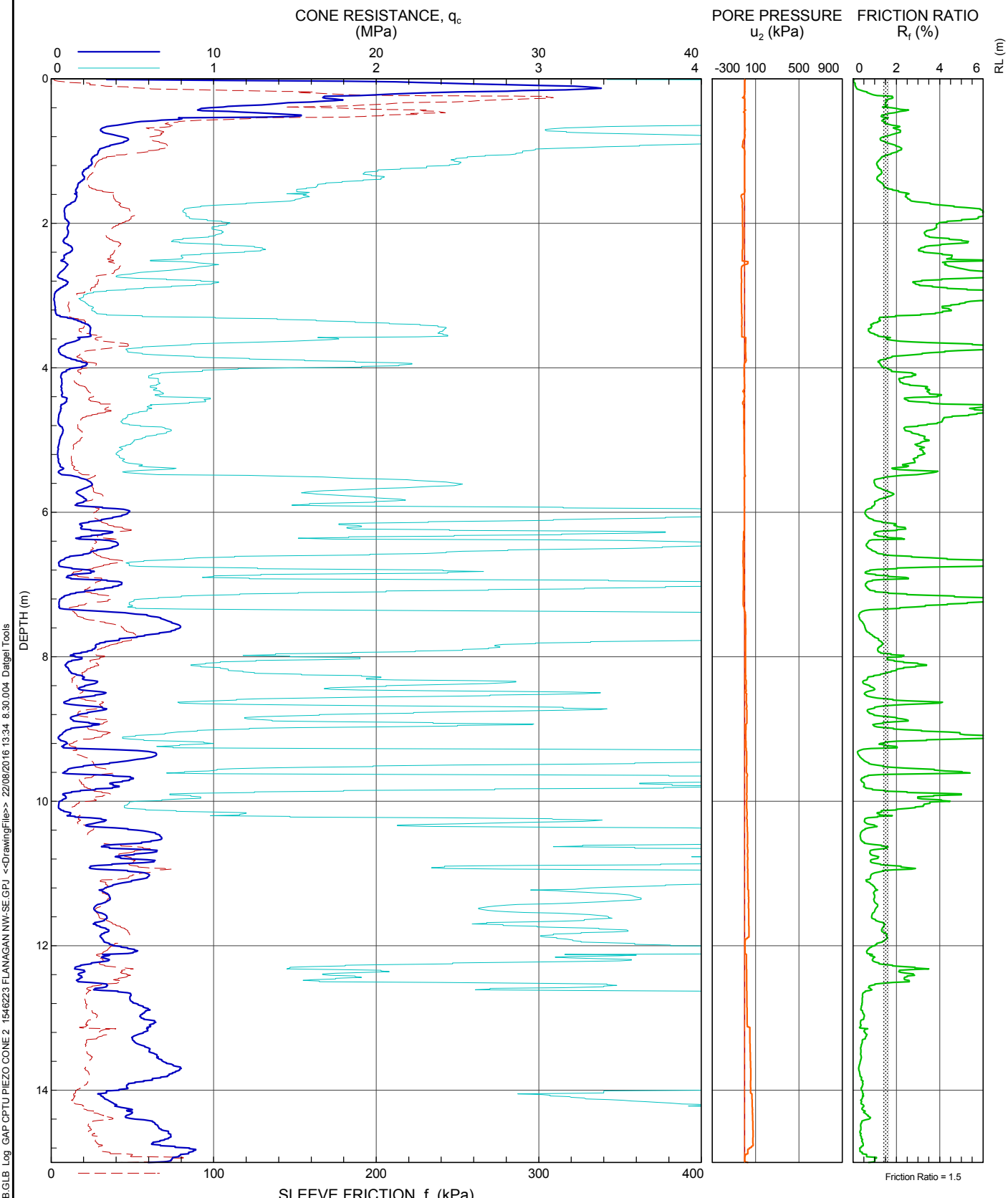
REPORT OF PIEZO-CONE PROBE: CTP11

SHEET: 1 OF 2
CONE No.:

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363759.0 m E 8135734.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 18.75 m

RIG:
CONTRACTOR: GEO Investigate
RECORDED: DATE:
CHECKED: DATE:



COMMENT:
Dissipation Test

This report of piezo-cone probe 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. F10
RL3

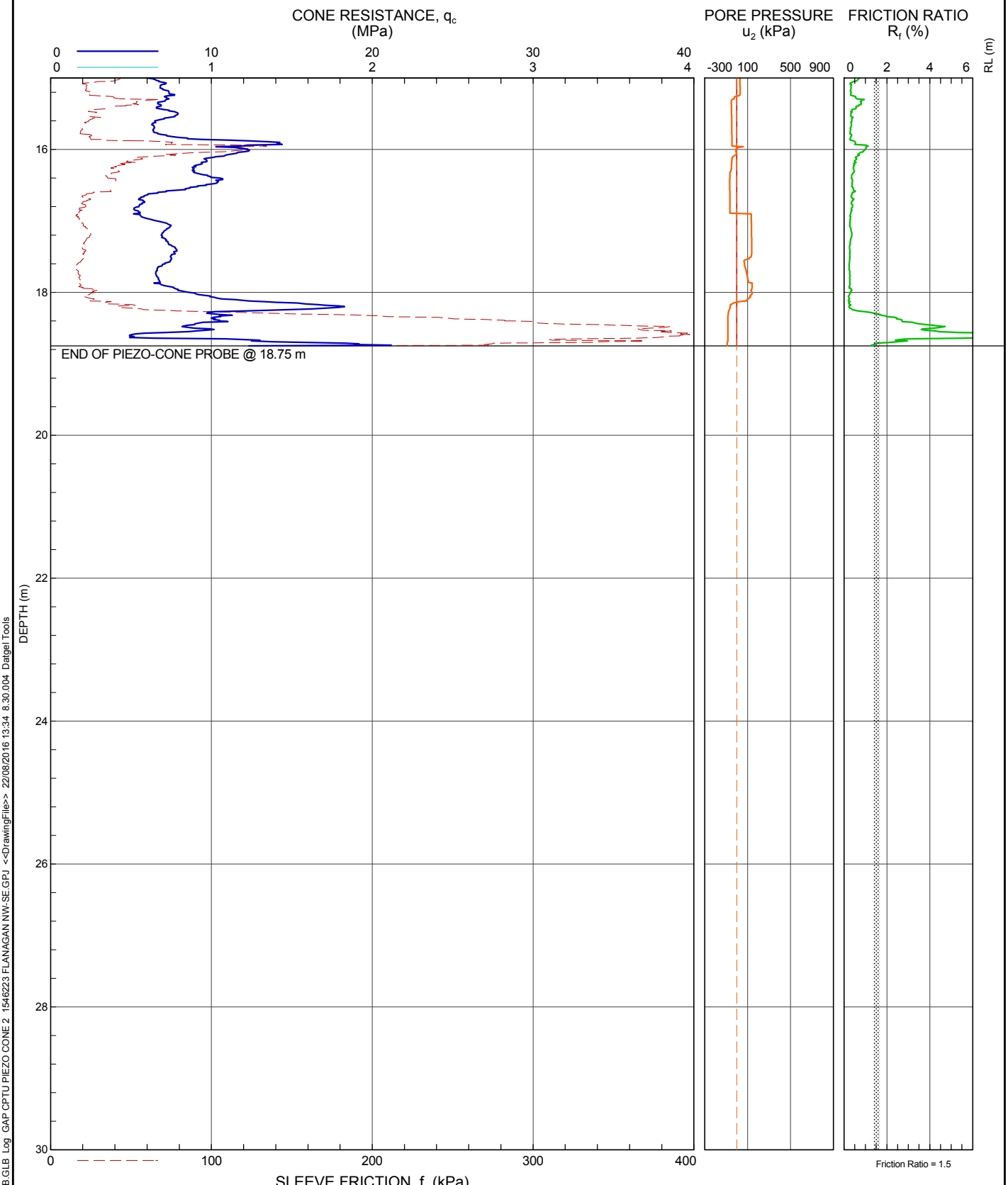
GAP 8_10.0 LIB.GLB Log GAP CPTU PIEZO CONE 2 1546223 FLANAGAN NW-SE.GPJ <<DrawingFile>> 22/08/2016 13:34 8.30.004 Datgel Tools

REPORT OF PIEZO-CONE PROBE: CTP11

SHEET: 2 OF 2
CONE No.:
RIG:
CONTRACTOR: GEO Investigate
RECORDED: DATE:
CHECKED: DATE:

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 363759.0 m E 8135734.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 18.75 m



COMMENT:
Dissipation Test

This report of piezo-cone probe 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. F10
RL3

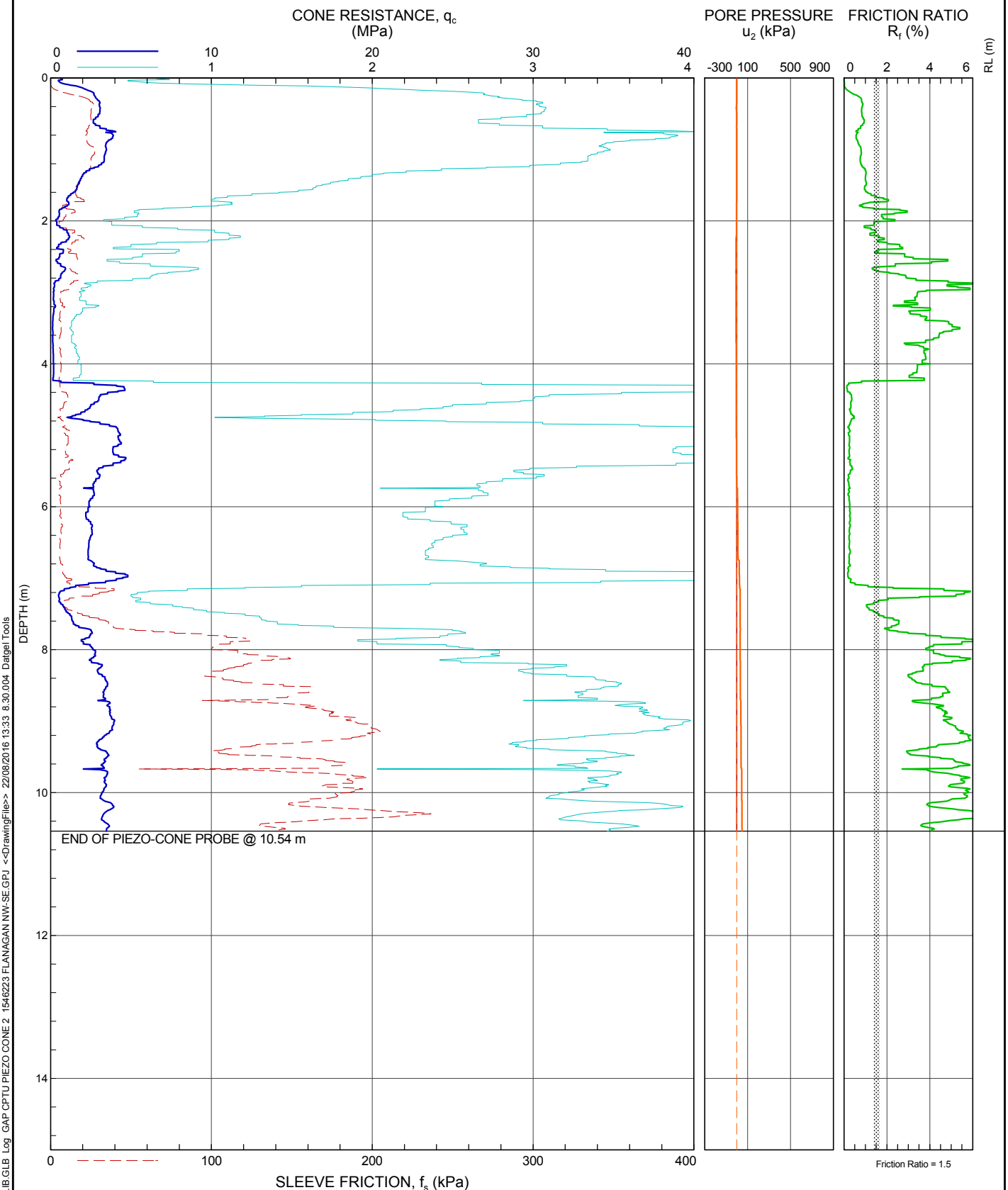
GAP 8_10.0 LIB.GLB Log GAP CPTU PIEZO CONE 2 1546223 FLANAGAN NW-SE.GPJ <<DrawingFile>> 22/08/2016 13:34 8.30.004 Datgel Tools

REPORT OF PIEZO-CONE PROBE: CPT27

SHEET: 1 OF 1
CONE No.:
RIG:
CONTRACTOR: GEO Investigate
RECORDED: DATE:
CHECKED: DATE:

CLIENT: Flanagan Consulting Group
PROJECT: EIS Stage 1 - Port Development
LOCATION: Northern Sands
JOB NO: 1546223

COORDS: 364225.0 m E 8135191.0 m N MGA94 56
SURFACE RL: DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 10.54 m



COMMENT:
Dissipation Test

This report of piezo-cone probe 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. F10
RL3

GAP 8_10.0 LIB.GLB Log GAP CPTU PIEZO CONE 2 1546223 FLANAGAN NW-SE.GPJ <<DrawingFile>> 22/08/2016 13:33 8.30.004 Datgel Tools

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT REPORTS

 FILL

 GRAVEL (GP or GW)

 SAND (SP or SW)

 SILT (ML or MH)

 CLAY (CL, CI or CH)

 ORGANIC SOILS (OL or OH or Pt)

 COBBLES or BOULDERS

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

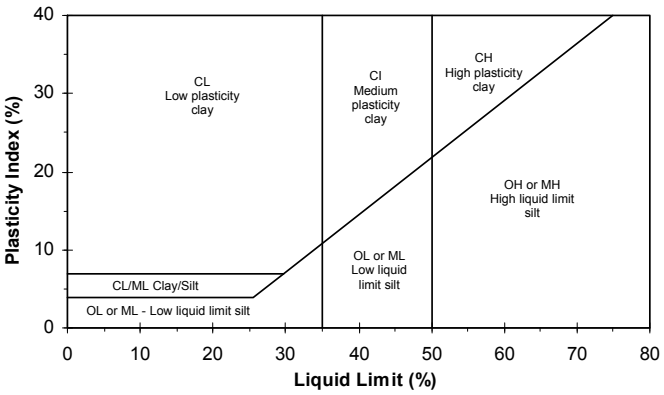
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

AS1726 - 1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726 - 1993

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

AS*	Auger Screwing	RD	Rotary blade or drag bit	NQ	Diamond Core - 47 mm
AD*	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V-Bit	RAB	Rotary Air Blast	HQ	Diamond Core - 63 mm
*T	TC-Bit, e.g. ADT	RC	Reverse Circulation	HMLC	Diamond Core – 63mm
HA	Hand Auger	PT	Push Tube	BH	Tractor Mounted Backhoe
ADH	Hollow Auger	CT	Cable Tool Rig	EX	Tracked Hydraulic Excavator
DTC	Diatube Coring	JET	Jetting	EE	Existing Excavation
WB	Washbore or Bailer	NDD	Non-destructive digging	HAND	Excavated by Hand Methods

PENETRATION/EXCAVATION RESISTANCE

L **Low resistance.** Rapid penetration possible with little effort from the equipment used.

M **Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.

H **High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.

R **Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (s_v = peak value, s_r = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests
DCP	Dynamic cone penetration test
CPT	Static cone penetration test
CPTu	Static cone penetration test with pore pressure (u) measurement

Ranking of Visually Observable Contamination and Odour (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

SCR = Solid Core Recovery (%)

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \text{Axial lengths of core} > 100 \text{ mm}}{\text{Length of core run}} \times 100$$

APPENDIX B

Important Information

IMPORTANT INFORMATION RELATING TO THIS REPORT

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

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