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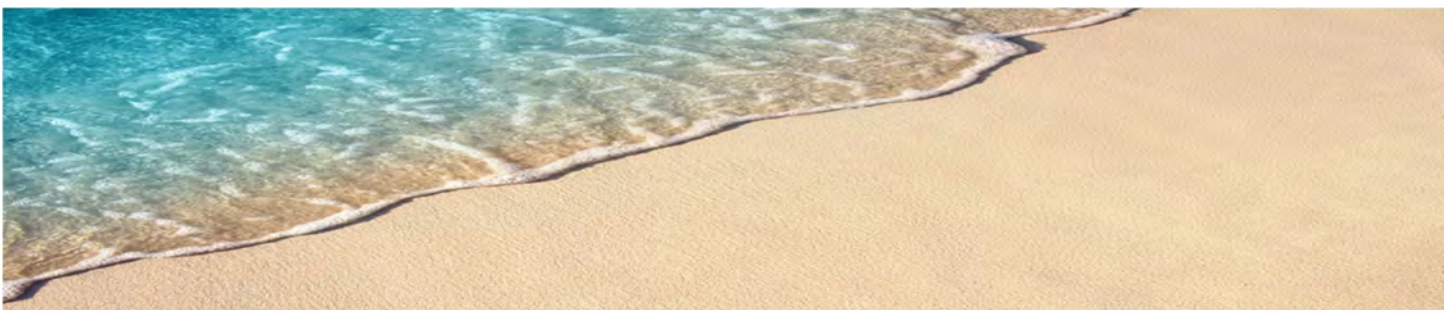
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TANTABIDDI BOATING FACILITY

Geotechnical Interpretive Report

Department of Transport

Report 2021-10-01





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Executive Summary

A geotechnical interpretive report has been prepared to satisfy the scope of work required for DOT404017c189 dated 1st September 2021.

The work entailed a review of the geotechnical factual report prepared by CMW Geosciences, entitled Tantabiddi Boating Facility, North West Cape WA, Factual Geotechnical Investigation Report, by CMW Geosciences for Department of Transport, Ref:PER2020-0495AG Rev1, dated 4th August 2021.

BATHYMETRY

The Tandabiddi Boat Facility is located within a near shore rock platform. The onshore beach slopes from about RL 3 mCD to RL 1 mCD at an average slope of 3V:20H. The nearshore rock platform level ranges from RL 0.5 mCD to RL -1.6 mCD.

SUB-SEABED PROFILE

Boreholes drilled by CME and hand probing by DoT within the footprint of the proposed facility show a relatively thin veneer of uncemented sediments (soil) over carbonate rock.

The sub-seabed ground conditions encountered comprise:

- GRAVEL/SANDY GRAVEL - 0m to 2.1m thickness (average 0.2m) of GRAVEL/SANDY GRAVEL; underlain by
- CARBONATE ROCK – Calcirudite/Calcisiltite/Calcarenite, typically medium to high strength in the top 3m to 4m, becoming weaker (very low to medium strength) below. Uncemented sediments (SAND) was encountered at BH02 (5.2m to 6.4m) and BH12 (2.5m to 3.2m, end of hole).

We note that the presence of CLAY was encountered, but its presence appears to be minor, and is not expected to influence the behaviour of the material whether in situ or dredged.

DREDGABILITY

Dredging abrasivity was assessed, and excessive abrasion is not considered to be a major concern for dredging.

Excavability assessment indicates the rock material ranges from Easy Dig to Extremely to Very Hard Ripping, with most of the data in the Easy Ripping and Hard Ripping range. Some of the data (2 out of 31) is marginal requiring the equivalent of blasting (BH13 location at RL-0.79mCD and RL-1.67mCD), with a few of the data (3 out of 31) being very hard ripping. No strength data was provided at levels below RL-1.67mCD at BH13 and therefore hard dredging may be encountered at this location and surrounds.

The rock is expected to be dredgeable with cutter suction dredgers (CSD) of suitable horsepower and equipped with rock cutting teeth. Typically the larger the cutter suction dredger is, the stronger the rock it can cut, however the shallow depth of water may preclude the use of large CSD's. Smaller suitably equipped dredges with sufficient cutting power may be suitable.

Alternatively the rock may be excavated using shallow draft backacter dredgers (backhoe dredgers) that can be fitted with both ripping tools and buckets. These would be supported by suitable small tugs/workboats and dumb barges for transporting the spoil to shore where it can be unloaded by excavator at a temporary materials offloading facility (MOF). Locally available shallow draft backacter dredgers with breakout capability of 30t are available, These can also be fitted with rock breakers.

Any dredging contract specification should ensure that either of the above methods will be considered acceptable..

DREDGE SPOIL

The dredge spoil will be carbonate in nature and will be equivalent to a Sandy Gravel with fines. The fines will be produced as part of the dredging (cutting) process. There also will be fines content in the infill of the voids and vughs within the carbonate rock mass.

Any Silt traps incorporated into spoil disposal areas for the purpose of retaining the fines and thereby reducing turbidity in the discharge receiving waters should be located well beyond proposed buildings and other settlement sensitive structures and within areas designated for less settlement sensitive infrastructure such as carparks.

PILING

Two different pile types were considered: driven piles and drilled and grouted piles. Axial and lateral pile design parameters are presented.

Driven Piling

Driven piling may encounter issues with early refusal in the stronger units within the rock mass. A pile driving shoe would need to be used.

An alternative iterative process can be considered by driving the piles, followed by drilling and then re-driving the piles. However this is a very difficult and costly method of achieving the desired penetration depth.

Drilled and Grouted Piling

In light of recent successful experience with the use of grouted Roto-piling for Geraldton Port Enhancement Project (7m pile penetration), Exmouth Harbour

Upgrade (10m+ penetration), and other coastal projects, we recommend that Roto-piling (screw drilled and grouted pile technique) should be considered for the project.

Drilled and grouted piling (e.g. Roto-piling or conventional rock socket) may encounter hole collapse. We note that no hole collapse is recorded in CMW (2021). Water and muds are injected into the drill pipe during the drilling process to flush the cuttings created by the bit and to reduce heat produced at the drill head, but mud was not used for hole support, and the holes were drilled predominantly using seawater as the drilling fluid.

BREAKWATER

The breakwater crest level is at about +5mCD with base level of 0mCD. Breakwater maximum batter is 1V:1.5H.

The sub-seabed conditions should provide adequate foundation support for proposed breakwaters embankments at Tantabiddi Boat Facility. Settlement is unlikely given the thin layer of uncemented sediments (sandy gravel) overlying rock. Any settlement will likely occur during construction.

1. INTRODUCTION

Objective

This report presents an interpretation of the results of a geotechnical investigation completed by CMW Geosciences for Department of Transport for the proposed Tantabiddi Boat Facility. The objectives of the geotechnical investigation were to evaluate the subsurface conditions at the exploratory locations within the perimeter of the proposed Tantabiddi Boat Facility, as well as to provide geotechnical information and recommendations for use in planning, design and construction of the facility. There is an existing Boat Ramp at the Tantabiddi site.

Project Understanding

Tantabiddi Boat Ramp precinct is of regional significance and is a gateway to the Ningaloo Reef tourism and recreational experiences. The ramp is on the west side of the North West Cape at the mouth of the Tantabiddi Creek and can be impacted during rain events and cyclones. These impacts can result in build-up of sand and restricted access for boat launching. In addition, there is an ongoing operational issue with congestion which leads to conflict between commercial operators and recreational users for access at this facility.

The DoT has been tasked to provide technical assistance regarding the suitability of a new location for a facility. Presently the preferred position of a new facility is located approximately 250m south of the existing site.

Three preliminary concepts for a new boating facility have been developed and supported for use initially in key stakeholder engagement and then wider community engagement. It is expected that the concept will evolve and be refined to reflect stakeholder and community input.

The concepts comprise the following options:

1. OPTION WITH PASSENGER TRANSFER JETTIES, OPTION 7B-2
 - Dredge Basin Area 25,300 m², Overall Breakwater Length 505 m
 - 3no. boat ramps, Commercial Loading Wharf, Tender/Dinghy Holding Jetties, Passenger Transfer Jetties
2. OPTION WITH BOAT PENS, OPTION 9B
 - Dredge Basin Area 47,700 m², total dredge volume excluding over dredging allowance 156,000 m³, Overall Breakwater Length 645 m
 - 3no. boat ramps, 40no. boat pens, Commercial Loading Wharf, Small Boat Loading Wharf

3 OPTION 10C

- Similar to Option 9B with staged development

The Dredge Basin and approach channel will be dredged to a depth of RL -2.65mCD for all options. Plans of the above options are shown in APPENDIX A – Tantabiddi Concept Plans.

SCOPE OF WORK

The geotechnical scope of work as proposed in scope DOT404017c189 dated 1st September 2021 comprised:

1. Conduct a technical review of the Factual Geotechnical report prepared by CMW Geosciences for the following key elements:
 - Dredgability of the material within the proposed channel and basin noting preferred dredging methodology
 - Suitability of dredge spoil for use as fill for the onshore earthworks
 - Pile driving for the proposed marine structures
 - Stability of the proposed breakwaters
2. Prepare an Interpretive report based on the technical review undertaken.
3. Attend a meeting to review and discuss the report recommendations

2. FIELDWORK

CMW Geoscience conducted a geotechnical site investigation for the proposed Tantabiddi Boat Facility in 2021. The fieldwork and results are presented in CMW (2021).

The objectives of the geotechnical investigation were to provide information to support:

- Confirmation of the geotechnical conditions within the entrance channel alignment and the protected basin;
- Assessment of dredge conditions and suitability of dredge spoil for use as fill in the proposed car/trailer parking area and other areas of fill needed for this development;
- Confirmation of the geotechnical stability of the breakwaters and revetments

The fieldwork comprised the drilling of 10 diamond cored marine boreholes, denoted BH01 to BH04, BH08, BH10 to BH13 and BH16, to target depths of either 7.0m or 3.0m below Chart Datum (CD), with boreholes drilled up to 7.5m depth below seabed level. Operational photographs were taken and provided for reference in CMW (2021). The boreholes were advanced using HQ3 triple tube coring with Standard Penetration Tests (SPT's) conducted at 1.5m intervals were deemed

appropriate in soil. Engineering logs associated field testing and photographs of the core trays are presented in CMW (2021).

All soil and rock types intersected were logged according to the Unified Soil Classification System and the Australian Standard Rock Strength Classification System (AS 1726). Borehole logs are presented in Appendix B.

Probing

Hand probing and sampling was carried out by DoT at different locations within the proposed boating facility precinct, as shown in Appendix B. The aim of this work was to ascertain the thickness of the sediment layer overlying the rock basement.

LABORATORY TESTING

Laboratory testing was carried out on selected samples obtained during the field investigation, and the results are presented in CMW (2021). The testing program consisted of the following:

- determination of the unconfined compressive strength (UCS);
- determination of point load index (I₅ (50));
- determination of Brazilian tensile strength (BTS)
- bulk density
- particle size distribution tests (wet sieve)
- calcium carbonate content
- Chechar Abrasivity Index

A summary of the laboratory test results is presented in Table 1. Test certificates are presented in CMW (2021).

Comparison of the strength test data indicate the following strength classification for the carbonate rock under AS 1726:

- Is₅₀ values of 0.16MPa to 8.61MPa, give Low to Very High strength. The average Is₅₀ is 2.2MPa and median is 1.3MPa, indicating a High Strength rock on average.
- UCS values of 1.94MPa to 23.9MPa, predominantly Low to Medium strength, The average UCS is 11.7MPa and median is 12.3MPa, indicating a Medium strength rock on average.
- BTS values of 0.6MPa to 3.3MPa. If we consider BTS values to be equivalent of Is₅₀ values, the material is predominantly Medium to High strength rock.

Pairs of UCS and Is₅₀ or BTS results on appropriate adjacent depth samples are plotted below in order to derive a simple correlation between UCS and Is₅₀ or BTS. The linear regression curve fit shown gives a constant of about 5.6 which is a typical value for a weak coastal carbonate rock material found in Western Australia:

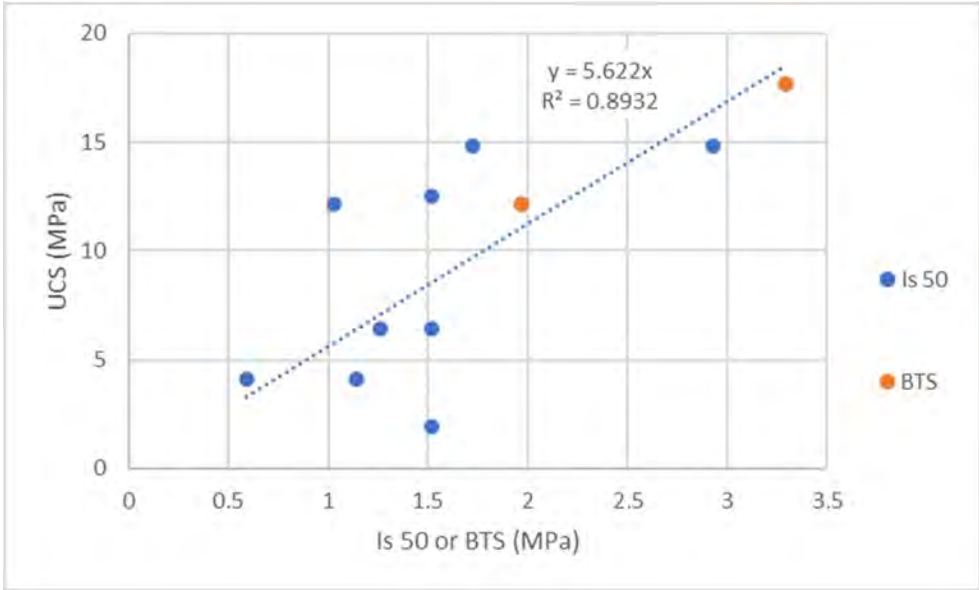


Figure 1: Correlation between UCS and Is50 or BTS

Table 1: Summary of Borehole Results

| Borehole BH | Start Depth | End Depth | Mid-Depth | Seabed Level | Sample RL | Material | USCS | 100 | 75 | 37.5 | 19 | 9.5 | 4.75 | 2.36 | 1.18 | 0.6 | 0.425 | 0.3 | 0.15 | 0.075 | CaCO3 | Cerchar Abrasivity Index | Bulk Density | Brazilian Indirect Tensile | Maximum UCS | Point Load Index, Is50 | |
|-------------|-------------|-----------|-----------|--------------|-----------|--------------------------|------|-----|-----|------|----|-----|------|------|------|-----|-------|-----|------|-------|-------|--------------------------|--------------|----------------------------|-------------|------------------------|------|
| | m bgl | m bgl | m bgl | m AHD | m AHD | | | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | % | CA | t/m3 | MPa | MPa | MPa | |
| 12 | 0.24 | 0.36 | 0.3 | -1.7 | -2 | CALCIRUDITE | | | | | | | | | | | | | | | | | | | | | 1.35 |
| 12 | 1 | 1.1 | 1.05 | -1.7 | -2.75 | CALCIRUDITE | | | | | | | | | | | | | | | | | | | | | 1.16 |
| 1 | 0.6 | 0.74 | 0.67 | -1.24 | -1.91 | CALCISILTITE | | | | | | | | | | | | | | | | | | | | | 2.93 |
| 1 | 1.7 | 2 | 1.85 | -1.24 | -3.09 | CALCISILTITE | | | | | | | | | | | | | | | | | 2.24 | | 14.96 | | |
| 1 | 2.4 | 2.5 | 2.45 | -1.24 | -3.69 | CALCISILTITE | | | | | | | | | | | | | | | | | | | | | 1.72 |
| 1 | 3.3 | 3.4 | 3.35 | -1.24 | -4.59 | CALCISILTITE | | | | | | | | | | | | | | | | | | | | | 0.16 |
| 1 | 7 | 7.2 | 7.1 | -1.24 | -8.34 | CALCISILTITE | | | | | | | | | | | | | | | | | | | | | 3.19 |
| 2 | 0.3 | 0.4 | 0.35 | -1.31 | -1.66 | CALCARENITE | | | | | | | | | | | | | | | | | | | | | 1.03 |
| 2 | 0.4 | 0.7 | 0.55 | -1.31 | -1.86 | CALCISILTITE | | | | | | | | | | | | | | | 100 | | 1.95 | | 12.14 | | |
| 2 | 0.7 | 0.8 | 0.75 | -1.31 | -2.06 | CALCISILTITE | | | | | | | | | | | | | | | | | 1.89 | 1.97 | | | |
| 2 | 1.4 | 1.5 | 1.45 | -1.31 | -2.76 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 0.59 |
| 2 | 2.75 | 2.95 | 2.85 | -1.31 | -4.16 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | 98.9 | | 2.05 | | 4.14 | | |
| 2 | 4.9 | 5 | 4.95 | -1.31 | -6.26 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 1.14 |
| 2 | 6.6 | 6.7 | 6.65 | -1.31 | -7.96 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 0.73 |
| 3 | 0.23 | 0.36 | 0.295 | -1.33 | -1.625 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 1.02 |
| 3 | 0.4 | 0.5 | 0.45 | -1.33 | -1.78 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | 1.98 | 1.76 | | | |
| 3 | 0.54 | 0.68 | 0.61 | -1.33 | -1.94 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | 97.2 | | | | | | 1.52 |
| 3 | 0.8 | 1 | 0.9 | -1.33 | -2.23 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | 0.35 | 1.87 | | 1.94 | | |
| 3 | 2.4 | 2.7 | 2.55 | -1.33 | -3.88 | CALCISILTITE | | | | | | | | | | | | | | | 100 | | 2.04 | | 12.54 | | |
| 3 | 4 | 4.3 | 4.15 | -1.33 | -5.48 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | 1.93 | | 6.44 | | |
| 3 | 6.3 | 6.4 | 6.35 | -1.33 | -7.68 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 1.26 |
| 13 | 0.1 | 0.3 | 0.2 | -1.6 | -1.8 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | 98.2 | | | | | | 8.61 |
| 13 | 1 | 1.15 | 1.075 | -1.6 | -2.675 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 4.09 |
| 13 | 0 | 1.35 | 0.675 | -1.6 | -2.275 | CALCISILTITE/CALCARENITE | | | | 100 | 64 | 40 | 29 | 24 | 20 | 16 | 14 | 11 | 4 | 2 | | | | | | | |
| 16 | 1.5 | 1.8 | 1.65 | -2.1 | -3.75 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | 2.52 | | 23.91 | | |
| 16 | 2.3 | 2.4 | 2.35 | -2.1 | -4.45 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 3.88 |
| 4 | 0.5 | 0.6 | 0.55 | -1.57 | -2.12 | CALCARENITE | | | | | | | | | | | | | | | 95.7 | 1.13 | | | | | 4.72 |
| 4 | 0.6 | 1.15 | 0.875 | -1.57 | -2.445 | CALCARENITE | | | | | | | | | | | | | | | | | | | | | |
| 4 | 1 | 1.15 | 1.075 | -1.57 | -2.645 | CALCARENITE | | | | | | | | | | | | | | | 99 | | | | | | |
| 4 | 2.28 | 2.35 | 2.315 | -1.57 | -3.885 | CALCARENITE | | | | | | | | | | | | | | | | | 1.7 | 0.64 | | | 1.31 |
| 8 | 0 | 1.6 | 0.8 | -1.57 | -2.37 | SANDY GRAVEL | GP | | 100 | 74 | 29 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | |
| 8 | 1.6 | 2 | 1.8 | -1.57 | -3.37 | CALCISILTITE/CALCARENITE | | | | | | | | | | | | | | | | | | | | | 0.87 |
| 10 | 0.5 | 0.7 | 0.6 | -3.4 | -4 | CALCARENITE | | | | | | | | | | | | | | | | | 2.25 | | 17.7 | | |
| 10 | 0.7 | 1 | 0.85 | -3.4 | -4.25 | CALCARENITE | | | | | | | | | | | | | | | 84.5 | | 2.26 | 3.29 | | | |
| 11 | 0.3 | 0.5 | 0.4 | -3.01 | -3.41 | CALCARENITE | | | | | | | | | | | | | | | | | | | | | 0.19 |

3. GEOLOGY, GEOMORPHOLOGY

Regional Setting

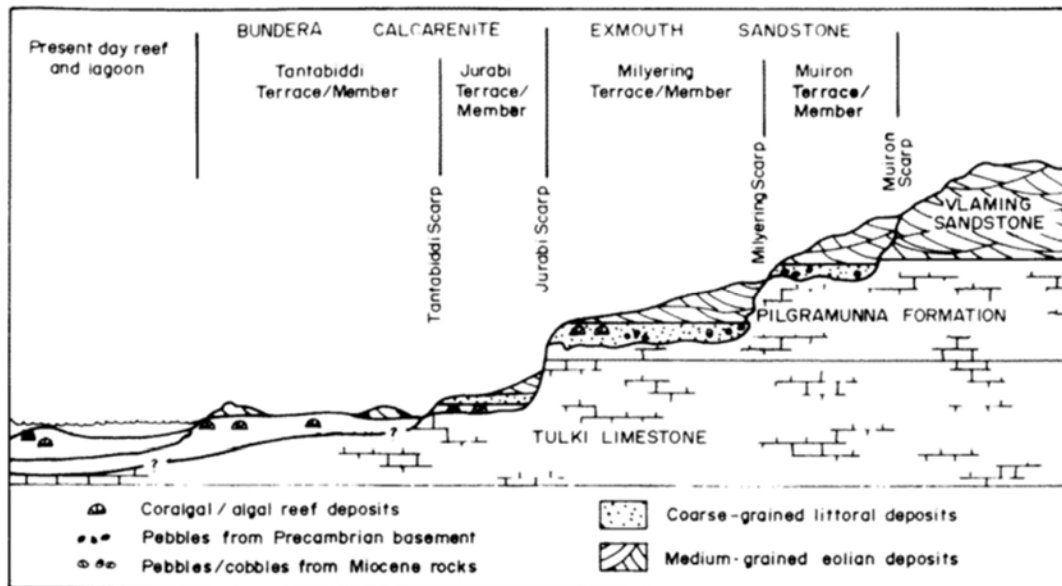
The Tantabiddi Boat Ramp precinct is on the west side of the North West Cape (approx. 15 km west from Exmouth) at the mouth of the Tantabiddi Creek. The project site opens to the Indian Ocean to the west, with the North West Cape hinterland to the east. The site is located in the southern portion of Jurabi Coastal Park.

Geological Setting

The Tantabiddi Boating Facility is located on the southern side of the Tantabiddi Creek mouth. The geology/geomorphology of the site, based on Wyroll et al (1993) and Collins et al (2000), comprises:

- Holocene coastal deposits – a complex of dune and beach sequences, predominantly sand; underlain by
- Tantabiddi Member (last interglacial) – emergent reef platform, dominant lagoon facies - the Tantabiddi Member is part of the Bunderra Calcrenite unit, and is underlain by
- Tulki Limestone.

Tantabiddi Creek potentially brings deposits of Quaternary alluvial sediments to the site. These sediments comprise fans and alluvial deposits, with dominance of coarse gravel conglomerate, some moderately to well cemented with calcrete development.



Wyroll et al (1993) Schematic Cross Section

Bathymetry

The Tandabiddi Boat Facility is located within a near shore rock platform. Information relating to bathymetry of the is shown in Appendix B. The onshore beach slopes from about RL 3 mCD to RL 1 mCD at an average slope of 3V:20H. The nearshore rock platform level ranges from RL 0.5 mCD to RL -1.6 mCD.

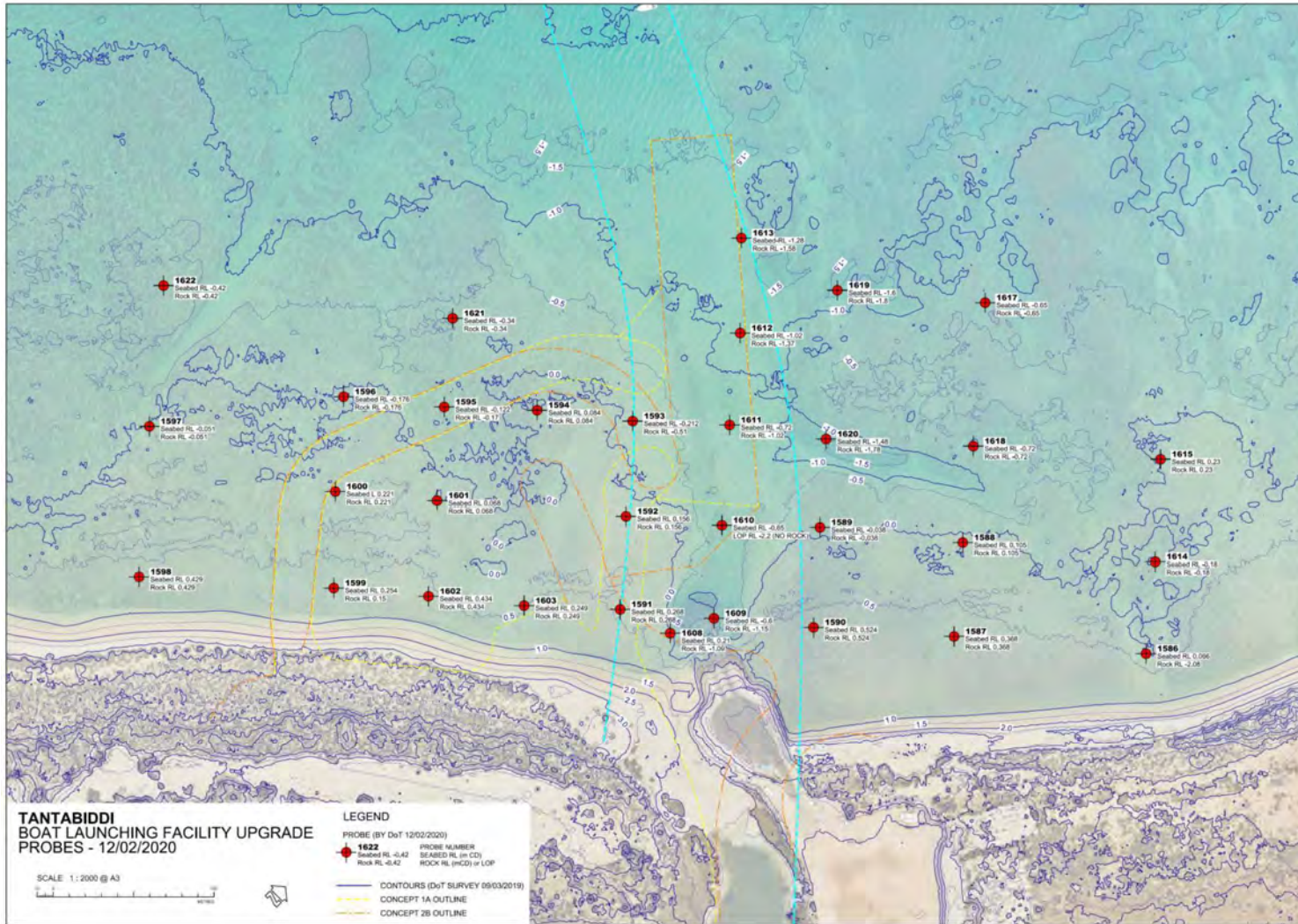


Figure 2: Probe Locations and Results

4. Subsurface Ground Conditions

Boreholes drilled by CMW and hand probing by DoT in the nearshore environment within the footprint of the proposed facility show a relatively thin veneer of uncemented sediments (soil) over carbonate rock.

The sub-seabed ground conditions encountered comprise:

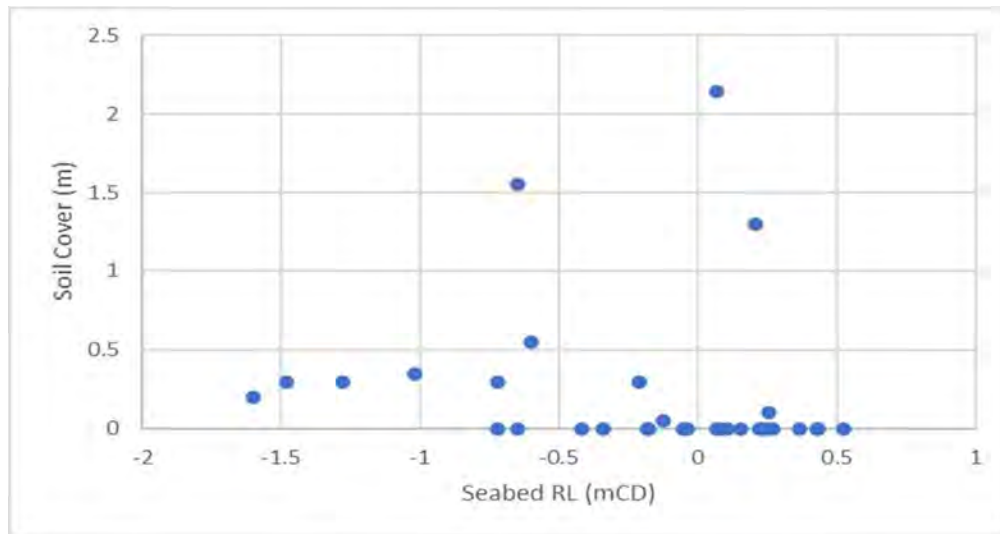
- GRAVEL/SANDY GRAVEL - 0m to 2.1m thickness (average 0.2m) of GRAVEL/ SANDY GRAVEL; underlain by
- CARBONATE ROCK – Calcirudite/Calcisiltite/Calcarenite, typically medium to high strength in the top 3m to 4m, becoming weaker (very low to medium strength) below. Uncemented sediments (SAND) was encountered at BH02 (5.2m to 6.4m) and BH12 (2.5m to 3.2m, end of hole). We have termed the rock as CARBONATE ROCK as nearly all but one of the carbonate content test result are above 90%. Also the two petrographic test results are 99%-100% calcite. The one Carbonate Content test result below 90% (84.5% for BH10, 0.7m-1.0m) would give a rock classification of “Siliceous” into the Calcarenite/Calcisiltite naming under the Clark & Walker carbonate sediments classification system.

The presence of CLAY was encountered and reported as follows:

- Trace of CLAY between 1.4m to 1.5m depth in BH01 bore log
- BH12 daily log states “clay/ sand-or soft clay was inferred from 2.70m based on the observations of the return flush; the borehole was terminated at 3.20m depth”. The geological cross-section shows BH12 as having CLAY from 2.7m to 3.2m depth, but the BH12 bore log has no CLAY present, and instead has “SAND (inferred): fine to coarse grained - inferred from drilling muds, leached calcarenite”.
- The petrographic analysis of BH4 sample 1.0m to 1.15m depth has sample as comprising 99% Calcite and 1% Clay.

The existence of CLAY appears to be minor, and is not expected to influence the behaviour of the material whether in situ or dredged.

The below figure presents the thickness of the Gravel/Sandy Gravel veneer plotted versus seabed RL for the water jet probe locations.



Cross Sections

Geotechnical cross sections from CMW (2021) are presented in Appendix A. The cross sections illustrate the relative position of the various soil/rock types. Note that the vertical RLs are presented relative to Australian Height Datum (AHD) in terms of RL datum mAHD rather than mCD.

5. DREDGING

Dredging Abrasivity

The two Cerchar Abrasivity (CA) tests gave results of “not very abrasive” and “medium to abrasive”. An alternative definition of the CA test results describes the results as “Not Abrasive” and “Very Slightly Abrasive”.

The carbonate content values range from 84.5% to 100%, while the two petrographic analyses give the sample at 99% and 100% calcite, with no free quartz.

On the above basis, excessive abrasion is not considered to be a major concern for dredging.

The CA tests and carbonate content tests correspond to 4 no. tests used to assess abrasivity. If core samples are still available, additional abrasivity-related testing may be undertaken although the samples may have dried out which is likely to result in increased the sample strength and therefore provide misleading results. Any further testing should focus on CA and calcium carbonate content covering the depth interval and area that is to be dredged.

Presence of Clay

There would appear to be some but minimal amount of clay in the material likely to be dredged however the small quantity identified should not pose any problems or issues..

Rippability

Dredging assessment was undertaken adopting the excavability assessment method of Pettifer and Fookes (1994) wherein the Is_{50} value and fracture spacing for the rock material is compared against field case histories of excavation. The limits for Dig, Easy Ripping, Hard Ripping, Extremely to Very Hard Ripping, and Blasting are presented on the the figure below. It is accepted that blasting will not be permitted in this locality therefore this term should be replaced with “Rock Breaking”.

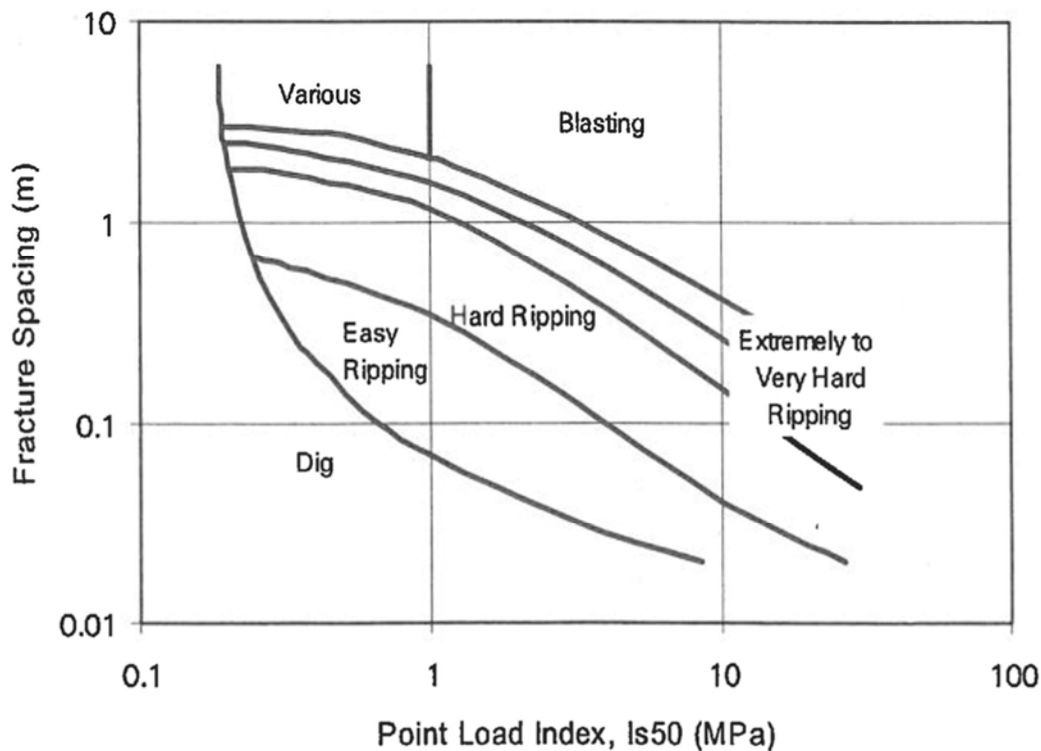


Figure 3: Excavability assessment method of Pettifer and Fookes based on Point Load Index and Fracture Spacing

The samples tested for Is_{50} , UCS and BTS were used. The fracture spacing for the samples was derived from the core photographs in CMW (2021). It is known that typically carbonate rock does not display fractures and jointing as exists in other rock types. But the fracturing of the rock during the drilling does indicate weak zones in the rock mass, that are likely to fracture during the dredging process. The rock break at the end of the drilling run or at at the 1m length (length of core tray) was not counted as a fracture in the assessment. The Is_{50} value was used directly. The BTS

was taken to be equivalent of an Is50 value. The UCS was converted to Is50 by dividing by 5.6 (correlation value).

The data are tabulated below, and the results are plotted next page. Also presented next page is the range of rock strength and fracture spacing based on the borehole logs – medium to high strength (Is50 of 0.3MPa to 3MPa) and 0.1m to 1m fracture spacing.

The plots indicate that the rock material ranges from Easy Dig to Extremely to Very Hard Ripping, with most of the data in the Easy Ripping and Hard Ripping range.

Table 2 Summary of all borehole data showing assessment of Is50 and Fracture Spacing

| BH | Depth Range (m) | | | Mid-Depth | Seabed RL | RL | Material | Is50 or BTS | Fracture Spacing m | Comment |
|-----------------|-----------------|----|------|-----------|-----------|-------|--------------------------|-------------|--------------------|------------------|
| | to | to | to | mCD | mCD | MPa | | | | |
| ALL DATA | | | | | | | | | | |
| 12 | 0.24 | to | 0.36 | 0.3 | -0.69 | -0.99 | Calcirudite | 1.35 | 0.1 | |
| 12 | 1 | to | 1.1 | 1.05 | -0.69 | -1.74 | Calcirudite | 1.16 | 0.1 | |
| 1 | 0.6 | to | 0.74 | 0.67 | -0.23 | -0.9 | Calcisiltite | 2.93 | 0.2 | |
| 1 | 1.7 | to | 2 | 1.85 | -0.23 | -2.08 | Calcisiltite | 2.65 | 0.3 | UCS / 5.6 |
| 1 | 2.4 | to | 2.5 | 2.45 | -0.23 | -2.68 | Calcisiltite | 1.72 | 0.2 | |
| 1 | 3.3 | to | 3.4 | 3.35 | -0.23 | -3.58 | Calcisiltite | 0.16 | 0.2 | |
| 1 | 7 | to | 7.2 | 7.1 | -0.23 | -7.33 | Calcisiltite | 3.19 | 0.2 | |
| 2 | 0.3 | to | 0.4 | 0.35 | -0.3 | -0.65 | Calcarenite | 1.03 | 0.5 | |
| 2 | 0.4 | to | 0.7 | 0.55 | -0.3 | -0.85 | Calcisiltite | 2.17 | 0.5 | UCS / 5.6 |
| 2 | 0.7 | to | 0.8 | 0.75 | -0.3 | -1.05 | Calcisiltite | 1.97 | 0.5 | BTS |
| 2 | 1.4 | to | 1.5 | 1.45 | -0.3 | -1.75 | Calcisiltite/Calcarenite | 0.59 | 0.1 | |
| 2 | 2.75 | to | 2.95 | 2.85 | -0.3 | -3.15 | Calcisiltite/Calcarenite | 0.74 | 1.0 | UCS / 5.6 |
| 2 | 4.9 | to | 5 | 4.95 | -0.3 | -5.25 | Calcisiltite/Calcarenite | 1.14 | 0.2 | |
| 2 | 6.6 | to | 6.7 | 6.65 | -0.3 | -6.95 | Calcisiltite/Calcarenite | 0.73 | 0.2 | |
| 3 | 0.23 | to | 0.36 | 0.295 | -0.32 | -0.62 | Calcisiltite/Calcarenite | 1.02 | 0.3 | |
| 3 | 0.4 | to | 0.5 | 0.45 | -0.32 | -0.77 | Calcisiltite/Calcarenite | 1.76 | 0.3 | BTS |
| 3 | 0.54 | to | 0.68 | 0.61 | -0.32 | -0.93 | Calcisiltite/Calcarenite | 1.52 | 0.3 | |
| 3 | 0.8 | to | 1 | 0.9 | -0.32 | -1.22 | Calcisiltite/Calcarenite | 0.35 | 0.5 | UCS / 5.6 |
| 3 | 2.4 | to | 2.7 | 2.55 | -0.32 | -2.87 | Calcisiltite | 2.24 | 0.6 | UCS / 5.6 |
| 3 | 4 | to | 4.3 | 4.15 | -0.32 | -4.47 | Calcisiltite/Calcarenite | 1.15 | 1.0 | UCS / 5.6 |
| 3 | 6.3 | to | 6.4 | 6.35 | -0.32 | -6.67 | Calcisiltite/Calcarenite | 1.26 | 0.1 | |
| 13 | 0.1 | to | 0.3 | 0.2 | -0.59 | -0.79 | Calcisiltite/Calcarenite | 8.61 | 0.5 | |
| 13 | 1 | to | 1.15 | 1.075 | -0.59 | -1.67 | Calcisiltite/Calcarenite | 4.09 | 1.0 | |
| 16 | 0 | to | 1.35 | 0.675 | -1.09 | -1.77 | Sandy Gravel | | | |
| 16 | 1.5 | to | 1.8 | 1.65 | -1.09 | -2.74 | Calcisiltite/Calcarenite | 4.27 | 0.5 | UCS / 5.6 |
| 16 | 2.3 | to | 2.4 | 2.35 | -1.09 | -3.44 | Calcisiltite/Calcarenite | 3.88 | 0.5 | |
| 4 | 0.5 | to | 0.6 | 0.55 | -0.33 | -0.88 | Calcarenite | 4.72 | 0.1 | |
| 4 | 1 | to | 1.15 | 1.075 | -0.33 | -1.41 | Calcarenite | | | |
| 4 | 2.28 | to | 2.35 | 2.315 | -0.33 | -2.65 | Calcarenite | 1.31 | 0.3 | |
| 8 | 0 | to | 1.6 | 0.8 | -0.56 | -1.36 | Sandy Gravel | | | |
| 8 | 1.6 | to | 2 | 1.8 | -0.56 | -2.36 | Calcisiltite/Calcarenite | 0.87 | 0.4 | |
| 10 | 0.5 | to | 0.7 | 0.6 | -2.39 | -2.99 | Calcarenite | 3.16 | 0.4 | UCS / 5.6 |
| 10 | 0.7 | to | 1 | 0.85 | -2.39 | -3.24 | Calcarenite | 3.29 | 0.4 | BTS |
| 11 | 0.3 | to | 0.5 | 0.4 | -2 | -2.4 | Calcarenite | 0.19 | 0.3 | |

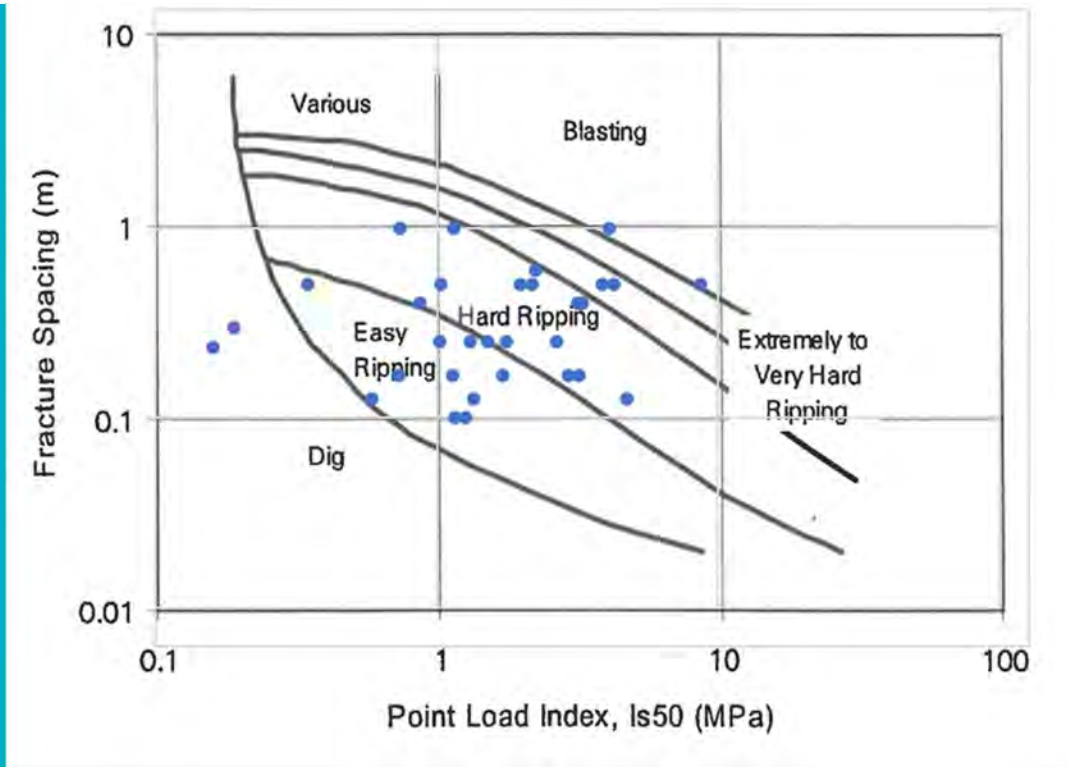


Figure 4: Analysis of dredgability based on Point Load Index and Fracture spacing based on Core Photographs – all boreholes

Point Load Index based on Laboratory test data and Fracture spacing based on review of core photographs

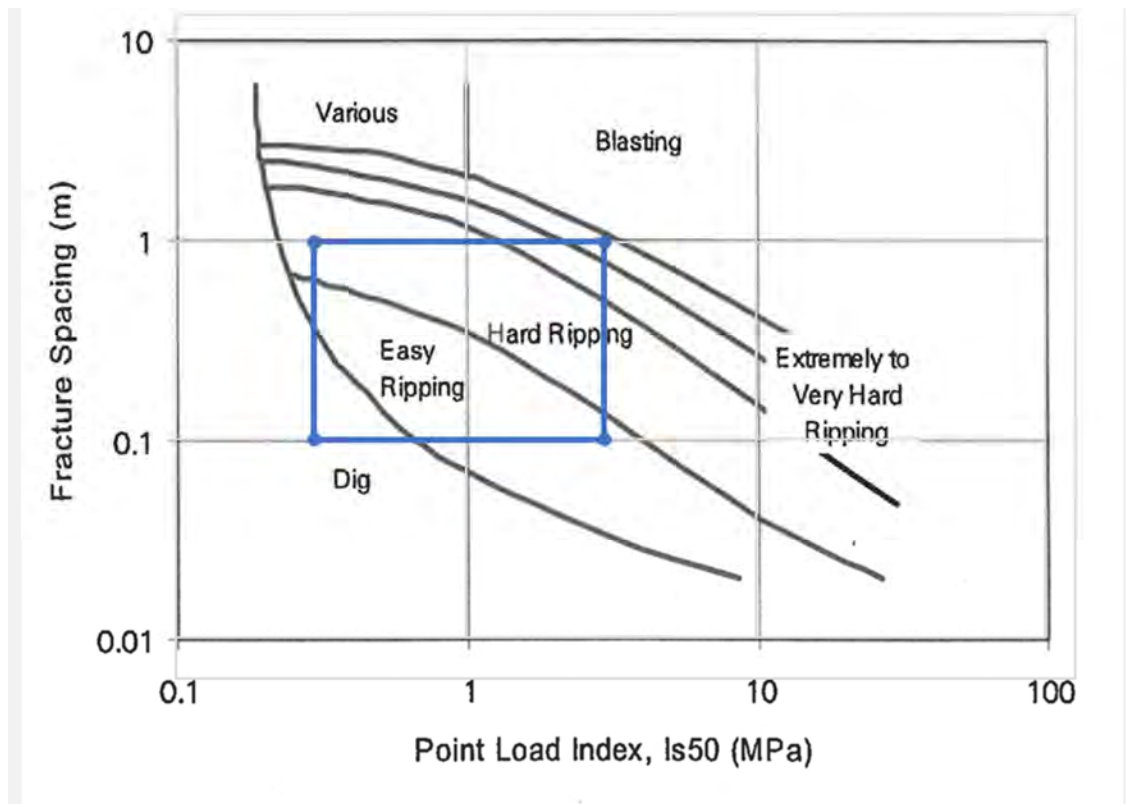


Figure 5: Dredgability range bounds based on all borehole logs

The dredged level for the Basin is RL-2.65mCD. Allowing for some overdredge, the laboratory test data for rock above RL-3.15mCD is plotted on the Pettifer and Fookes chart in Figure 6 below. This shows that most of the data falls within the Easy and Hard Ripping range except for BH13 which is at the entrance to the basin where hard ripping may be encountered. We note that at BH13, there is no strength data at levels between RL-1.67mCD and RL-3.15mCD, and therefore hard dredging may be encountered at this location and nearby.

Dredgability analysis for the boreholes that fall within the dredge areas (approach channel and basin) are also plotted on the Pettifer and Fookes Chart in Figure 7 where the individual boreholes are labelled.

The rock is expected to be dredgeable by cutter suction dredgers fitted with rock cutting teeth or by shallow draft backhoe dredgers. Typically the larger the cutter suction dredger is, the stronger the rock it can cut, but depth of water may preclude the use of large plant. Suitable plant and expertise is available locally within Western Australia..

An analysis of the power requirements for the variable material that is expected to be encountered is shown in Appendix C – Estimate Dredge Plant Power Requirements.

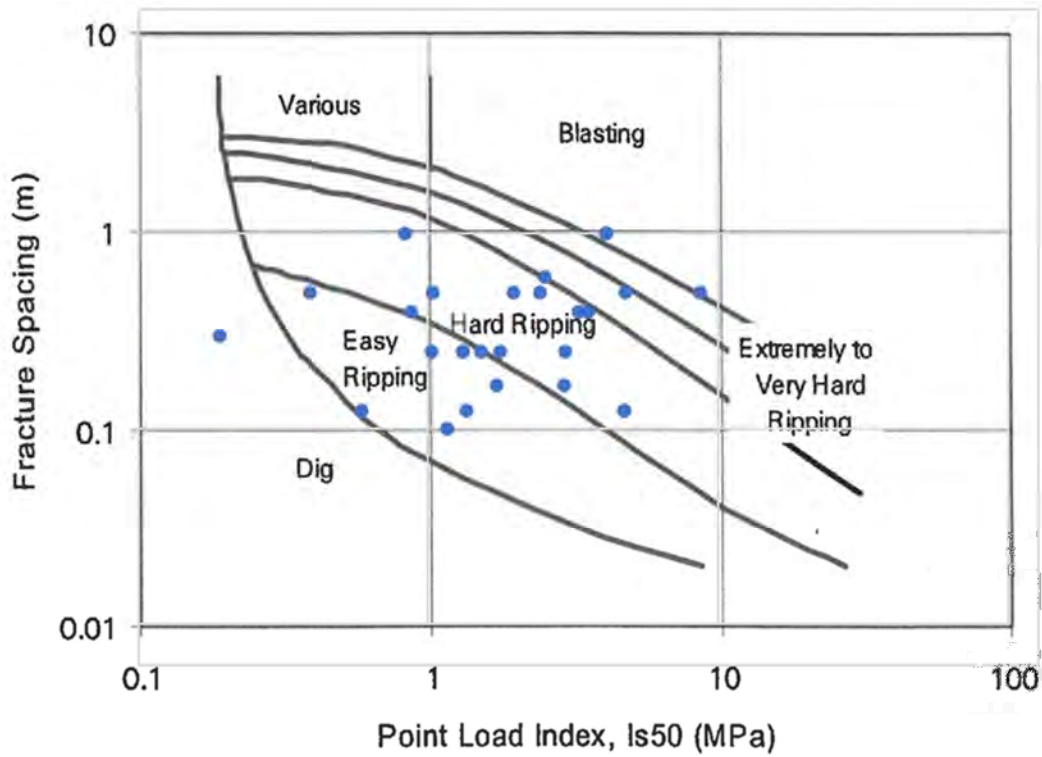


Figure 6: Analysis of dredgability based on those boreholes which terminated above RL -3.15

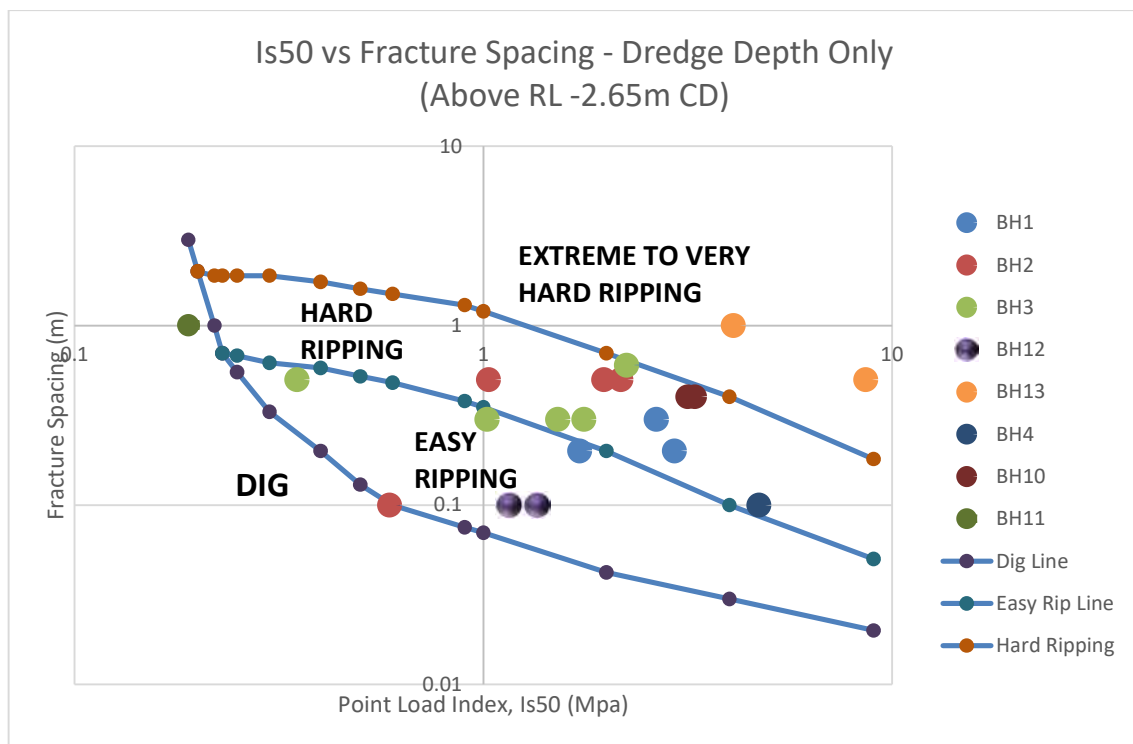


Figure 7: Dredgability analysis for boreholes within the dredge areas

Transects along the approach channel and along the harbour basin showing the dredge depth and borehole information are shown in APPENDIX B – Borehole, Probe Locations and Transects.

Bulking Factor

It is estimated that rock excavated with a cutter suction dredge will have a bulking factor of up to 1.3, while equipment that leaves the rock more intact such as a backhoe dredge will result in a bulking factor of up to 1.2.

The bulking factor for uncemented sediments can be assumed to be unity.

These bulking factors assume that the rock material is broken into discrete particles, and along with uncemented sediments, will be in a loose state after hydraulic placement.

The bulking factors are based on the difference in measured/assessed density of the in situ material to that expected post dredging. For the rock and gravel/sand at Tantabiddi, a bulking factor of 1.3 is a typical median value for these materials given in Table 2.3 of Guidelines for the beneficial use of dredged material, by T.N. Burt, Report SR 488, dated November 1996. Also the bulking factor of up to 1.3 is typical of the increase in rock volume for fragmentation by various dredger types (e.g. cutter suction, bucket wheel, bucket, dipper, backhoe) given in BS 6439-5, “Maritime structures — Part 5: Code of practice for dredging and land reclamation”.

For the soft rock and limited thickness of gravel/sand at the Tantabiddi site,.

If compaction is possible post placement, then the equivalent bulking factor will reduce. A reduction in bulking factor value of 10% may be possible.

6. RECOMMENDATIONS FOR RE-USE OF DREDGE SPOIL

There are a number of considerations if the Basin is to be excavated by dredging and the spoil used as fill for future developments. The work of Soil & Rock Engineering (1995) for the Exmouth Boat Harbour has been examined in deriving these recommendations.

Spoil Material Type

The dredge spoil will be carbonate in nature and is expected to be the equivalent of a Sandy Gravel with fines. Fines will be produced as part of the dredging (cutting) process. There also will be fines content in the infill of the voids and vughs within the carbonate rock mass.

Silt Traps

Silt traps are normally incorporated into dredging contracts to retain the fines and reduce turbidity in the discharge receiving waters. It is recommended that the silt traps be located well beyond proposed buildings and other settlement sensitive structures and within in areas designated for less settlement sensitive infrastructure such as carparks etc. It is also recommended that as large an area as possible is used as a silt trap such that the fines can be contained in a relatively thin layer rather than in a small deep pocket. Containing these materials in a thin layer over a large area will maximise the drying times of any cohesive materials and options for the landuse of this area at a later date.

7. FUTURE DEVELOPMENT

Hydraulic Fill

The nature of hydraulic fill operations are such contols are needed to manage the placement and compaction of materials. Settlement ponds can be managed such that fines (clay/mud size fractions) can be collected at one end and subsequently removed if necessary.

Where the excavation of the Basin is carried out by dredging, it is recommended that the placed fill is thoroughly investigated to the full depth of the fill, in order to assess foundation conditions for buildings, before buildings are designed and constructed. Boreholes with Standard Penetration Testing (SPT) at 1.5 m depth intervals and/or cone penetrometer testing (CPT) are appropriate methods of investigation in this regard.

Fill Placed by Other Means

In the event that dredging is undertaken by backhoe dredgers and spoil transferred to shore by barge then transferred to the fill site, it is recommended that the spoil is spread in layers (minimum layer thickness of 150 mm pre-compaction) and each layer compacted to achieve a minimum density ratio of 92% Modified Compaction as determined by AS 1289. 5. 2. 1.

Proof Compaction

After the site has been filled to the satisfaction of the Supervising Engineer, by either method (dredged spoil or dry excavation) the surface of the site should be proof compacted using a heavy, self-propelled, smooth drum vibrating roller capable of operating in variable frequency modes. A Dynapac CA 511, or equivalent, is recommended (subject to the protection of adjacent structures from damaging ground vibrations).

The following proof compaction procedure is recommended:

- (i) The entire site should be given a minimum of 4 coverages with the roller operating in the low frequency /high amplitude mode. A coverage is defined as overlapping passes with a minimum overlap of 20%;
- (ii) the site should then be given an additional minimum of 4 coverages with the roller operating in the high frequency/low amplitude mode;
- (iii) all weak areas, that deform excessively under rolling, should be removed and replaced with clean sand satisfying the structural fill requirements.
- (iv) on completion of vibratory rolling, 2 coverages of the site should be made with the roller operating in a static mode. This will compact the sands in the upper 300mm, that were disturbed by cyclic mobility.

It is recommended that the proof compaction be supervised by an Engineer, experienced in earthworks.

Selection Requirements for Structural Fill - Cohesionless

The following information is provided in the event the finished surface is to be covered by a layer of structural fill prior to development. For this study, cohesionless structural fill has been defined as sand fill satisfying the following criteria:

- (i) containing less than 5% by weight of soil fractions finer than 0.075mm; and
- (ii) having a plasticity index equal to 0%, (i.e. non plastic).
- (iii) Any sand used for structural filling should comply with the following:
- (iv) The sand shall be clean, cohesionless, free draining and free of all silty, organic or any other deleterious inclusions;
- (v) the sand shall contain no more than 5% (by weight) of fractions finer than 0.075mm; and
- (vi) the ratio of the maximum to minimum density shall be greater than 1.20. The maximum and minimum densities shall be determined in accordance with test AS 1289. 5. 5 .1.

The Perth Sand Penetrometer can be used for compaction control of sands complying with the above criteria.

It is recommended that a 25 kg representative sample(s) of the proposed structural fill be delivered to a NATA registered Testing Authority at least one week before approval is required.

8. GEOTECHNICAL DESIGN STRENGTHS

Based on the borehole and laboratory results, the following design geotechnical parameters for foundation analysis were derived.

Bearing Capacity

Geotechnical design strength parameters for in situ materials are given in the following table:

| Material | Total Unit Weight (kN/m ³) | Submerged Unit Weight (kN/m ³) | Strength |
|----------------------|--|--|--|
| Uncemented Sediments | 18 | 8 | Friction Angle of 30deg |
| Carbonate Rock | 20 | 10 | UCS value of 12MPa (average) 8.5MPa (median) 2.2MPa (15-percentile) |

Pile Axial Design

The skin friction and end bearing values are based on 15-percentile UCS of 2.2MPa. Geotechnical design strength parameters for pile axial design are the following. :

| Material | Submerged Unit Weight (kN/m ³) | Driven Pile Skin Friction (kPa) | Grouted Pile Skin Friction (kPa) | End Bearing |
|----------------------|--|--|--|--|
| Uncemented Sediments | 8 | N/A | N/A | N/A |
| Carbonate Rock | 10 | 150 (Compression) 100 (Tension) Assume first 1m into rock has only half the above values | 500 (Compression) 300 (Tension) Assume first 1m into rock has only half the above values | 4.5 UCS = 10MPa, applied on the pile toe steel rim |

Note that pile uplift (tension) loading also needs to check against failure by pullout cone of the rock mass, Assume a 90deg pullout cone apex angle. The pullout cone failure mode may limit the tensile (uplift) capacity of the piling.

Pile Lateral Design

Floating jetty structures require only lateral capacity. Tests on ungrouted roto piles conducted at Two Rocks marina where there is presence of limestone rock at or near the surface (ie thin layer of overlying unconsolidated sediments) revealed that the apparent point of fixity was approximately 1.25m below the rock level. This is due to the fact that the annulus between the rock wall and the outside of the pile was not filled by either sediment or grout. If the annulus is sand filled or filled the apparent point of fixity will be at or just above rock level depending upon the depth of unconsolidated material overlying the rock..

Geotechnical design strength parameters for pile lateral design are the following:

| Material | Submerged Unit Weight (kN/m ³) | Strength |
|----------------------|--|---|
| Uncemented Sediments | 8 | Friction Angle of 30deg ($c'=0$) |
| Carbonate Rock | 10 | UCS value of 2.2MPa (15-percentile) Undrained shear strength, S_u of 1.1MPa. Also perform a check analysis assuming a friction angle of 40deg ($c'=0$) for the Carbonate Rock |

Geotechnical Reduction Factor

Geotechnical strength reduction factors shall be based on AS2159 – Australian Piling Code. AS2159 allows for increase in the reduction factor is appropriate pile load testing is undertaken. If no pile testing is undertaken then a geotechnical strength reduction factor of 0.45 will apply.

9. PILE DESIGN

Two different pile types were considered: driven piles and drilled and grouted piles.

It is anticipated that driving difficulty will be encountered, particularly in driving raking piles since those piles are normally required to be installed deeper than the vertical piles.

An alternative iterative process can be considered by driving the piles, followed by drilling and then re-driving the piles. However this is a very difficult and costly method of achieving the desired penetration depth.

In light of recent successful experience with the use of grouted Roto-piling for Geraldton Port Enhancement Project (7m pile penetration), Exmouth Harbour Upgrade (10m+ penetration), and other coastal projects, we recommend that Roto-piling (screw drilled and grouted pile technique) should be considered for the project.

Driven Piling

Driven piling may encounter issues with early refusal in the stronger units within the rock mass. A pile driving shoe would need to be used.

Drilled and Grouted Piling

Drilled and grouted piling (e.g. Roto-piling or conventional rock socket) may encounter hole collapse. We note that no hole collapse is recorded in CMW (2021). Water and muds are injected into the drill pipe during the drilling process to flush the cuttings created by the bit and to reduce heat produced at the drill head, but mud was not used for hole support, and the holes were drilled predominantly using seawater as the drilling fluid.

Uplift Loading

If large tension (uplift) loads are envisaged and therefore long length of pile, the maximum depth of investigation was only 7.5m, and no geotechnical data exists below that depth. Refer to the borehole logs for the depth of investigation at specific locations.

Uplift load capacity of piling may be limited by pullout cone failure and this needs to be checked along with usual skin frictional resistance.

Uplift or tension capacity will only be required for fixed jetty structures that may be subject to berthing loads or uplift due to wave forces if the deck level is low and can be impacted by waves in adverse conditions. In these situations it is recommended that the roto piles are grouted.

10. RECOMMENDATIONS FOR PILE INSTALLATION

Piling Contractor

Piling Contractors (Contractor) should be selected carefully by DoT. It is recommended that the Contractors should provide the following programs for DoT review, prior to any piling work

- proposed procedure for splicing/welding of steel piles;
- test pile work method statement;
- pile driving, drilling and grouting equipment;
- pile installation sequence;
- pile driving proposal including hammer energy to be used and proposed driving set to achieve ultimate driving resistance for driven piles; and
- cement grouting technique for drilled and grouted piles.

Pile Load Testing (Test Pile Installation)

Where piles are to be used for fixed jetties then to confirm the design pile length and pile size, a pile testing program is recommended to be performed which involves PDA testing for driven piles and PDA testing or static pile testing for drilled and grouted piles.

It is recommended that the Contractor should record and provide the results of the pile load tests to DoT. Should a test pile fail to meet the load test requirements, the contractor must notify the DoT or its representative immediately and await instructions.

It is also recommended that the test results of pile deflection/load measured during the test should be verified by a geotechnical engineer.

Where piles are to be used for floating structures then it is recommended that 3% of the piles are subject to a lateral loading test with the load to be applied at a level of 0.6m above HAT.

Installation of Driven Piles

We recommend the Contractor shall survey the position of all pile locations using a licensed surveyor and provide the DoT with a copy of survey results. The record shall include the relevant information listed below

- number of blows required for each 250mm length of pile driven;
- sea bed level;
- toe level;
- temporary compression over the last 10 blows;
- time driving commences and ceases; and
- any stoppages and reasons for stoppages.

Temporary compression traces shall be taken over the last 10 blows on every pile driven and shall be submitted with the record. The Contractor shall also record the length from the underside of the pile cap or platform beam to the toe of the pile.

Installation of Drilled and Grouted Piles

In light of recent successful experience with the use of grouted Roto-piling for Geraldton Port Enhancement Project (7m pile penetration), Exmouth Harbour Upgrade (10m+ penetration), and other coastal projects, we recommend that Roto-piling (screw drilled and grouted pile technique) should be considered for the project.

11. BREAKWATER

The sub-seabed conditions should provide adequate foundation support for proposed breakwaters embankments at Tantabiddi Boat Facility.

The breakwater crest level is approximately RL +5mCD with base level of 0mCD. Breakwater maximum batter is 1V:1.5H. For a factor of safety of 1.5, the required rock mass UCS value for the foundation is less than 100kPa which is achievable.

Given the ground conditions, any settlement will be negligible and will likely occur during construction of the breakwater. Estimated overall settlements are in the order of 5mm to 10mm for breakwater placed directly on rock foundation. The greatest thickness of uncemented sediments encountered was about 1.6m (BH08, Sandy Gravel), and its presence would increase overall settlement by a further 10mm at this location.

Placement of breakwater fill also may self-weight penetrate into the layer of uncemented sediment (0m to 2.1m thickness, average 0.2m) above rock. For this it is prudent to allow potentially an extra 50mm to 100mm thickness of breakwater fill required for placement.

Global stability requirements for the breakwater is also not expected to be an issue at this location.

12. REFERENCES

AS 1289.5.2.1:2017 Methods of testing soils for engineering purposes, Method 5.2.1: Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort.

AS 1289.5.5.1-1998 Methods of testing soils for engineering purposes, Method 5.5.1: Soil compaction and density tests - Determination of the minimum and maximum dry density of a cohesionless material - Standard method.

AS 1726:2017 Geotechnical site investigations

CMW (2021) Tantabiddi Boating Facility, North West Cape WA, Factual Geotechnical Investigation Report, by CMW Geosciences for Department of Transport, Ref:PER2020-0495AG Rev1, dated 4th August 2021.

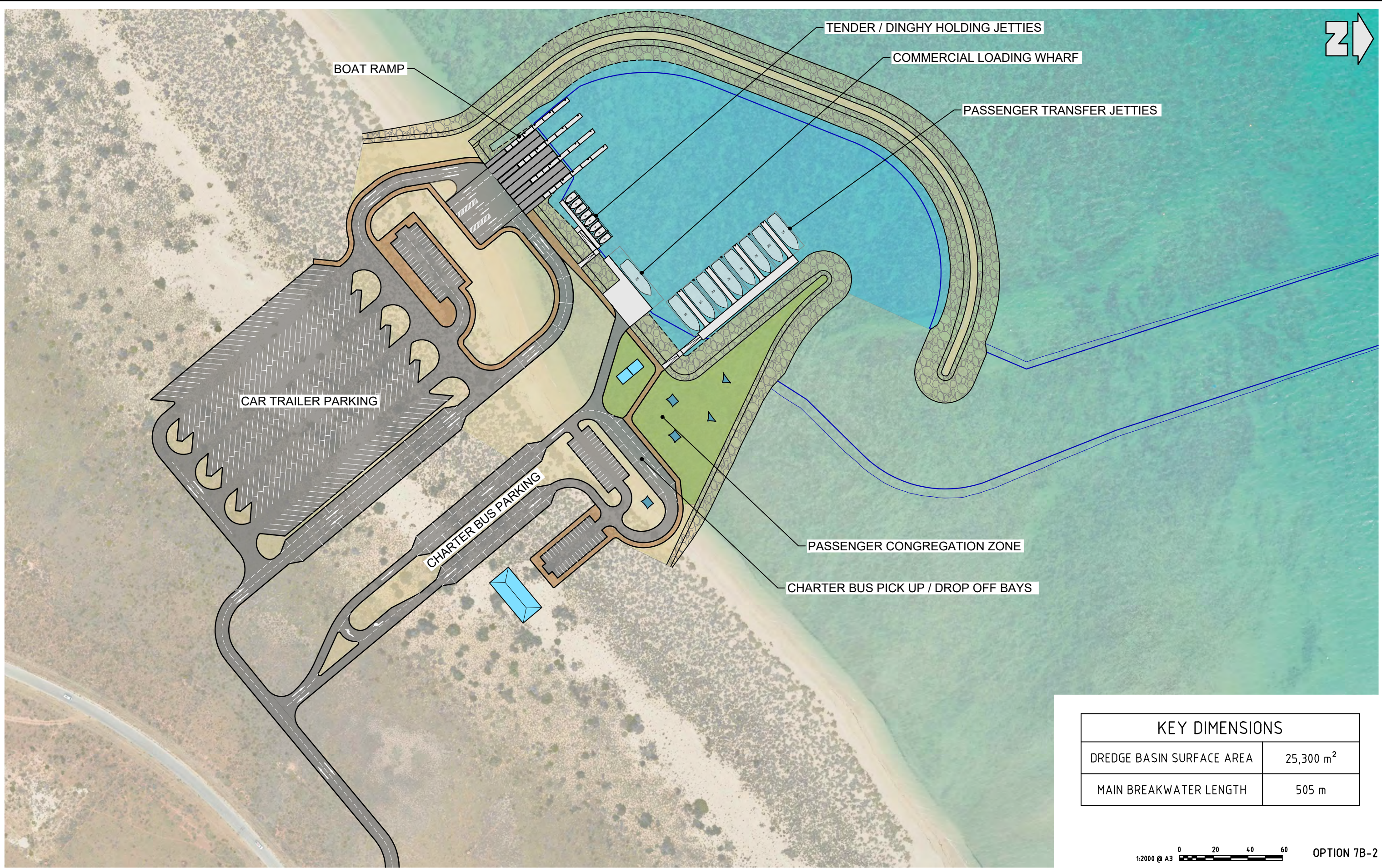
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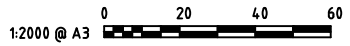
Soil & Rock Engineering (1995) Exmouth Boat Harbour and Quarry Site, Geotechnical Investigation, Report prepared for Coastal and Facilities Management, Department of Transport, Fremantle. Ref: 3611/00/CL, dated 27 March, 1995.

Wyrwoll K-H, Kendrick G, Long JA (1993) The geomorphology and Late Cenozoic geomorphological evolution of the Cape Range-Exmouth Gulf region. In: Humphreys W F 1993 (eds) The biogeography of Cape Range, Western Australia. Records of the Western Australian Museum, Supplement No.45, 1993.

13. APPENDIX A – Tantabiddi Concept Plans

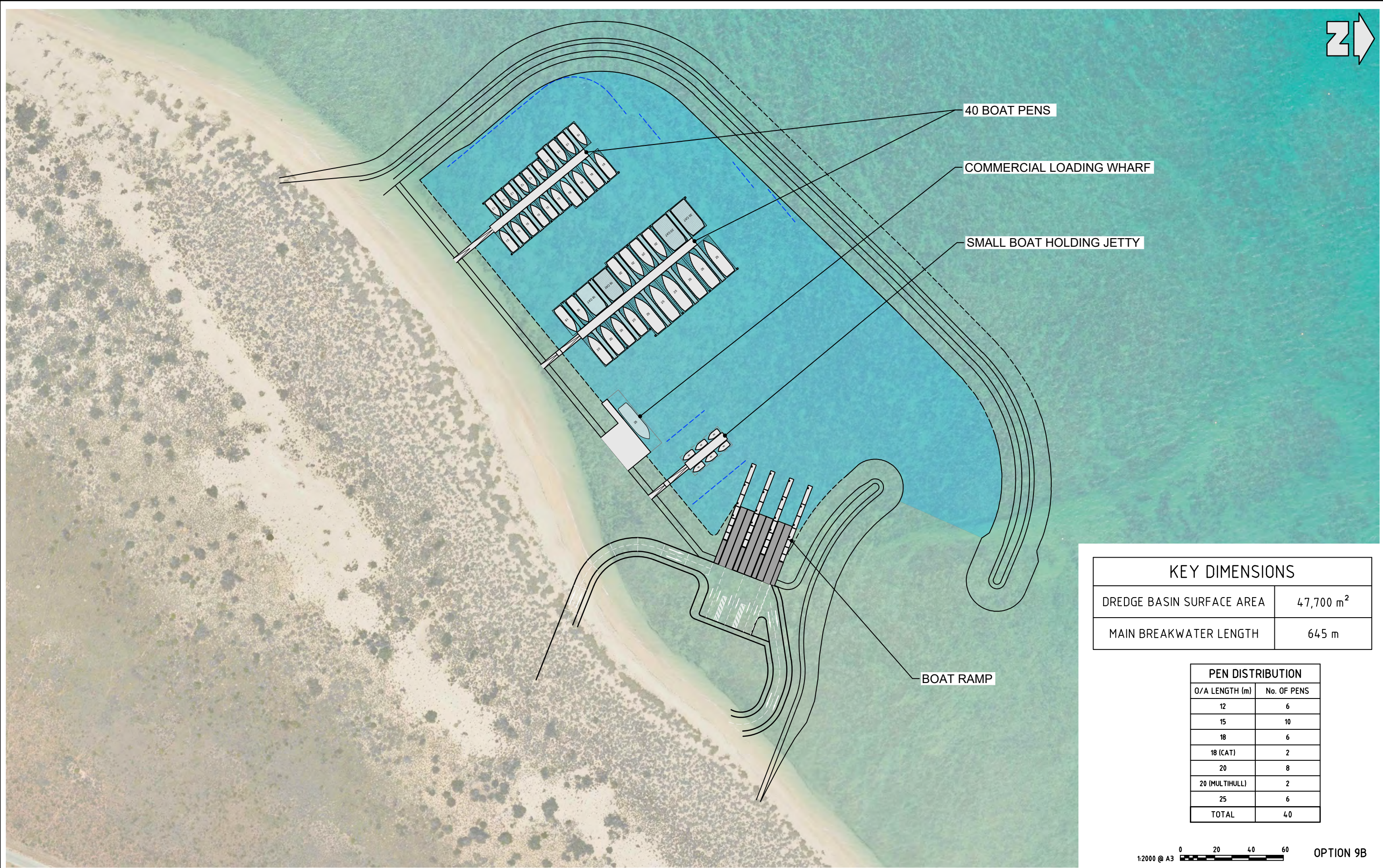


| KEY DIMENSIONS | |
|---------------------------|-----------------------|
| DREDGE BASIN SURFACE AREA | 25,300 m ² |
| MAIN BREAKWATER LENGTH | 505 m |



OPTION 7B-2

TANTABIDDI BOATING FACILITY UPGRADE
 OPTION WITH PASSENGER TRANSFER JETTIES
 OPTION 7B-2



40 BOAT PENS

COMMERCIAL LOADING WHARF

SMALL BOAT HOLDING JETTY

BOAT RAMP

| KEY DIMENSIONS | |
|---------------------------|-----------------------|
| DREDGE BASIN SURFACE AREA | 47,700 m ² |
| MAIN BREAKWATER LENGTH | 645 m |

| PEN DISTRIBUTION | |
|------------------|-------------|
| O/A LENGTH (m) | No. OF PENS |
| 12 | 6 |
| 15 | 10 |
| 18 | 6 |
| 18 (CAT) | 2 |
| 20 | 8 |
| 20 (MULTIHULL) | 2 |
| 25 | 6 |
| TOTAL | 40 |

1:2000 @ A3 OPTION 9B

TANTABIDDI BOATING FACILITY UPGRADE
 OPTION WITH BOAT PENS
 OPTION 9B

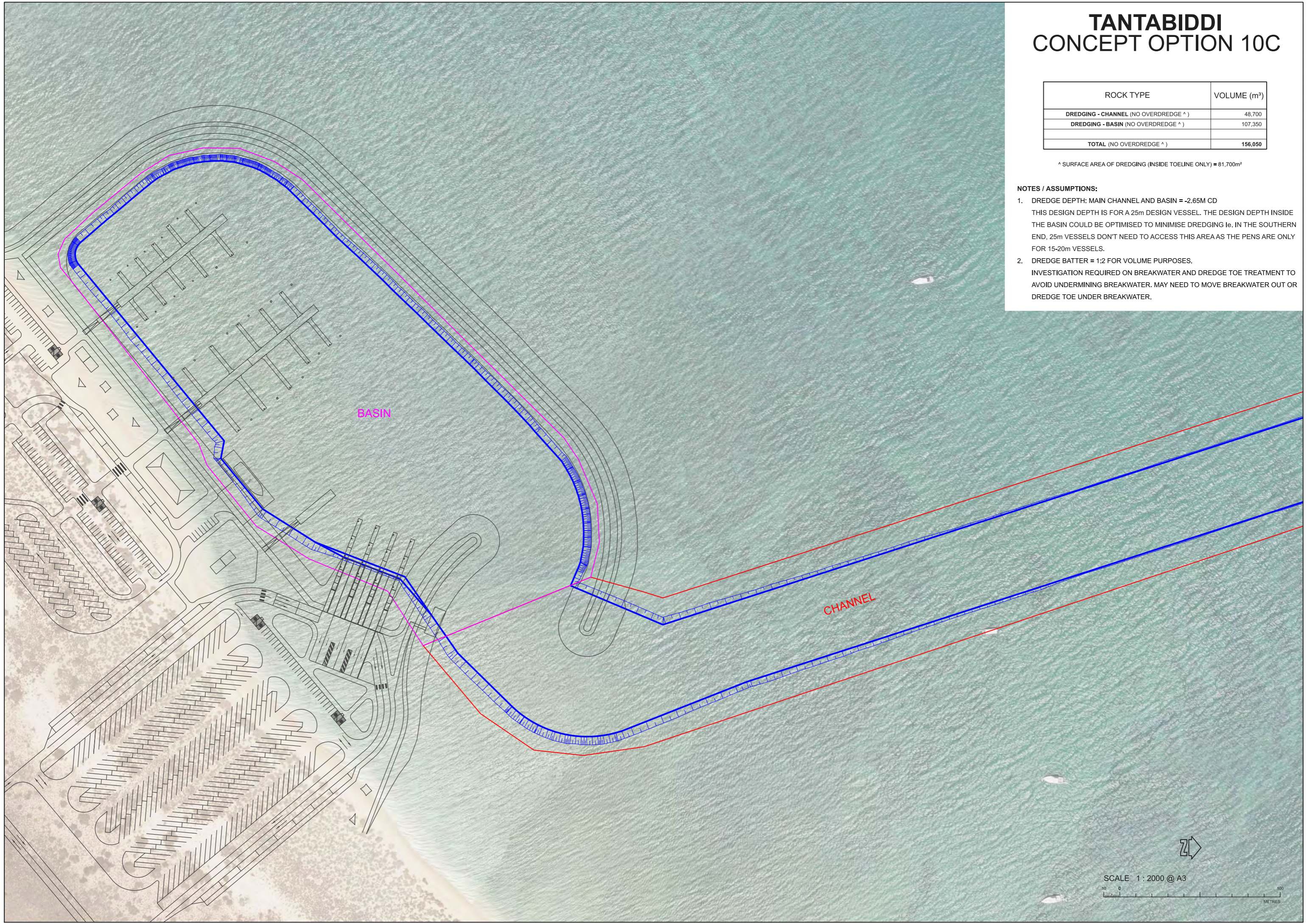
TANTABIDDI CONCEPT OPTION 10C

| ROCK TYPE | VOLUME (m ³) |
|--------------------------------------|--------------------------|
| DREDGING - CHANNEL (NO OVERDREDGE ^) | 48,700 |
| DREDGING - BASIN (NO OVERDREDGE ^) | 107,350 |
| TOTAL (NO OVERDREDGE ^) | 156,050 |

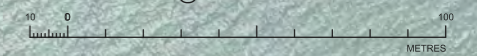
^ SURFACE AREA OF DREDGING (INSIDE TOELINE ONLY) = 81,700m²

NOTES / ASSUMPTIONS:

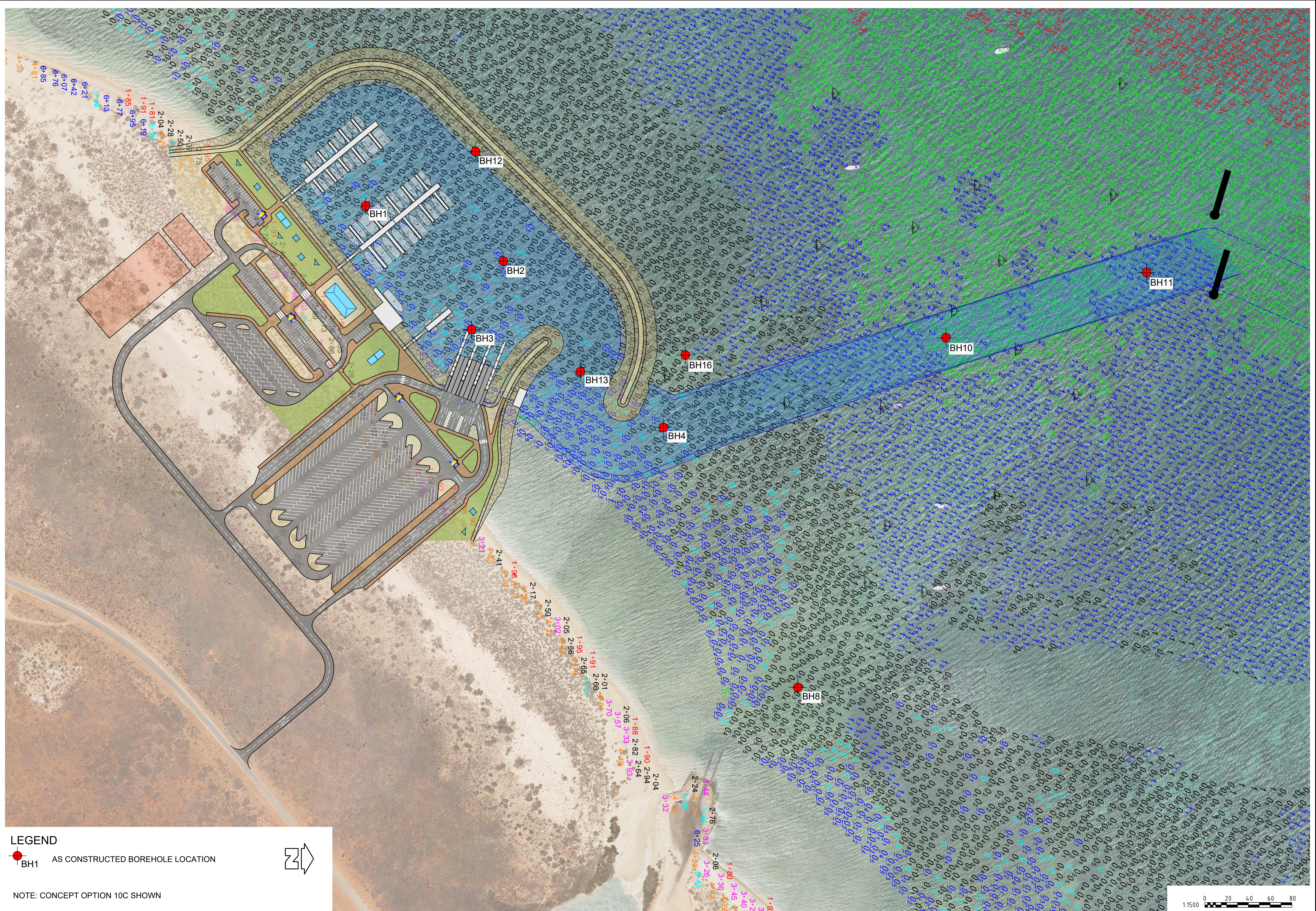
- DREDGE DEPTH: MAIN CHANNEL AND BASIN = -2.65M CD
THIS DESIGN DEPTH IS FOR A 25m DESIGN VESSEL. THE DESIGN DEPTH INSIDE THE BASIN COULD BE OPTIMISED TO MINIMISE DREDGING I.e. IN THE SOUTHERN END, 25m VESSELS DON'T NEED TO ACCESS THIS AREA AS THE PENS ARE ONLY FOR 15-20m VESSELS.
- DREDGE BATTER = 1:2 FOR VOLUME PURPOSES.
INVESTIGATION REQUIRED ON BREAKWATER AND DREDGE TOE TREATMENT TO AVOID UNDERMINING BREAKWATER. MAY NEED TO MOVE BREAKWATER OUT OR DREDGE TOE UNDER BREAKWATER.




SCALE 1 : 2000 @ A3



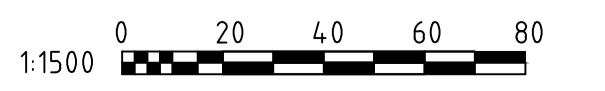
14. APPENDIX B – Borehole, Probe Locations and Transects

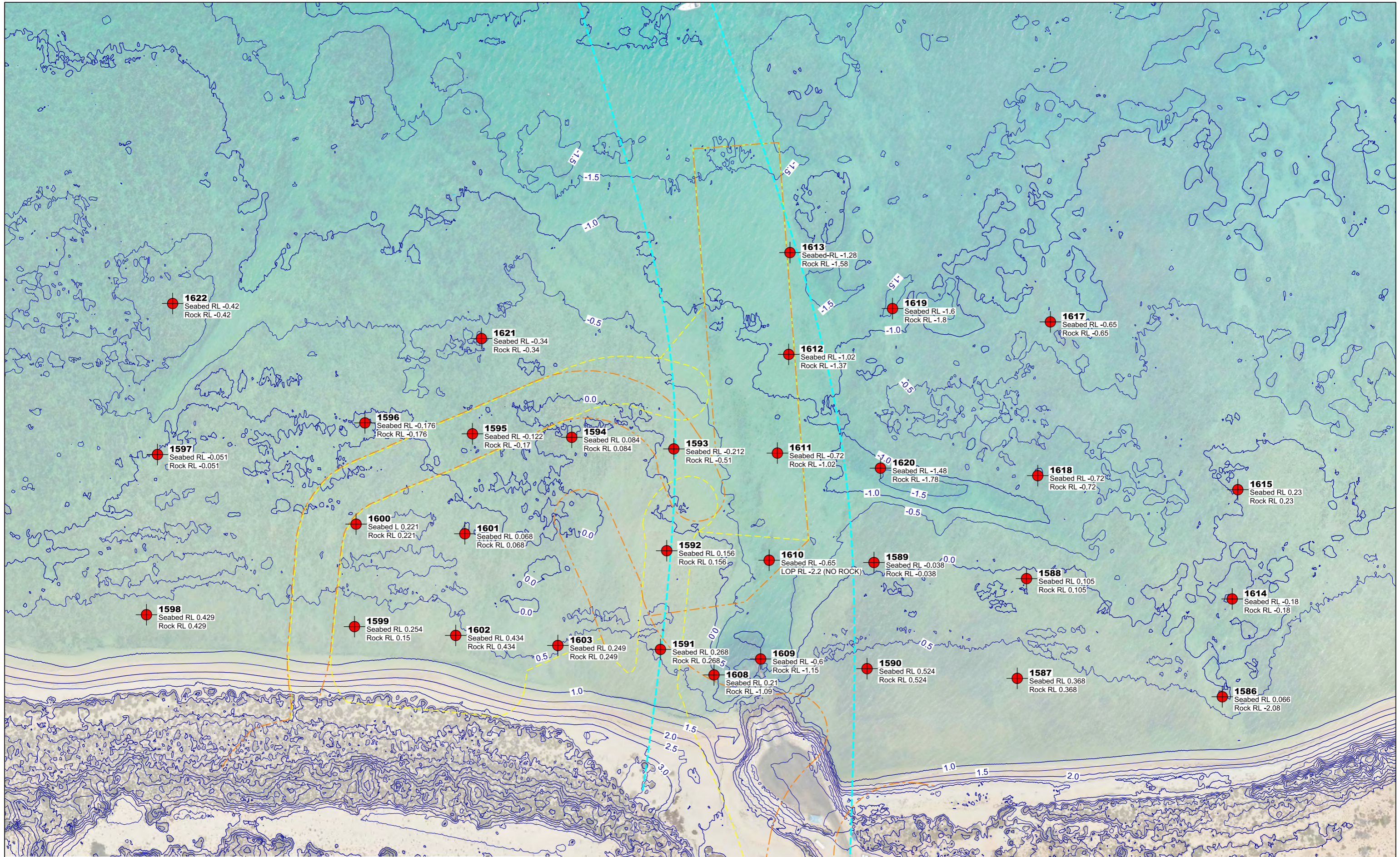


LEGEND
 AS CONSTRUCTED BOREHOLE LOCATION



NOTE: CONCEPT OPTION 10C SHOWN





**TANTABIDDI
BOAT LAUNCHING FACILITY UPGRADE
PROBES - 12/02/2020**

SCALE 1 : 2000 @ A3

 METRES



LEGEND

PROBE (BY DoT 12/02/2020)

1622 PROBE NUMBER
 Seabed RL -0.42 SEABED RL (m CD)
 Rock RL -0.42 ROCK RL (mCD) or LOP

CONTOURS (DoT SURVEY 09/03/2019)

CONCEPT 1A OUTLINE

CONCEPT 2B OUTLINE

1622
Seabed RL -0.42
Rock RL -0.42

1621
Seabed RL -0.34
Rock RL -0.34

1613
Seabed RL -1.28
Rock RL -1.58

1619
Seabed RL -1.6
Rock RL -1.8

1617
Seabed RL -0.65
Rock RL -0.65

1612
Seabed RL -1.02
Rock RL -1.37

1596
Seabed RL -0.176
Rock RL -0.176

1595
Seabed RL -0.122
Rock RL -0.17

1594
Seabed RL 0.084
Rock RL 0.084

1593
Seabed RL -0.212
Rock RL -0.51

1611
Seabed RL -0.72
Rock RL -1.02

1620
Seabed RL -1.48
Rock RL -1.78

1618
Seabed RL -0.72
Rock RL -0.72

1615
Seabed RL 0.23
Rock RL 0.23

1597
Seabed RL -0.051
Rock RL -0.051

1600
Seabed L 0.221
Rock RL 0.221

1601
Seabed RL 0.068
Rock RL 0.068

1592
Seabed RL 0.156
Rock RL 0.156

1610
Seabed RL -0.65
LOP RL -2.2 (NO ROCK)

1589
Seabed RL -0.038
Rock RL -0.038

1588
Seabed RL 0.105
Rock RL 0.105

1614
Seabed RL -0.18
Rock RL -0.18

1598
Seabed RL 0.429
Rock RL 0.429

1599
Seabed RL 0.254
Rock RL 0.15

1602
Seabed RL 0.434
Rock RL 0.434

1603
Seabed RL 0.249
Rock RL 0.249

1591
Seabed RL 0.268
Rock RL 0.268

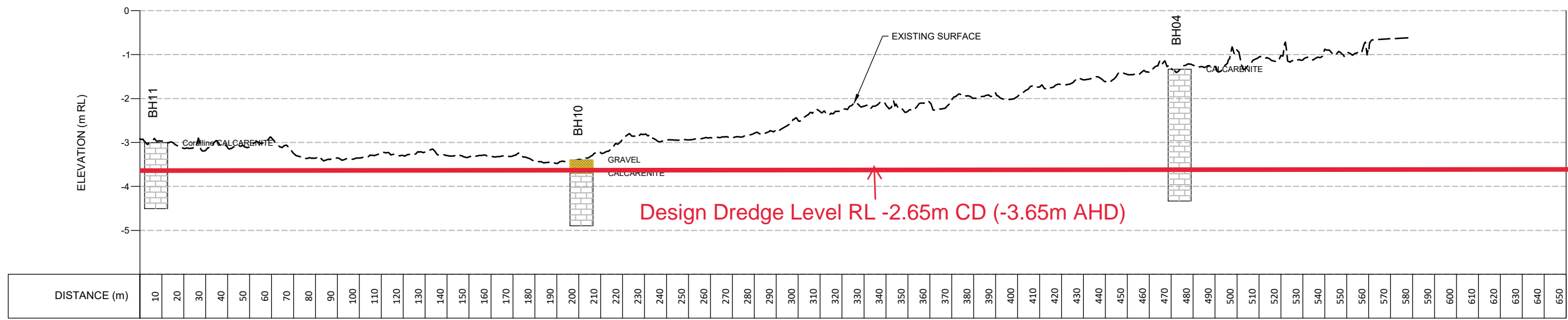
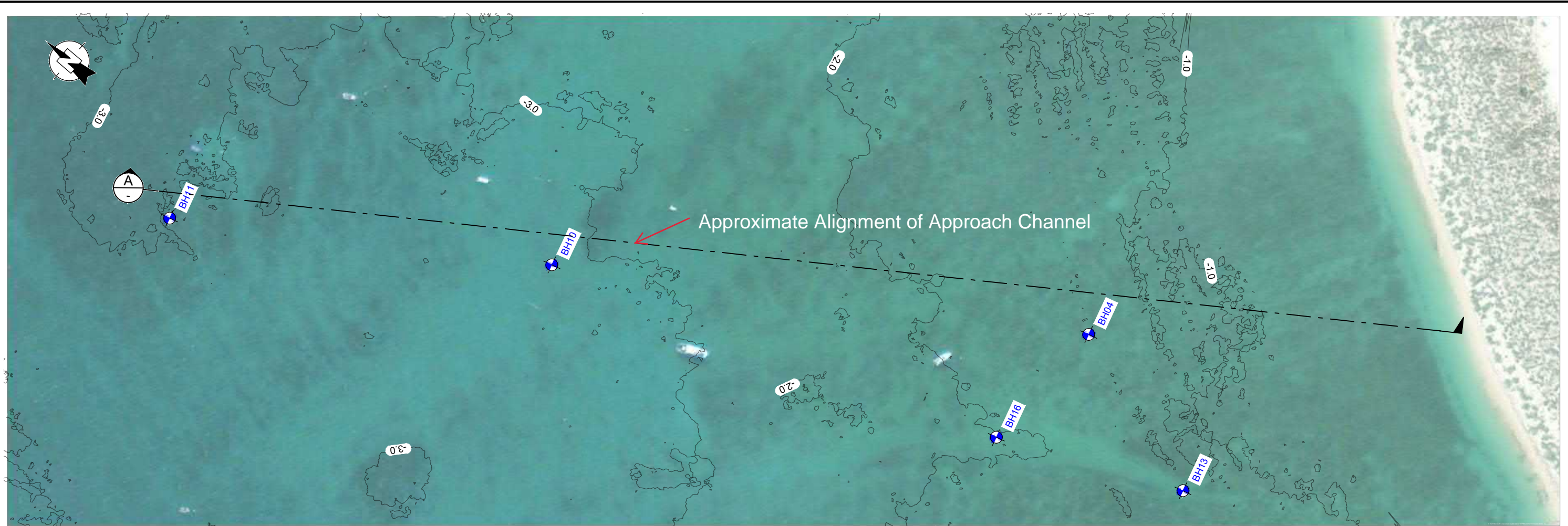
1609
Seabed RL -0.6
Rock RL -1.15

1590
Seabed RL 0.524
Rock RL 0.524

1587
Seabed RL 0.368
Rock RL 0.368

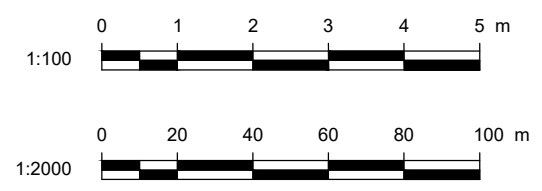
1586
Seabed RL 0.066
Rock RL -2.08

1608
Seabed RL 0.21
Rock RL -1.09

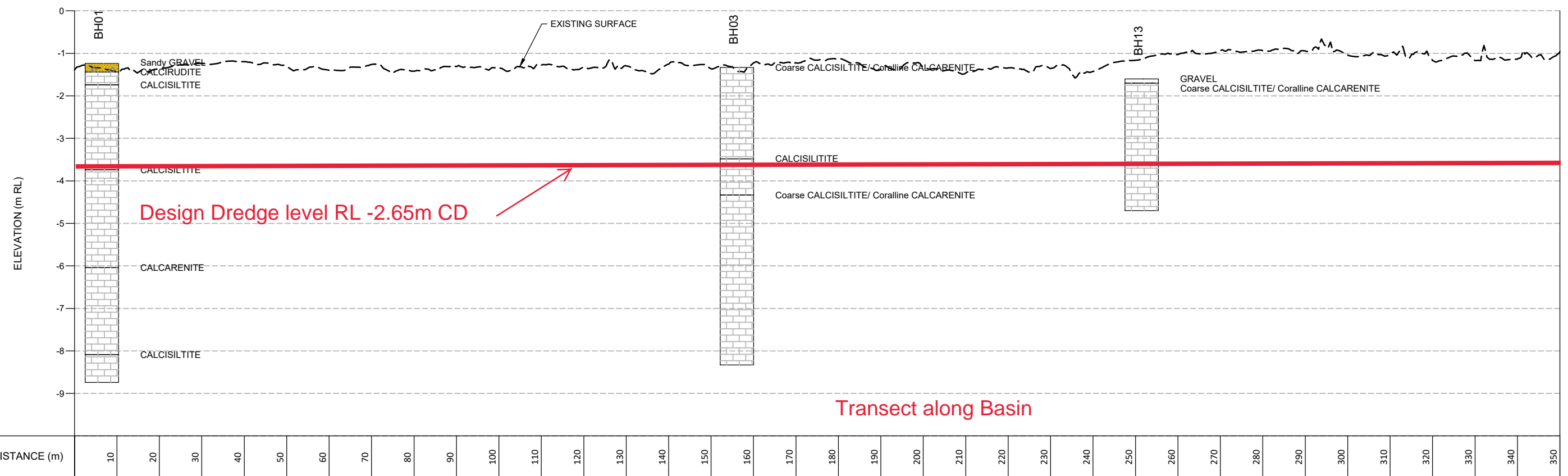
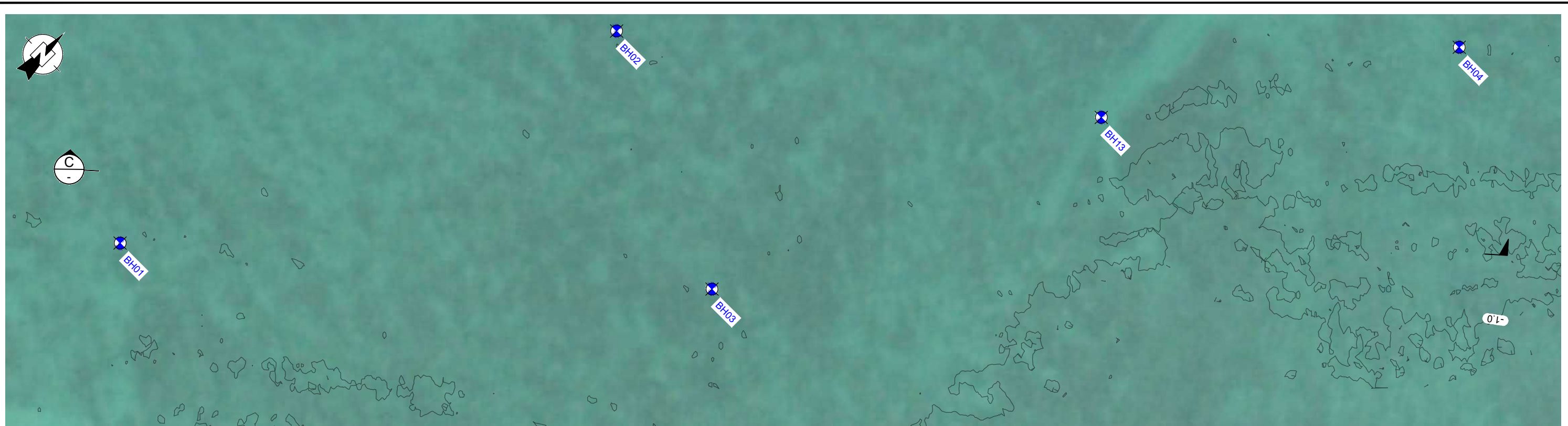


SECTION A
SCALE: H 1:2000, V 1:100.

- NOTES:
1. AERIAL FROM BING MAPS
 2. ELEVATIONS IN m AHD
 3. BOREHOLES ARE OFFSET AND PROJECTED ON TO SECTION LINE



| | | | | | |
|----------|------------------------------------|-----------|----------|----------|--------------|
| CLIENT: | DEPARTMENT OF TRANSPORT | DRAWN: | DE | PROJECT: | PER2020-0495 |
| PROJECT: | TANTABIDDI BOATING FACILITY | CHECKED: | TR | DRAWING: | 02 |
| TITLE: | GEOTECHNICAL SECTION A | REVISION: | A | SCALE: | AS SHOWN |
| | | DATE: | 18.06.21 | SHEET: | A3 L |



SECTION C
SCALE: H 1:1000, V 1:100.

NOTES:

1. AERIAL FROM BING MAPS
2. ELEVATIONS IN m AHD
3. BOREHOLES ARE OFFSET AND PROJECTED ON TO SECTION LINE



| | | | | | |
|----------|------------------------------------|-----------|----------|----------|--------------|
| CLIENT: | DEPARTMENT OF TRANSPORT | DRAWN: | DE | PROJECT: | PER2020-0495 |
| PROJECT: | TANTABIDDI BOATING FACILITY | CHECKED: | TR | DRAWING: | 04 |
| TITLE: | GEOTECHNICAL SECTION C | REVISION: | A | SCALE: | AS SHOWN |
| | | DATE: | 18.06.21 | SHEET: | A3 L |

15. Appendix C – Estimate Dredge Plant Power Requirements

Based on the Pettifer and Fookes charts

Summary of borehole data within dredge areas showing assessment of Is50 and Fracture Spacing and assesment of power requirements for various plant types

| ALL DATA | | | | | mCD | mCD | | MPa | m | | | | | | | kW | kW | T |
|----------|------|-----------------|------|------------|----------|-------|-------------------------|-------------|---------------------|-------|---------------------|---|-------------------|--|------------------------|---------------------|-----------------------------|---|
| BH | from | Depth Range (m) | to | Mid- Depth | SeabedRL | RL | Material | Is50 BTS | Fracture Spacing | UCS | Strength x Fract | Excavatability Definition Pettifer-Fookes | Dozer Requirement | Dredge Size (from Pettifer Fookes) | CSD Size (from UCS) | CSD Cutter Power | Backhoe Excavtaor Sizing | Equivalent Excavtaor Machine Mass |
| 12 | 0.24 | to | 0.36 | 0.3 | -0.69 | -0.99 | Calcirudite | 1.35 | 0.1 | 7.56 | 0.135 | Easy Ripping | CAT D6 | M | L | 400 - 900 | 350 - 700 | 80 - 200 |
| 12 | 1 | to | 1.1 | 1.05 | -0.69 | -1.74 | Calcirudite | 1.16 | 0.1 | 6.50 | 0.116 | Easy Ripping | CAT D6 | M | L | 400 - 900 | 350 - 700 | 80 - 200 |
| 1 | 0.6 | to | 0.74 | 0.67 | -0.23 | -0.9 | Calcsiltite | 2.93 | 0.2 | 16.41 | 0.586 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 1 | 1.7 | to | 2 | 1.85 | -0.23 | -2.08 | Calcsiltite | 2.65 | 0.3 | 14.84 | 0.795 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 1 | 2.4 | to | 2.5 | 2.45 | -0.23 | -2.68 | Calcsiltite | 1.72 | 0.2 | 9.63 | 0.344 | Easy Ripping | CAT D6 | M | L | 400 - 900 | 350 - 700 | 80 - 200 |
| 2 | 0.3 | to | 0.4 | 0.35 | -0.3 | -0.65 | Calcarenite | 1.03 | 0.5 | 5.77 | 0.515 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 2 | 0.4 | to | 0.7 | 0.55 | -0.3 | -0.85 | Calcsiltite | 2.17 | 0.5 | 12.15 | 1.085 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 2 | 0.7 | to | 0.8 | 0.75 | -0.3 | -1.05 | Calcsiltite | 1.97 | 0.5 | 11.03 | 0.985 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 2 | 1.4 | to | 1.5 | 1.45 | -0.3 | -1.75 | Calcsiltite/Calcarenite | 0.59 | 0.1 | 3.30 | 0.059 | Easy Ripping | CAT D6 | M | M | 400 - 900 | 350 - 700 | 80 - 200 |
| 2 | 2.75 | to | 2.95 | 2.85 | -0.3 | -3.15 | Calcsiltite/Calcarenite | 0.74 | 1 | 4.14 | 0.74 | Hard Ripping | CAT D8 | L | M | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 3 | 0.23 | to | 0.36 | 0.295 | -0.32 | -0.62 | Calcsiltite/Calcarenite | 1.02 | 0.3 | 5.71 | 0.306 | Easy Ripping | CAT D6 | M | L | 400 - 900 | 350 - 700 | 80 - 200 |
| 3 | 0.4 | to | 0.5 | 0.45 | -0.32 | -0.77 | Calcsiltite/Calcarenite | 1.76 | 0.3 | 9.86 | 0.528 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 3 | 0.54 | to | 0.68 | 0.61 | -0.32 | -0.93 | Calcsiltite/Calcarenite | 1.52 | 0.3 | 8.51 | 0.456 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 3 | 0.8 | to | 1 | 0.9 | -0.32 | -1.22 | Calcsiltite/Calcarenite | 0.35 | 0.5 | 1.96 | 0.175 | Easy Ripping | CAT D6 | M | S | 400 - 900 | 350 - 700 | 80 - 200 |
| 3 | 2.4 | to | 2.7 | 2.55 | -0.32 | -2.87 | Calcsiltite | 2.24 | 0.6 | 12.54 | 1.344 | Very Hard Ripping | CAT D9 | XL | L | 2200 - 4500 | 1,500 - 3,000 | 400 - 750 |
| 13 | 0.1 | to | 0.3 | 0.2 | -0.59 | -0.79 | Calcsiltite/Calcarenite | 8.61 | 0.5 | 48.22 | 4.305 | Extremely Hard Rippin | CAT D11 | XXL | XXL | > 4500 | >3,000 | >750 |
| 13 | 1 | to | 1.15 | 1.075 | -0.59 | -1.67 | Calcsiltite/Calcarenite | 4.09 | 1 | 22.90 | 4.09 | Extremely Hard Rippin | CAT D11 | XXL | XL | > 4500 | >3,000 | >750 |
| 4 | 0.5 | to | 0.6 | 0.55 | -0.33 | -0.88 | Calcarenite | 4.72 | 0.1 | 26.43 | 0.472 | Hard Ripping | CAT D8 | L | XL | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 4 | 1 | to | 1.15 | 1.075 | -0.33 | -1.41 | Calcarenite | | | 0.00 | | | | | | | | |
| 4 | 2.28 | to | 2.35 | 2.315 | -0.33 | -2.65 | Calcarenite | 1.31 | 0.3 | 7.34 | 0.393 | Easy Ripping | CAT D6 | M | L | 400 - 900 | 350 - 700 | 80 - 200 |
| 10 | 0.5 | to | 0.7 | 0.6 | -2.39 | -2.99 | Calcarenite | 3.16 | 0.4 | 17.70 | 1.264 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 10 | 0.7 | to | 1 | 0.85 | -2.39 | -3.24 | Calcarenite | 3.29 | 0.4 | 18.42 | 1.316 | Hard Ripping | CAT D8 | L | L | 900 - 1800 | 700 - 1,500 | 200 - 400 |
| 11 | 0.3 | to | 0.5 | 0.4 | -2 | -2.4 | Calcarenite | 0.19 | 0.3 | 1.06 | 0.057 | Hard Digging | CAT 245 Backhoe | S | S | 150 - 400 | <350 | <80 |

16. Appendix D – Borehole Logs

Explanatory Notes – Soil Description

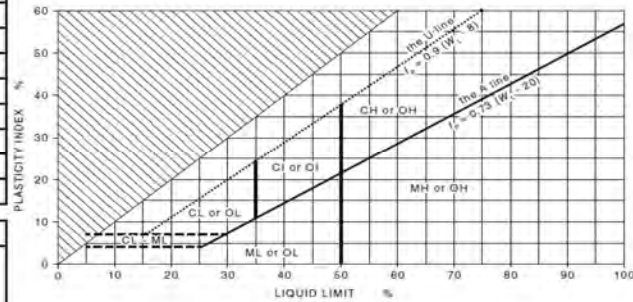


| | | | | | | | |
|--|---------------|--|---------------|--|---------------|--|--------------------|
| | GRAVEL | | Gravelly SAND | | Sandy CLAY | | FILL |
| | SILTY GRAVEL | | SILTY SAND | | SILT | | TOPSOIL |
| | CLAYEY GRAVEL | | CLAYEY SAND | | Gravelly SILT | | COBBLES & BOULDERS |
| | Sandy GRAVEL | | CLAY | | Sandy SILT | | CONCRETE |
| | SAND | | Gravelly CLAY | | PEAT | | NO CORE |

| | | | |
|----|----------------------|----|------------------------|
| GP | Poorly Graded Gravel | ML | Low Plasticity Silt |
| GW | Well Graded Gravel | MH | High Plasticity Silt |
| GM | Silty Gravel | CL | Low Plasticity Clay |
| GC | Clayey Gravel | CI | Medium Plasticity Clay |
| SP | Poorly Graded Sand | CH | High Plasticity Clay |
| SW | Well Graded Sand | OL | Organic Soils (LP) |
| SM | Silty Sand | OH | Organic Soils (HP) |
| SC | Clayey Sand | PT | Peat |
| | Fill | | Cobbles & Boulders |

Soil colours based on BS5 internal report (M/05/123 'A Revised scheme for coding unclassified deposits', 2006).

| WATER | |
|-------|----------------------|
| | Groundwater (Strike) |
| | Groundwater (rise) |



CLASSIFICATION AND INFERRED STRATIGRAPHY

| Particle Size | | |
|----------------|--------------|-------------------|
| Major Division | Sub Division | Particle Size |
| Boulders | | > 200 mm |
| Cobbles | | 63 to 200 mm |
| Gravel | Coarse | 19 to 63 mm |
| | Medium | 6.7 to 19 mm |
| | Fine | 2.36 to 6.7 mm |
| Sand | Coarse | 0.6 to 2.36 mm |
| | Medium | 0.21 to 0.6 mm |
| | Fine | 0.075 to 0.21 mm |
| Silt | | 0.002 to 0.075 mm |
| Clay | | < 0.002 mm |

| SECONDARY/MINOR COMPONENTS | |
|---|---|
| TERMS FOR SANDS/GRAVELS (Less than 35% Particles < 0.075mm) | TERMS FOR CLAYS/SILTS (More than 35% Particles < 0.075mm) |
| trace... sand/gravel = <15% clay/silt = <5% | trace... sand/gravel = <15% |
| with... sand/gravel = >15%, <30% clay/silt = >5%, <12% | with... sand/gravel = >15%, <30% |
| Sandy... / Gravelly... >30% | Sandy... / Gravelly... >30% |
| Clayey... / Silty ... >12% | |

MOISTURE CONDITION (Cohesionless Soils)

| Symbol | Term | Description |
|--------|-------|---|
| D | Dry | Looks and feels dry. Cohesionless and free-running. |
| M | Moist | No free water on remoulding. Soil feels cool, darkened in colour. Soil tends to cohere. |
| W | Wet | Free water on remoulding. Soil feels cool, darkened in colour. Soil tends to cohere. |

MOISTURE CONDITION (Cohesive Soils)

| Symbol | Term | Description |
|--------|-------|--|
| <PL | Dry | Looks and feels dry. Hard and friable or powdery, well dry of the plastic limit |
| =PL | Moist | Soil feels cool, darkened in colour. Soil can be moulded. Near plastic limit. |
| >PL | Wet | Soils feels cool, darkened in colour. Usually weakened and free water forms when remoulding. Wet of plastic limit. |

DENSITY (Cohesionless Soils)

| Sym. | 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 |

STIFFNESS (Cohesive Soils)

| Sym. | 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 |

SAMPLING AND LABORATORY / INSITU TESTING RESULTS

| | | | | | |
|-----|---------------------------|----|----------------------------|-----|---------------------------------|
| B | Bulk Disturbed Sample | U | Undisturbed Push-in Sample | CBR | California Bearing Ratio |
| BLK | Block Sample | W | Water Sample | UCS | Unconfined Compressive Strength |
| C | Core Sample | LL | Liquid Limit | PLI | Point Load Index |
| ES | Environmental Soil Sample | PI | Plasticity Index | N | SPT-N Value |
| P | Piston Sample | LS | Linear Shrinkage | | |

DRILLING/EXCAVATION METHOD

| | | | | | |
|------|-----------------------|-----|--------------------|-----|---------------------------|
| AC | Air Core | HA | Hand Auger | RC | Rotary Cored |
| ADH | Hollow Auger Drilling | HQ | Rotary Core 63.5mm | RO | Rotary Open Hole |
| AD/V | Auger with V-Bit | HQ3 | Rotary Core 61.1mm | SPT | Standard Penetration Test |
| AD/T | Auger with TC-Bit | PQ3 | Rotary Drill 83mm | TP | Test Pit |
| DPP | Direct Push Probe | PT | Push Tube | W | Wash Bore |

Explanatory Notes – Rock Description



| | | | | | | | |
|--|-----------|--|-----------|--|--------------|--|-------------|
| | MUDSTONE | | LIMESTONE | | CONGLOMERATE | | GYPSUM |
| | SILTSTONE | | CHALK | | IGNEOUS | | SHALE |
| | SANDSTONE | | BRECCIA | | METAMORPHIC | | PYROCLASTIC |

| ROCK MATERIAL STRENGTH | | | | |
|------------------------|----------------|---|---|--|
| Symbol | Term | Uniaxial Compressive Strength - UCS (MPa) | Point Load Index - $I_{5(50)}$ (MPa) - GUIDE ONLY | Field Guide |
| EL | Extremely Low | Less than 0.6 | Less than 0.03 | Easily remoulded by hand to a material with soil properties (logged as soil). |
| VL | Very Low | 0.6 to 2 | 0.03 to 0.1 | Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 3 cm thick can be broken by finger pressure. |
| L | Low | 2 to 6 | 0.1 to 0.3 | Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling. |
| M | Medium | 6 to 20 | 0.3 to 1 | Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty. |
| H | High | 20 to 60 | 1 to 3 | A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer. |
| VH | Very High | 60 to 200 | 3 to 10 | Hand specimen breaks with pick after more than one blow; rock rings under hammer. |
| EH | Extremely High | More than 200 | More than 10 | Specimen requires many blows with geological pick to break through intact material; rock rings under hammer. |

| WEATHERING CLASSIFICATION | | |
|---------------------------|--------------------------|---|
| Symbol | Term | Definition |
| RS | Residual Soil | Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported. |
| XW | Extremely weathered rock | Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible. |
| HW (or DW) | Highly Weathered | Rock strength usually changed by weathering. The rock may be highly discoloured. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products. |
| MW (or DW) | Moderately Weathered | The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock. |
| SW | Slightly weathered rock | Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock. |
| FR | Fresh rock | Rock shows no sign of decomposition or staining. |

| CEMENTATION CLASSIFICATION | | |
|----------------------------|----------------------------|---|
| Symbol | Term | Definition |
| Uc | Uncemented | Clean grains, exhibiting soil properties. |
| VWc | Very weakly cemented | Marginal soil-rock strengths, collapsing feel under light finger pressure, cement seen on some washed grains. |
| Wc | Weakly Cemented | Collapsing feel under light soil pressure, breaks down to individual grains or with some grains cemented together, cement seen on many washed grains. |
| MWc | Moderately Weakly Cemented | Cement on nearly all grains, breaks down to lumps and some individual grains under finger pressure, can crush to individual grains under knife blade. |
| Mo | Moderately Cemented | Cement on most grains, can break fragments off by hand and crush to small lumps under knife blade. |
| We | Well Cemented | Practically all grains cemented together, cannot break fragments off by hand, dull sound under hammer. |
| VWe | Very Well Cemented | Most Primary Pores filled with cement, requires firm blow with hammer to break off fragments, rings when struck |

| ROCK CORE RECOVERY | | |
|--------------------|------------------------------|--|
| Symbol | Term | Definition |
| TCR | Total Core Recovery (%) | The ratio of total length of core recovered to length of core run drilled, expressed as a percentage. |
| SCR | Solid Core Recovery (%) | The ratio of the total length of solid cylindrical pieces of core recovered to length of core run drilled, expressed as a percentage. |
| RQD | Rock Quality Designation (%) | The ratio of the total length of solid cylindrical pieces of core over 100mm in length recovered to length of core run drilled, expressed as a percentage. |

Explanatory Notes – Defect Description



| Defect Type | | | |
|--------------|---------------------|---|---------|
| ABBREVIATION | TERM | DEFINITION | DIAGRAM |
| PT | Parting | A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed. | |
| JT | Joint | A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. | |
| SS | Sheared Surface | A near planar, curved or undulating surface which is usually smooth, polished or slickensided and which shows evidence of shear displacement. | |
| SZ | Sheared Zone | Zone of rock material with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge-shaped blocks. | |
| CS | Crushed Zone / Seam | Seam of soil material with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock material which may be more weathered than the host rock. The seam has soil properties. | |
| SM | Seam | Seam of soil material usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1 mm thick may be described as a veneer or coating on a joint surface. | |

| Surface Roughness | | |
|-------------------|-----------------------|--|
| ABBREVIATION | TERM | Description |
| VR | Very Rough | Many large irregularities generally > 1 mm |
| RO | Rough | Many small irregularities generally > 1 mm |
| SM | Smooth | Few or no surface irregularities |
| PO | Polished | Shiny smooth surface |
| SI | Slickensided/Striated | Grooved/striated surface, usually polished |

| Surface Shape | | |
|---------------|------------|-----------------------------------|
| ABBREVIATION | TERM | Description |
| PL | Planar | Does not vary in orientation |
| CU | Curved | gradual change in orientation |
| UN | Undulating | wavy surface |
| ST | Stepped | one or more well defined steps |
| IR | Irregular | many sharp changes in orientation |

| Coatings | | |
|--------------|----------|-------------------------------------|
| ABBREVIATION | TERM | Description |
| CN | Clean | No visible coating |
| SN | Stained | No coating but surface discoloured |
| VN | Veneer | visible coating too thin to measure |
| CT | Coating | visible coating up to 1mm thick |
| IF | Infilled | Over 1mm thick of soil present |

| Orientation | |
|--------------|-----------------------|
| ABBREVIATION | TERM |
| SH | Sub Vertical |
| SV | Sub Horizontal |
| 10° | Angle from horizontal |

| Aperture | |
|--------------|---------------------------------------|
| ABBREVIATION | TERM |
| DIS | Discontinuous |
| CL | Closed |
| 5mm | Measured width between joint surfaces |

| Block Shape | |
|-------------|---|
| Term | Description |
| Blocky | Roughly equidimensional blocks. |
| Tabular | thickness of blocks much less than length or width. |
| Columnar | lengths much greater than other dimensions |
| Irregular | Irregular discontinuities without arrangement into distinct sets, |

BOREHOLE LOG - BH01

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 08/05/2021



1:25 Sheet 1 of 2

Logged by: TR Position: E.807136m N.7573582m (GDA 2020) Hole Diameter: 61mm Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -1.24 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|--|--|-------------|--------------------|---------------|---|---|---|----|--|---|---|
| | | | TCR | SCR | RQD | | | | | | | VL | L | M | H | VH | | | |
| HQ3 | | | 100 | 50 | 30 | -1.2 | | GP: Sandy GRAVEL: pale grey mottled cream & yellowish brown, fine to coarse grained, subangular to subrounded; sand, fine to coarse grained, calcareous with cream shell and coral fragments (< 30mm) | | | | | | | | | 0.20-0.50m:PT, IR, aperture 2-5mm, (infilled sand & fine gravel) | | |
| | | | | | | -1.4 | | CALCIRUDITE: medium to coarse grained clasts of fine grained calcarenite and coarse grained calcisiltite, high strength cream mottled pale grey; matrix fine to medium grained calcarenite, medium to high strength, pale grey brown mottled cream and pale yellow | | | | | | | | | 0.50-1.50m:PT, IR, aperture 2-5mm, (infilling sand) 0.60-0.74m:C | | |
| | | | | | | -1.7 | | ... from 0.20m to 0.27m, medium gravel sized subangular fragments of white and cream, coral; matrix fine to medium grained calcarenite, grey brown. | | | | | | | | | 0.77-0.81m:C | | |
| | | | | 100 | 78 | 51 | 1 | | CALCISILTITE: coarse grained cream, mottled pale grey and pale orange yellow; with medium grained clasts of fine grained calcarenite, with shell fragments (<10mm), dark grey. | | | | | | | | | 1.50-2.50m:PT, IR, 2-5mm aperture, (clean trace orange brown stain) 1.70-2.00m:C | |
| | | | | | | | 2 | | ... from 1.20m to 1.40m, becoming very low to low strength, sandy cream mottled pale brown. ... from 1.40m to 1.50m, becoming very hard gravelly SAND, fine to medium grained, subangular trace clay, low plasticity ... from 1.50m to 2.50m, with medium to coarse grained clasts of coral subrounded to subangular | | | | | | | | | 2.10-2.20m:C 2.40-2.50m:C | |
| | | | 100 | 92 | 75 | 3 | | CALCISILTITE: coarse grained, cream mottled pale pale grey white and pale pink, with clasts of coral (<40mm) and grey shells (<10mm) medium to coarse grained. ... from 2.50m to 4.80m, with shell borings (<10mm) | | | | | | | | | 2.50-6.90m:PT, IR, 5-15mm, (infilled with medium sand) 2.67-2.80m:C 2.80-2.90m:C | | |
| | | | | | | 4 | | ... from 3.70m to 4.00m, SAND fine to medium cream dense to very dense (LEACHED CALCARENITE) | | | | | | | | | | 3.20-3.30m: No core (core loss) 3.30-3.40m:C 4.00-4.30m:C | |
| | | | 100 | 95 | 62 | 5 | | CALCARENITE: fine to medium grained, cream mottled pale orange and pale grey, low to medium strength, with medium to coarse grained, subangular clasts of coral (recovered as fine to coarse grained gravel and trace cobbles) | | | | | | | | | 4.70-4.80m:C | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample

CORE PHOTOGRAPHS: BH01

Client: Department of Transport
 Project: Tantabiddie Boating Facility
 Location: Tantabiddie Boat Ramp, WA
 Project ID: PER2020-0495
 Date: 8/02/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807136.1, N: 7573581.7 | Hole Diameter: HQ 96mm | Plant: SUBSEA HQ3 RIG |
| Checked by: MT | Elevation: -1.24 | Angle from Horizontal: 90° | Contractor: TAMS |



BH01: 0.0m to 5.0m



BH01: 5.0m to 7.5m

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.

BOREHOLE LOG - BH02

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 09/05/2021



1:25 Sheet 1 of 2

Logged by: TR Position: E.807187m N.7573708m (GDA 2020) Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -1.31 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|---|-----------------------|-------------|--------------------|---------------|---|---|---|----|----|--|---------------------|---|
| | | | TCR | SCR | RQD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 100 | 100 | 91 | -1.3 | | Coralline CALCARENITE: medium to coarse grained, pale grey mottled, cream, dark grey and white; medium to high strength, coral is medium to coarse grained subrounded to subangular with dark grey shells (<30m) with shell borings* (<50mm) stained dark grey. | W | | | | | | | | | 0.00-0.40m:PT, IR, aperture 5mm, stained dark grey | | |
| | | | | | | -1.7 | | CALCISILTITE: coarse grained, cream mottled pale brown; medium to high strength trace to with borings (<10mm) | | | | | | | | | | 0.40-0.80m:PT, stepped, smooth, 1-3mm, clean | | |
| | | | | | | -2.1 | | Coarse CALCISILTITE/ Coralline CALCARENITE: fine to medium grained cream mottled pale brown; medium to high strength, coral is medium to coarse grained subrounded trace pale grey shells, with cobble sized (<100mm) subrounded fragments of coral below 2.2m, with shell borings* (5-10mm). | | | | | | | | | | 0.80-1.30m:PT, IR, stained dark grey | | |
| | | | | | | 1 | | ... from 1.30m to 5.20m, mottled pale brown; shell borings stained orange brown. | | | | | | | | | | 1.30-2.20m:PT, ST, aperture 5-10mm, (stained orange brown) | | |
| | | | | | | 2 | | | | | | | | | | | | 2.20-4.50m:PT, ST, aperture <5mm, (clean) | | |
| | | | 100 | 100 | 63 | | | | | | | | | | | | | | | |
| | | | | | | 3 | | ... from 3.25m to 3.40m, recovered as sandy GRAVEL, fine to medium grained subangular, sand medium to coarse | | | | | | | | | | | | |
| | | | 93 | 67 | 45 | | | ... from 4.15m to 4.40m, recovered as sandy GRAVEL, fine to medium grained subangular, sand medium to coarse | | | | | | | | | | | | |
| | | | | | | 4 | | ... from 4.50m to 5.20m, with shell borings (<10mm) | | | | | | | | | | | | |
| | | | 100 | 66 | 36 | | | | | | | | | | | | | | | |
| | | | | | | 5 | | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc

This report must be read in conjunction with accompanying notes and abbreviations.

BOREHOLE LOG - BH02

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 09/05/2021



1:25 Sheet 2 of 2

Logged by: TR Position: E.807187m N.7573708m (GDA 2020) Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -1.31 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|--|-----------------------|-------------|--------------------|---------------|---|---|---|----|----|---|---------------------|---|
| | | | TCR | SCR | RCD | | | | | | | VL | L | M | H | VH | EH | | | |
| | | | 0 | 0 | 0 | -6.5 | | Coarse CALCISILTITE/ Coralline CALCARENITE: fine to medium grained cream mottled pale brown; medium to high strength, coral is medium to coarse grained subrounded trace pale grey shells, with cobble sized (< 100mm) subrounded fragments of coral below 2.2m, with shell borings* (5-10mm). SP: SAND: cream, mottled pale brown, fine to medium grained, subangular to subrounded, with gravel, trace shell fragments (< 5mm). Gravel: fine to medium grained, subangular to subrounded, cream and grey calcarenite and white coral. | MD | | | | | | | | | 5.20-5.60m: No core (core loss) | | |
| | | | 63 | | | 6 | | | | | | | | | | | | 6.00-6.40m: No core (core loss) | | |
| | | | 83 | 45 | 33 | -7.7 | | Coarse CALCISILTITE/ Coralline CALCARENITE: fine to medium grained; cream mottled pale brown; medium to high strength; coral is fine to coarse grained, subrounded with shell borings (<10mm) | | | | | | | | | | 6.40-7.00m: PT, IR, aperture 5-20mm, (infilled with sand) | | |
| | | | | | | 7 | | Borehole terminated at 7.0 m | | | | | | | | | | 6.90-7.00m: No core (core loss) | | |
| | | | | | | 8 | | | | | | | | | | | | | | |
| | | | | | | 9 | | | | | | | | | | | | | | |
| | | | | | | 10 | | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc
 This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH02

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 9/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-----------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807136.1, N: 7573708 | Hole Diameter: HQ 96mm | Plant: SUBSEA HQ3 RIG |
| Checked by: MT | Elevation: -1.31 | Angle from Horizontal: 90° | Contractor: TAMS |



BH02: 0.0m to 5.0m



BH02: 5.0m to 7.0m

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.

CORE PHOTOGRAPHS: BH03

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 10/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|------------------------------------|----------------------------|-----------------------|
| Logged by: RC | Position: E: 807249.8 , N: 7573679 | Hole Diameter: HQ 96mm | Plant: SUBSEA HQ3 RIG |
| Checked by: MT | Elevation: -1.33 | Angle from Horizontal: 90° | Contractor: TAMS |



BH03: 0.0m to 5.0m



BH03: 5.0m to 7.0m

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.

BOREHOLE LOG - BH04

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 11/05/2021



1:25 Sheet 1 of 1

Logged by: TR Position: E.807340m N.7573855m (GDA 2020) Hole Diameter: 61mm Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -1.35 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|---|-----------------------|-------------|--------------------|---------------|---|---|---|----|---|---------------------|---|
| | | | TCR | SCR | RQD | | | | | | | VL | L | M | H | VH | | | |
| HQ3 | | | 80 | 62 | 46 | -1.4 | | CALCARENITE: fine grained pale grey mottled greenish grey and pale pink; with grey and white shell fragments (<25mm) with vugs (<75mm) stained dark grey or partly infilled with grey calcarenite, medium to high strength. | | | | | | | | | 0.00-2.45m:PT, IR, Aperture 5 to 8mm, (Infilled fine gravel and sand) 0.00-0.13m:C | | |
| | | | | | | 1 | | ... from 1.50m to 1.60m, hard/very dense sandy gravel ... from 1.50m to 3.00m, becoming low to medium strength | | | | | | | | | 0.50-0.60m:C 1.00-1.15m:C 1.20-1.50m: No core (core loss) | | |
| | | | 63 | 50 | 27 | 2 | | ... from 1.90m to 2.05m, hard/very dense sandy gravel | | W | | | | | | | 2.28-2.35m:C 2.45-3.00m: No core (core loss) | | |
| | | | | | | 3 | | Borehole terminated at 3.0 m | | | | | | | | | | | |
| | | | | | | 4 | | | | | | | | | | | | | |
| | | | | | | 5 | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample

This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH04

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 11/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807579.0, N: 7573978.9 | Hole Diameter: HQ 96mm | Plant: SUBSEA HQ3 RIG |
| Checked by: MT | Elevation: -1.57 | Angle from Horizontal: 90° | Contractor: TAMS |



BH04: 0.0m to 3.0m

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.

BOREHOLE LOG - BH08

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 12/05/2021



1:25 Sheet 1 of 1

Logged by: TR Position: E.807579m N.7573979m (GDA 2020) Hole Diameter: 61mm Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -1.57 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|---|-----------------------|-------------|--------------------|---------------|---|---|---|----|----|---|---|---|
| | | | TCR | SCR | RCD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 100 | | | -1.6 | | GP: Sandy GRAVEL: cream mottled orange brown, pale pink and yellow, fine to coarse grained, subangular to subrounded with cobbles (<90mm); sand fine to medium grained; Gravel and cobbles are fine grained calcarenite, coral and shells | | | | | | | | | | 0.00-1.60m:D 0.5m:SPT: (3,6,7) N=13 | | |
| | | | 100 | | | -3.2 | | Coarse CALCISILTITE/ Coralline CALCARENITE: fine grained; cream mottled pale pinkish brown, with vugs (<50mm) stained pale reddish brown or partly infilled with reddish brown sand, fine to medium grained with shell borings (<10mm) | | | | | | | | | | 1.60-2.00m:PT, IR, (aperture < 5mm infilled reddish brown sand) 1.60-2.00m:C | | |
| | | | 100 | 90 | 57 | | | ... from 2.50m to 3.00m, recovered as subangular to angular gravel | | | | | | | | | | | 2.00-2.50m:PT, IR, (aperture < 5mm infilled reddish brown sand) | |
| | | | 100 | 0 | 0 | | | | | | | | | | | | | | | |
| | | | | | | | 3 | Borehole terminated at 3.0 m | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. D = small disturbed sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc
 This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH08

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 12/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807579.0, N: 7573878.9 | Hole Diameter: HQ 96mm | Plant: Subsea HQ3 Rig |
| Checked by: MT | Elevation: -1.57 | Angle from Horizontal: 90° | Contractor: TAMS |



BH08: 0.0m to 3.0m

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.

BOREHOLE LOG - BH10

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 12/05/2021



1:25 Sheet 1 of 1

Logged by: TR Position: E.807257m N.7574115m (GDA 2020) Hole Diameter: 61mm Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -3.4 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|--|-----------------------|-------------|--------------------|---------------|---|---|---|----|----|--|---------------------|---|
| | | | TCR | SCR | RQD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 87 | 60 | 53 | -3.4 | | GP: GRAVEL: cream mottled dark and pale grey, fine to coarse grained, sub angular to sub rounded, of calcarenite, coral and shell fragments, trace sand; sand, fine to medium grained. | | | | | | | | | | 0.00-1.20m:PT, IR, rough, Aperture <5mm, (clean) | | |
| | | | | | | -3.7 | | CALCARENITE: fine grained, cream mottled pinkish brown and pale grey, with vugs (< 20mm) infilled trace reddish brown sand or clean, with shell borings* | | | | | | | | | | 0.50-0.70m:C 0.70-1.00m:C | | |
| | | | | | | 1 | | | | | | | | | | | | 1.30-1.50m: No core (core loss) | | |
| | | | | | | | | Borehole terminated at 1.5 m | | W | | | | | | | | | | |
| | | | | | | 2 | | | | | | | | | | | | | | |
| | | | | | | 3 | | | | | | | | | | | | | | |
| | | | | | | 4 | | | | | | | | | | | | | | |
| | | | | | | 5 | | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc
 This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH10

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 12/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807257.4, N: 7574115.2 | Hole Diameter: HQ 96mm | Plant: Subsea HQ3 Rig |
| Checked by: MT | Elevation: -3.4 | Angle from Horizontal: 90° | Contractor: TAMS |



BH10: 0.0m to 1.5m

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.

BOREHOLE LOG - BH11

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 13/05/2021



1:25 Sheet 1 of 1

Logged by: TR Position: E.807197m N.7574300m (GDA 2020) Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -3.01 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|------------|---|-----------------------|-------------|--------------------|---------------|---|---|---|----|----|--|---------------------|---|
| | | | TCR | SCR | RCD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 100 | 95 | 91 | -3.0 | 0.00-1.50m | Coralline CALCARENITE: fine grained, cream mottled pale pinkish brown and grey, coral is medium to coarse grained and cobble sized, subrounded with shell borings; with pale grey shells (<15mm) ... from 0.10m to 0.45m, vugs (<50mm) stained dark brown and partly infilled with gravelly sand | | W | | | | | | | | 0.00-1.50m:PT, IR, rough to smooth, stained Dark Brown 0.30-0.50m:C | | |
| | | | | | | | 1.50-5.00m | Borehole terminated at 1.5 m | | | | | | | | | | | | |
| | | | | | | | 2.00 | | | | | | | | | | | | | |
| | | | | | | | 3.00 | | | | | | | | | | | | | |
| | | | | | | | 4.00 | | | | | | | | | | | | | |
| | | | | | | | 5.00 | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc
 This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH11

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 13/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807197.4, N: 7574299.6 | Hole Diameter: HQ 96mm | Plant: Subsea HQ3 Rig |
| Checked by: MT | Elevation: -3.01 | Angle from Horizontal: 90° | Contractor: TAMS |



BH11: 0.0m to 1.5m

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.

BOREHOLE LOG - BH12

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 07/05/2021



1:25 Sheet 1 of 1

| Logged by: TR | | Position: E.807086m N.7573683m (GDA 2020) | | Hole Diameter: 61mm | | Plant: Subsea HQ3 Drill Rig | | | | | | | | | | | | | | |
|-----------------|------|---|--------|---------------------|-----|-----------------------------|-----------|-------------|--|-------------|--------------------|---------------|---|---|---|----|---------------------------------------|--|---------------------|---|
| Checked by: MAT | | Elevation: -1.7 m (AHD) | | Contractor: TAMS | | | | | | | | | | | | | | | | |
| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
| | | | TCR | SCR | RCD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 100 | 45 | 21 | -1.7 | | | CALCIRUDITE: medium to coarse grained, subangular clasts of fine grained calcarenite, coarse grained calcisiltite; high strength; matrix fine grained calcarenite low to medium strength; cream mottled pale grey & pale pink. ... from 0.00m to 0.65m, vug: filled with sad and shells (<20mm) ... at 0.63m, boring (<10mm) stained dark brown ... from 0.65m to 1.00m, as 0.0 to 0.60 low to medium strength ... from 1.00m to 1.25m, as 0.0 to 0.60 | | | | | | | | | 0.00-1.65m:PT, IR, 25mm aperture, (infilled sand, stained dark brown and grey) 0.15-0.24m:C 0.24-0.36m:C 0.36-0.54m:C 0.56-0.61m:C 0.96-1.00m:C 1.00-1.10m:C | | |
| | | | 72 | 17 | 0 | -3.0 | | | CALCARENITE/gravelly SAND: medium to coarse grained, cream mottled pale grey; trace to with fossil shells (<10mm)/hard gravelly SAND; fine to coarse grained; gravel; fine to coarse; subangular, calcareous. | | | | | | | | 1.65-1.90m: No core (inferred cavity) | | | |
| | | | | 0 | 0 | 0 | -3.3 | | CAVITY (inferred): | | | | | | | | | 1.90-2.10m: No core (core loss) | | |
| | | | | | | -3.5 | 2 | | CALCARENITE (inferred): low to medium strength | | | | | | | | | 2.10-2.50m: No core (inferred cavity) | | |
| | | | | | | -3.8 | | | CAVITY (inferred): drill string dropped | | | | | | | | | 2.50-2.70m: No core (core loss) | | |
| | | | | | | -4.2 | | | SP: SAND (inferred): fine to coarse grained - inferred from drilling muds, leached calcarenite | | | | | | | | | 2.70-3.20m: No core (core loss) | | |
| | | | 0 | 0 | 0 | | 3 | | Borehole terminated at 3.2 m | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample

CORE PHOTOGRAPHS: BH12

Client: Department of Transport
 Project: Tantabiddie Boating Facility
 Location: Tantabiddie Boat Ramp, WA
 Project ID: PER2020-0495
 Date: 7/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807086.2, N: 7573682.8 | Hole Diameter: HQ 96mm | Plant: Subsea HQ3 Rig |
| Checked by: MT | Elevation: -1.70 | Angle from Horizontal: 90° | Contractor: TAMS |



BH12: 0.0m to 3.2m

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.

BOREHOLE LOG - BH13

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 10/05/2021



1:25 Sheet 1 of 1

Logged by: TR Position: E.807289m N.7573779m (GDA 2020) Hole Diameter: 61mm Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -1.6 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|---|--|-------------|--------------------|---------------|---|---|---|----|----|---|---------------------|---|
| | | | TCR | SCR | RQD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 100 | 93 | 78 | -1.6 | | GP: GRAVEL: cream mottled pale orange brown, fine to coarse grained, subrounded to sub angular, of coral and calcarenite ... from 0.00m to 0.04m, stained dark greenish grey Coarse CALCISILTITE/ Coralline CALCARENITE: fine to medium grained; cream mottled pale pink and pale grey; medium to high strength' coral is medium to coarse grained; subrounded to subangular with pale grey shells (less than 25mm); with shell borings (less than 20mm) | L | | | | | | | | | 0.10-1.60m:PT, IR, aperture 5-10mm, (clean or infilled fine gravel stained brown) 0.10-0.30m:C | | |
| | | | | | | -1.7 | 1 | | | | | | | | | | | 1.00-1.15m:C | | |
| | | | | 100 | 100 | 80 | | 2 | | | | | | | | | | 1.60-3.10m:PT, IR, stained dark orange brown | | |
| | | | 100 | 20 | 20 | | 3 | | ... at 2.60m, recovered as fine to coarse gravel; trace cobble (<70mm) | | | | | | | | | | | |
| | | | | | | | | | Borehole terminated at 3.1 m | | | | | | | | | | | |
| | | | | | | | 4 | | | | | | | | | | | | | |
| | | | | | | | 5 | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc
 This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH13

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 10/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807288.6, N: 7573779.0 | Hole Diameter: HQ 96mm | Plant: Subsea HQ3 Rig |
| Checked by: MT | Elevation: -1.60 | Angle from Horizontal: 90° | Contractor: TAMS |



BH13: 0.0m to 3.1m

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BOREHOLE LOG - BH16

Client: Department of Transport
 Project: Tantabiddi Boating Facility
 Location: Exmouth
 Project ID: PER2020-0495
 Date: 11/05/2021



1:25 Sheet 1 of 1

Logged by: TR Position: E.807273m N.7573876m (GDA 2020) Hole Diameter: 61mm Plant: Subsea HQ3 Drill Rig
 Checked by: MAT Elevation: -2.096 m (AHD) Contractor: TAMS

| Drilling Method | Well | Groundwater | Coring | | | RL (m) | Depth (m) | Graphic Log | Rock/Soil Description | Consistency | Moisture Condition | Rock Strength | | | | | | Cementation/Weathering | Defect Spacing (mm) | Samples, test results and additional Data |
|-----------------|------|-------------|--------|-----|-----|--------|-----------|---|-----------------------|-------------|--------------------|---------------|---|---|---|----|---|--|---------------------|---|
| | | | TCR | SCR | RCD | | | | | | | VL | L | M | H | VH | EH | | | |
| HQ3 | | | 100 | 3 | 0 | -2.1 | 0 | GP: Sandy GRAVEL: cream mottled pinkish brown and yellow, fine to coarse grained, subangular to subrounded, of calcarenite, coral and shells; sand, fine to coarse grained. | | | | | | | | | | 0.00-1.35m: Gravel recovered from core barrel, sand from SPT. 0.00-1.35m:D 0.5m:SPT; (5,8,13) N=21 | | |
| | | | 100 | 100 | 72 | -3.4 | 1 | Coarse CALCISILTITE/ Coralline CALCARENITE: fine grained; cream mottled pale pinkish brown; medium to high strength; coral is medium to coarse grained; subrounded with vugs(<30mm); with shell borings (<20mm), vugs are infilled by fine grained calcarenite; reddish brown; low to medium strength | W | | | | | | | | 1.35-3.00m:PT, IR, 5-10mm aperture stained reddish brown, (infilled with fine grained calcarenite, reddish brown) 1.50-1.80m:C | | | |
| | | | 100 | 100 | 100 | | 2 | | | | | | | | | | 2.30-2.40m:C 2.50-2.60m:C | | | |
| | | | | | | 3 | | Borehole terminated at 3.0 m | | | | | | | | | | | | |
| | | | | | | 4 | | | | | | | | | | | | | | |
| | | | | | | 5 | | | | | | | | | | | | | | |

Termination reason: Target Depth Reached
 Remarks: Hole backfilled by tidal influence. C core sample. D= small disturbed sample. * a "shell boring" is a tube bored into the calcareous rock by a small mollusc
 This report must be read in conjunction with accompanying notes and abbreviations.

CORE PHOTOGRAPHS: BH16

Client: Department of Transport
Project: Tantabiddie Boating Facility
Location: Tantabiddie Boat Ramp, WA
Project ID: PER2020-0495
Date: 11/05/2021



Sheet No. 1 of 1

| | | | |
|----------------|-------------------------------------|----------------------------|-----------------------|
| Logged by: TR | Position: E: 807273.3, N: 7573875.6 | Hole Diameter: HQ 96mm | Plant: Subsea HQ3 Rig |
| Checked by: MT | Elevation: -2.10 | Angle from Horizontal: 90° | Contractor: TAMS |



BH16: 0.0m to 3.0m

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