Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Assessment

Proposed Alterations and Additions
1015 Barrenjoey Road, Palm Beach

Prepared for
John Boyd Properties

Project 45391.04
September 2022

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Geotechnics | Environment | Groundwater

Document History

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		6 September 2022
Reviewer		6 September 2022

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Geotechnical Assessment
Proposed Alterations and Additions
1015 Barrenjoey Road, Palm Beach

1. Introduction

Douglas Partners Pty Ltd (DP) has been engaged to undertake a geotechnical assessment in relation to the proposed alterations and additions at 1015 Barrenjoey Road, Palm Beach (the site).

The work was undertaken for Mr John Boyd, the property owner, acting under instructions from Walter Barda Design, the project architects. The report was prepared in general accordance with DP's proposal dated 6 June 2021.

The assessment comprised a walkover inspection of the site by a senior engineering geologist and reference to the following documents:

- DP report Project 45391 dated 13 March 2008 (previous geotechnical investigation undertaken in relation to the design of the existing residence);
- Architectural Drawings A-100, A-111, A-130, A-135 and A-190 by Walter Barda Design (Project No. 2010_16 Boyd, all Issue A dated 10 June 2022); and
- Structural Drawings S0 to S3 (for the existing residence) by Geoff Nines Fong and Partners P/L (Job SN7865, all Issue B dated 29 January 2015).

The previous geotechnical investigation by DP comprised the drilling of six test bores, six cone penetration tests and laboratory testing of selected samples. Details of the previous report are included herein where relevant to the currently proposed alterations and additions.

The current geotechnical assessment was undertaken in conjunction with the preparation of an acid sulfate soil management plan (ASSMP) for the proposed alterations and additions. Details of the ASSMP are provided in our report 45391.04.R.002.Rev0 dated 6 September 2022.

2. Site Description

The site is located on the south-western side of Barrenjoey Road, between the road and Pittwater foreshore, at the southern end of Sandy Beach. The site comprises a rectangular area of 1119 square metres, with a width of about 15 m and a length of about 75 m. The site is identified as Lot 54 of DP 14682. A site layout is presented in Drawing 1 Appendix B.

The site typically slopes gently in a south-westerly direction from the road to the beach, with surface levels falling from about RL 2.0 to about RL 1.5. At the time of the investigation the site was occupied by a two-storey sandstone and clad residence with a slate roof. A clad garage with terrace roof adjoined the north-eastern side of the residence and a detached timber deck and attached service rooms is located approximately 15 m to the south-west of the main residence.

Reference to the supplied structural design drawings for the existing residence indicates that the structures are founded on screw piles.

The remainder of the site around the existing structures is generally covered by grass lawns or paved. The lawn between the residence and the detached timber deck has been raised approximately 0.6 m above the general level of the adjacent properties and is supported by sandstone clad retaining walls.

The adjacent properties to the north-west and south-east are occupied by two and three storey residences which extend to within a couple of metres of the common boundaries.

3. Previous Investigation

3.1 Field Work Methods

A bobcat-mounted drilling rig was used to drill six bores (Bores 1 to 6) to depths of 3.45 m. The bores were drilled using spiral flight augers through the soils. Standard penetration tests were carried out at regular depth intervals within the soils and disturbed samples were collected from the augers. In two of the bores (Bores 2 and 5) standpipe piezometers were installed to depths of 3 m to allow measurement and sampling of the groundwater.

Following completion of the drilling, six cone penetration tests (CPTs 1 to 6) were undertaken immediately adjacent to the bore locations to obtain accurate measures of the density of the sands below the water table. Three of the CPTs (CPTs 2, 3 & 6) were taken to the original proposed investigation depth of 6 m, while the other three were continued to depths of 10-14 m to try to identify suitable founding materials for piles, if required.

The cone penetration tests involve forcing a 35 mm diameter cone into the soil at a constant rate and measuring the resistance to penetration. The testing equipment includes hydraulic rams mounted on the back of a ballasted truck in order to provide the reaction required to cause penetration. The resistance to penetration is recorded by strain gauges located in the cone tip and on the friction sleeve immediately behind the tip. The resistances are plotted continuously on a computer screen and are subsequently downloaded for later production of graphical results.

The locations of the tests are shown on Drawing 1 in Appendix B. The locations were measured using a tape from existing site features and the levels of the tests were measured relative to levels shown on the survey plan of the site.

3.2 Field Work Results

Details of the conditions encountered in the test bores are given on the borehole logs in Appendix C, together with notes defining the terms used to describe and classify the soils.

The results of the cone penetration tests are also given in Appendix C, together with general notes on the methods used in the tests and the interpretation of the results. It should be noted that there are a number of well documented interpretation procedures which all give similar but not necessarily identical results. The interpretation methods employed by Douglas Partners are based on overseas research and adapted for local conditions using the results of testing over approximately 20 years.

The results of the bores and CPTs indicated that most of the site is underlain by sand to depths of more than 14 m, with a few thin layers of silty sand and silty clay. CPT 5, the most northern test, was terminated at a depth of 10 m within very stiff to hard clay which is possibly the top of the weathered rock profile. An approximate section through the site with summary logs of the tests is given on Drawing 2 in Appendix B.

All the tests indicated that the upper 5-6 m of sands are very loose to loose. The deeper CPTs indicated that there were some medium dense layers within the sand below depths of about 6 m but that these were not consistent across the site. CPTs 1 and 4 both intersected medium dense sand layers below depths of about 12 m, and it is possible that this is a more consistent layer.

Groundwater levels were measured during drilling of the bores and after testing the CPTs. In addition, the water levels were measured in the two standpipes twice on one day and compared to the tide levels. The measured groundwater levels are summarised in Table 1 below.

Table 1: Measured Groundwater Levels

Test	Ground Level (m)	Water Levels (m AHD)			
		13/2/08 Bores	20/2/08 CPTs	20/2/08 Standpipes 9:25 am	20/2/08 Standpipes 11:40 am
1	1.50	0.5	0.45		
2	1.57	0.6	0.42	0.42	0.47
3	1.40	0.4	0.50		
4	1.50	0.5	0.55		
5	1.62	0.6	0.87	0.87	0.92
6	1.64	0.6	0.64		
Tide level (Fort Denison)				*1.75*	*1.11*

4. Previous Laboratory Testing

Particle size distribution tests were undertaken on two samples of the soils from Bore 3 and Bore 5. The detailed results of these tests are attached given in Appendix C and indicate that the soils are predominantly fine to medium grained sands with less than 6-8% fines.

In addition, chemical tests were undertaken on four soil samples to measure the pH, sulphate and chloride content. The detailed results for these tests are summarised in Table 2 below.

Table 2: Chemical Tests on Soils

Bore	Depth (m)	pH (pH units)	Sulphate (mg/kg)	Chloride (mg/kg)
1	0 - 0.5	7.8	<25	<100
5	1.0 - 1.5	6.5	<25	<100
5	2.5 - 3.0	6.1	<25	<100
6	0.5 - 1.0	6.4	<25	<100

5. Proposed Development

The proposed works will involve an upper storey addition to the front of the building (as viewed from Barrenjoey Road) for a rumpus room space, two guest bedrooms and a bathroom. The upper storey addition will be located above the existing ground level garage and over the existing driveway.

The proposed works will also involve a proposed in ground swimming pool and surrounding fence, and a small deck addition on the Pittwater frontage.

The footprints of the proposed alterations and additions are indicated on Drawing 1.

6. Comments

6.1 Interpreted Geotechnical Model

As indicated in previous sections and as shown on Drawing 2, the site is underlain by deep sand deposits with groundwater at shallow depth.

The sands are typically very loose to loose in the upper 5-6 m, with some non-continuous medium dense layers below this. Sand which is consistently medium dense is expected to occur below depths of about 12 m over most of the building footprint.

The monitoring of the groundwater indicates that, at the time of investigation in 2008, the groundwater was typically about 1 m below existing ground levels, but the water levels may be affected by the tidal variations in Pittwater.

6.2 Excavations

Excavation to depths of around 1.5 m to 2.5 m for the proposed swimming pool is expected to encounter very loose to loose sands. While the sands will be readily excavatable using standard earthmoving equipment, the controlling factor for the excavation will be the shallow groundwater level.

Unless underwater construction techniques are proposed, it will be necessary to dewater the building area to at least 0.5 m below the proposed pool excavation level in order to allow construction of the pool shell. Trafficability over the very loose sands is likely to be difficult, even after dewatering.

Any construction activities, including ground vibrations from earthmoving equipment and dewatering for excavation, could potentially contribute to differential settlement of the very loose and loose sands under adjacent buildings, particular those supported on shallow footings. It is therefore recommended that dilapidation surveys be carried out on the neighbouring buildings prior to commencement of construction so that an accurate assessment of any damage caused by the construction can be made.

Any temporary batter slopes proposed for the sands above the groundwater level should have slopes of 1.5:1 (H:V) or flatter.

6.3 Dewatering

Groundwater levels were measured at about 1 m below existing surface levels and it is probable that these levels will rise following high tides or periods of heavy rainfall. It is suggested that the design of the proposed swimming pool should allow for the groundwater levels to rise to the existing surface levels.

Temporary dewatering may be required in order to construct the proposed swimming pool.

The permeability of the sands has been estimated from the particle size distribution tests as being about 2 x 10-4 m/sec. There are no apparent low permeability layers within the strata which are suitable for providing a cut off.

Dewatering, if required, could be carried out using spear points. It should be noted that estimation of groundwater inflow is notoriously difficult, particularly for sites close to the sea, and many spears may be required to maintain target water levels.

6.4 Retaining Structures

For design of the pool walls, a cantilevered wall, a standard triangular earth pressure distribution should be adopted, using an active earth pressure coefficient (Ka) of 0.35 and a unit weight of 18 kN/m^3 for the sands above the water table.

6.5 Foundations

In accordance with the recommendations given in AS2870- 1996 (Residential slabs and footings) the site is underlain by deep loose sand and therefore has been classified as Class P.

Reference to the supplied structural design drawings for the existing residence indicates that the structures are founded on screw piles. The drawings indicate that each screw pile is required to support a vertical working load of 150 kN and have a design life of 100 years.

The structural engineer for the current project will need to determine whether the existing screw piles can support the additional loadings arising from the proposed alterations and additions or whether supplementary footings will be required

The options for new or additional foundation systems on the site include:

- strip footings founded at least 0.8 m below the basement level;
- screw piles; or
- piles founded on the medium dense sand layer at depths of about 12 m below existing surface levels.

6.5.1 Strip Footings

If strip footings are adopted, then they must be taken to at least 0.8 m below the finished basement level and may be designed for a maximum allowable bearing pressure of 50 kPa.

It should be noted that the very loose and loose sands will settle slightly under the load of the building and there may be some differential settlement between footings depending on the soil conditions immediately underlying the footings. There is also a potential for liquefaction of these sands should an earthquake occur, and this could result in some uneven settlements across the site.

Settlement of the strip footings under the design bearing pressures of 50 kPa are expected to be less than about 5-10 mm.

If strip footings are adopted, then it would be necessary to undertake regular testing to ensure that the near surface sands have been uniformly compacted. Conventionally testing is performed with a nuclear density meter to determine the in-situ density which is then compared to the maximum and minimum dry density achieved in the laboratory.

Alternatively, a dynamic sand penetrometer (Perth sand penetrometer - Test Method AS1289.6.3.3) may be used. In this test a steel rod is driven into the ground and the number of blows required to achieve penetration are recorded. For this site it is recommended that a minimum penetration resistance of 5 blows per 150 mm be specified for the 0.5 m below the footings.

If screw piled footings are adopted, then the piling contractor should be required to guarantee that the piles will support the design loads and no further testing is required.

6.6 Filling

It is generally expected that fine to medium grained sand which will be excavated from the proposed pool would be suitable for reuse on the site as filling, if required.

In areas where filling is required it is recommended that the following procedures be undertaken:

- Remove any existing vegetation from the ground surface;
- Place the sand filling in uniform layers approximately 300 mm thick and compacted to a density index of 70%; and

- On completion of the testing carry out Perth sand penetrometers to depths of 1.5 metres to ensure that the sand is uniformly well compacted. Minimum acceptable penetration resistances of 5 blows per 150 mm are considered appropriate to ensure the filling is adequately compacted for most purposes.

6.7 Seismic Design

For designs to be undertaken in accordance with AS1170.4-1993 (Earthquake Loads) an acceleration coefficient (a) of 0.08 and a site factor of 1.5 are considered appropriate for the site.

For designs undertaken in accordance with the recently revised edition of the standard AS1170.4-2007 (Earthquake actions in Australia) a hazard factor (z) of 0.08 and a sub-soil class De are recommended.

6.8 Stability Assessment

The former Pittwater Council's Geotechnical Risk Management Map (2007) indicates that a small portion of the north-eastern end of the site is identified as Hazard Zone 1 (H1). H1 applies to areas where the likelihood of slope instability has been assessed to range from possible to almost certain.

It is apparent that the regional map has been based on large scale assessment rather than individual assessment of each property. The current site is almost flat and underlain by deep sand deposits. The only potential slope stability hazard to this site would be failure of part of the hill slope on the other side of Barrenjoey Road off this site. In the unlikely event that this occurred, for damage to property to occur the slide would have to travel some distance across the road and on to the site.

The risk of slope failure on this site has been assessed for property and life in accordance with the requirements of Pittwater Council's Geotechnical Risk Management Policy (2007) and the guidelines prepared by the Australian Geomechanics Society 2007. The identified hazards within and above the site are summarised in the Table 3, together with a qualitative assessment of the likelihood of occurrence, consequence and risk to property and a quantitative assessment of the risk to life.

Table 3: Slope Risk Assessment for Proposed Development

Hazard	Risk to	Likelihood	Consequence	Risk
Failure of slope to the east of Barrenjoey Road	Property	Rare	Minor	Very Low
	Life			5×10^{-10}

For the loss of life, the individual risk can be calculated from:

$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$

where:

$R_{(LoL)}$ *is the risk (annual probability of loss of life (death) of an individual)*

$P_{(H)}$ *is the annual probability of the hazardous event (the boulder failure)*

$P_{(S:H)}$ *is the probability of spatial impact by the hazard (e.g. of the rock fall reaching the residence the taking into account the travel distance for a given event)*

$P_{(T:S)}$ *is the temporal probability (e.g. of the building being occupied by the individual) given the spatial impact*

$V_{(D:T)}$ *is the vulnerability of the individual (probability of loss of life of the individual given the impact).*

When compared to the requirements of the Pittwater GRMP, it is considered that the proposed design will achieve the "Acceptable Risk Management" criteria for both property and life under current and foreseeable conditions and that the site is suitable for the development proposed to be carried out.

7. Limitations

Douglas Partners (DP) has prepared this report for this project at 1015 Barrenjoey Road, Palm Beach in accordance with DP's email proposal dated 6 July 2022. The work was carried in accordance with DP's Conditions of Engagement.

This report is provided for the exclusive use of Mr John Boyd and his agents and only for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or another site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during previous investigations. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

Notes About this Report

About this Report

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Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

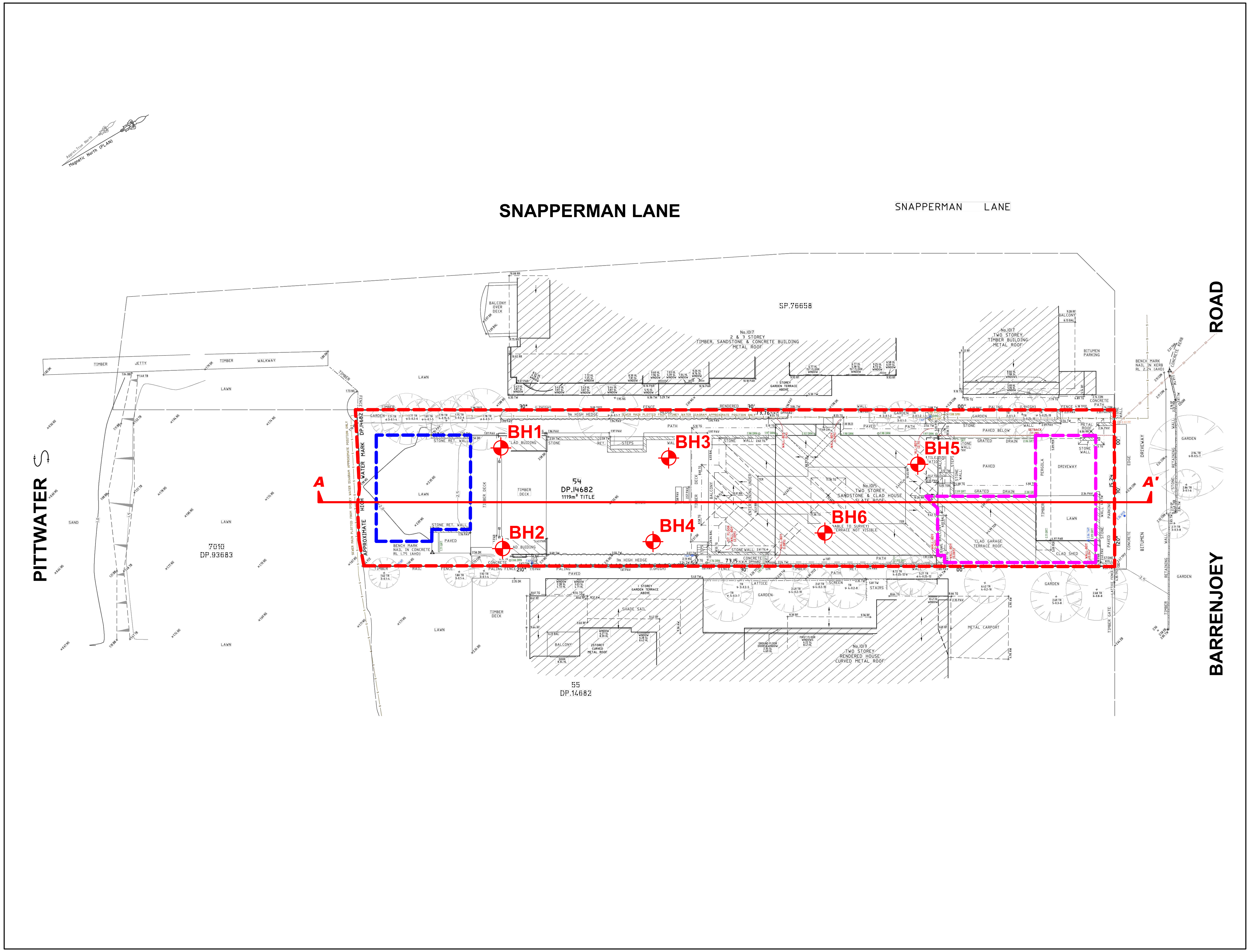
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

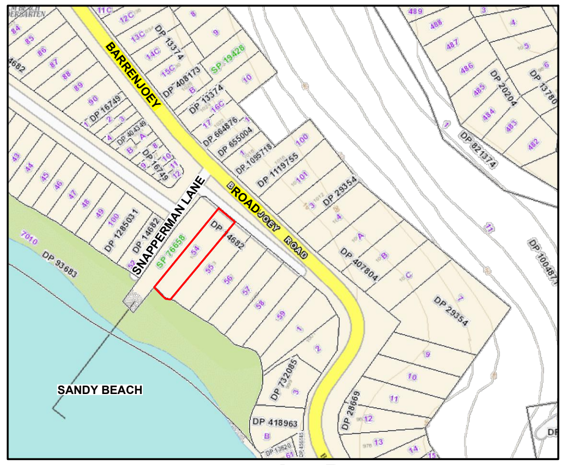
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings





Locality Plan

LEGEND

- Approximate Site Boundary
- Previous Test Bore + CPT
- Proposed Swimming Pool Outline
- Proposed Upper Storey Additions
- Geological Cross Section A-A' (Refer to Drawing 2)

NOTE:

1: Base Survey Plan from CMS Surveyors Pty Ltd, 21251detail-Issue 1 (Dated 07/04/2022)

0 2 4 6 8 10 15 20 30 40m

1:400 @ A3

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CLIENT: Mr. John Boyd		TITLE: **Site Plan**
OFFICE: Sydney	DRAWN BY: CC	**Proposed Alterations and Additions**
SCALE: 1:400 @ A3	DATE: 02.09.2022	**1015 Barrenjoey Road, Palm Beach**

PROJECT No:	45391.04
DRAWING No:	1
REVISION:	0

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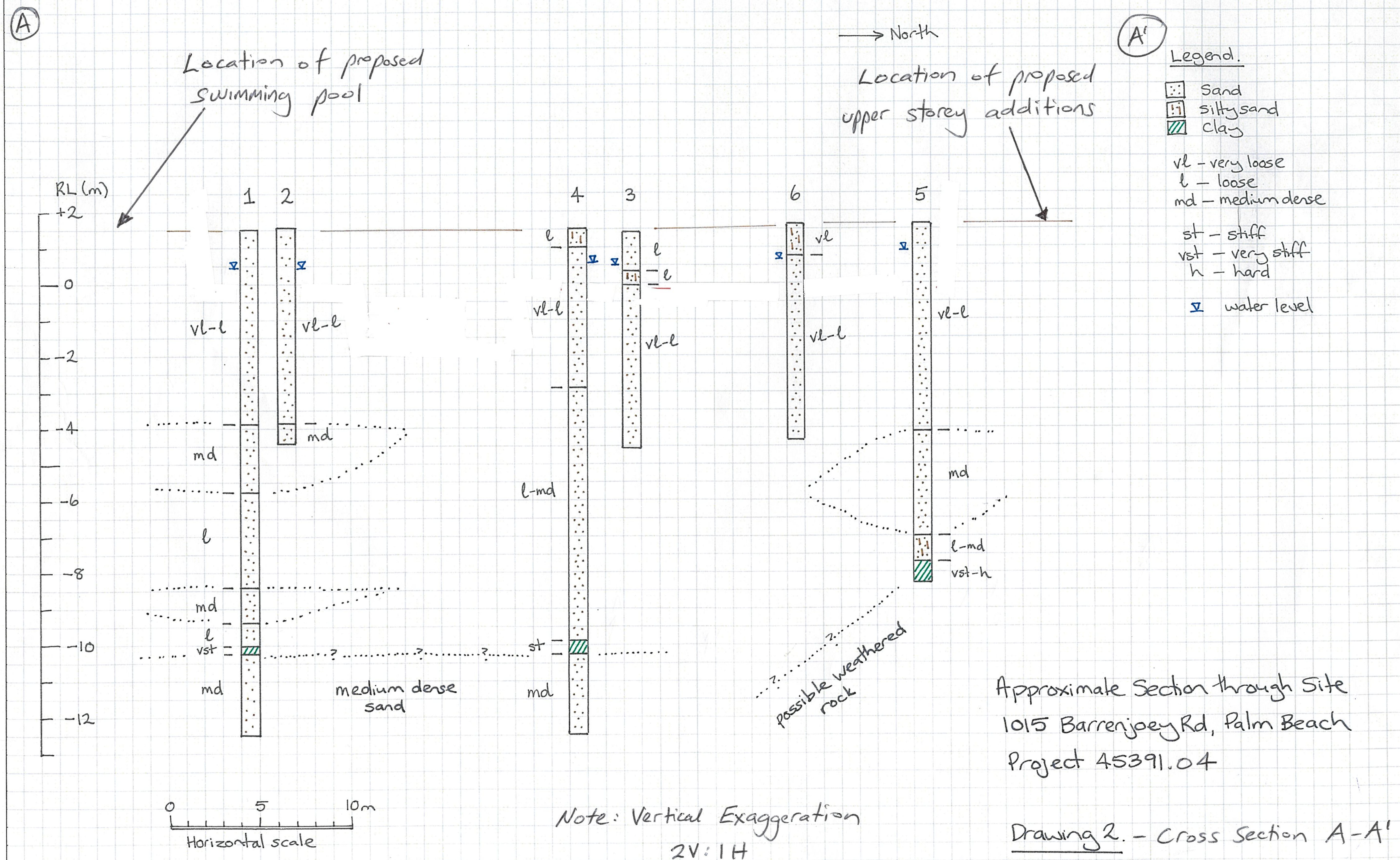
PROJECT: 1015 Barrenjoey Rd, Palm Beach - Alterations + Additions | Project No: 45391.02 | Page No: | Calcs By: | Checked By: | Date: Sept 2022



Approximate Section through Site
1015 Barrenjoey Rd, Palm Beach
Project 45391.04

Drawing 2. - Cross Section A-A'

FORM: A3 Grid

Appendix C

DP (2008) Borehole Logs

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.

  Soil tends to stick together.

  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.

  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w <PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w >PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈LL' (i.e. near the liquid limit).
- 'Wet' or 'w >LL' (i.e. wet of the liquid limit).

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $Is_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	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.
Extremely weathered	XW	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
Highly weathered	HW	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 recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	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 recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} > 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

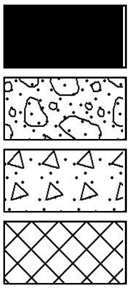
Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

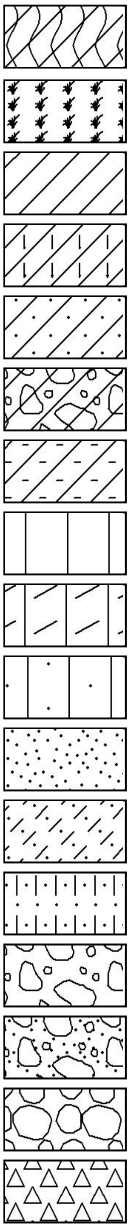
Graphic Symbols for Soil and Rock

General



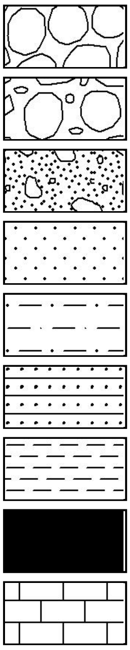
- Asphalt
- Road base
- Concrete
- Filling

Soils



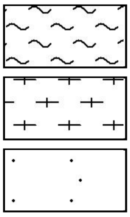
- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks



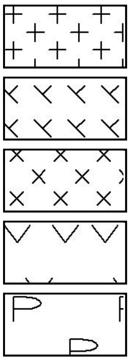
- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks



- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks



- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

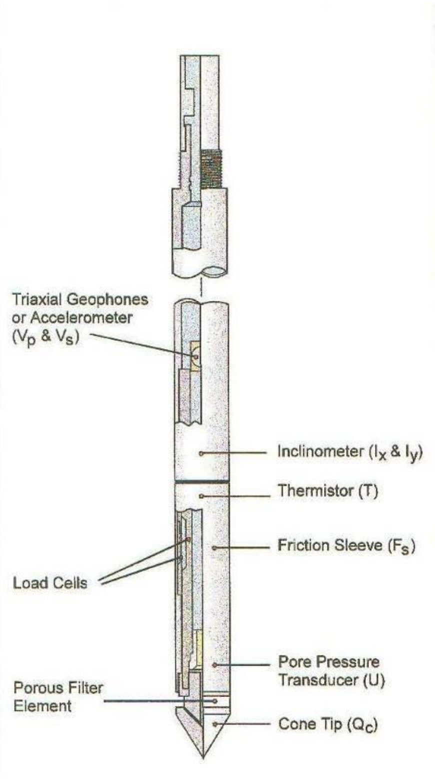


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.

Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

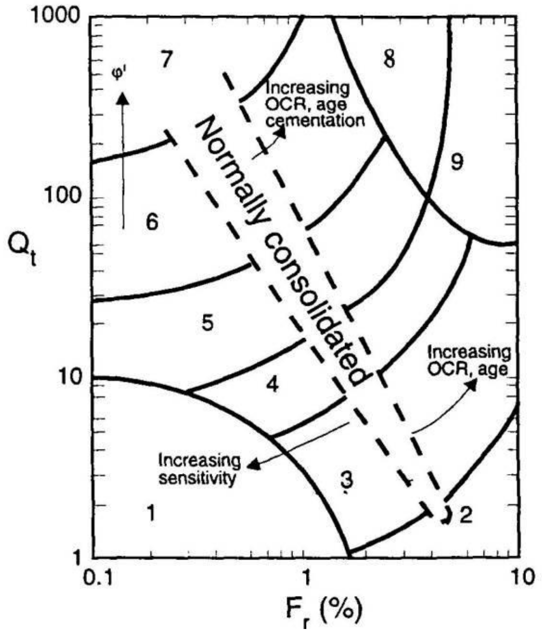


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

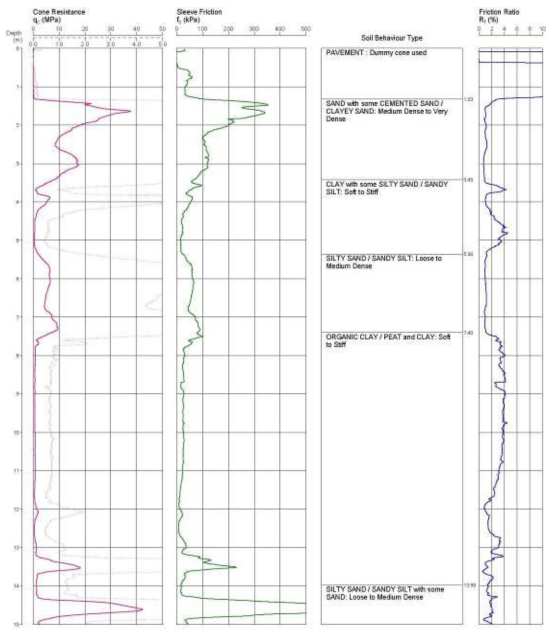


Figure 4: Sample Cone Plot

BOREHOLE LOG

CLIENT: John Boyd
PROJECT: New Residence
LOCATION: 1015 Barrenjoey Road, Palm Beach

SURFACE LEVEL: 1.50
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 45391
DATE: 13 Feb 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	FILLING (topsoil) - dark brown silty sand filling with some organic matter, roots, moist		A	0.0 0.05				
		SAND - very loose to loose, yellow, fine to medium grained sand, damp							
1		- yellow sand, saturated		A	1.0			▼	
				S			3,4,3 N = 7		
0					1.45 1.5				
				S			1,0,2 N = 2		
	2.0				1.95 2.0				
		SAND - very loose to loose, grey fine to medium grained sand, with some shells, saturated		S			1,0,2 N = 2		
-1					2.45				
				A	2.5				
				S			2,4,3 N = 7		
					2.95 3.0				
				S			1,2,1 N = 3		
-2	3.45	Bore discontinued at 3.45m - target depth reached			3.45				
-3									

RIG: Auger **DRILLER:** E Grima **LOGGED:** GN **CASING:** Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: JM
Date: 3/08

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

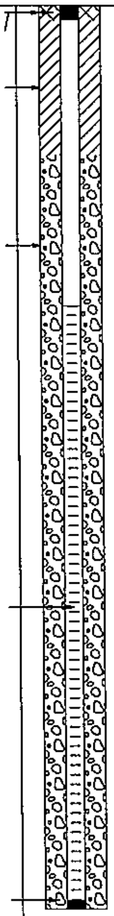
CLIENT: John Boyd
PROJECT: New Residence
LOCATION: 1015 Barrenjoey Road, Palm Beach

SURFACE LEVEL: 1.57
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 45391
DATE: 13 Feb 08
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
0.1	FILLING (topsoil) - dark brown silty sand filling, with some organic matter and roots	A	0.0 0.1			
	SAND - very loose to loose, yellow fine to medium grained sand, damp					
1	- yellow sand, saturated	A	1.0			▼ 13-02-08
		S			2,2,4 N = 6	
	- shell inclusions	A	1.45 1.5			
		S			1,1,1 N = 2	
2			1.95 2.0			
		S			1,1,4 N = 5	
		A	2.45 2.5			
		S			3,3,5 N = 8	
3			2.95 3.0			
		S			2,1,2 N = 3	
3.45	Bore discontinued at 3.45m - target depth reached		3.45			

Well Construction Details:



RIG: Auger DRILLER: E Grima LOGGED: GN CASING: Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling
REMARKS: Groundwater level measured on 13/02/08 - 1.0m bgl

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: [handwritten initials]
Date: 3/08

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: John Boyd
PROJECT: New Residence
LOCATION: 1015 Barrenjoey Road, Palm Beach

SURFACE LEVEL: 1.40
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 45391
DATE: 13 Feb 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.1	FILLING (topsoil) - dark brown silty sand filling, with some organic matter and roots, moist		A	0.0 0.1				
		SAND - yellow fine to medium grained sand, damp							
	1.0	SAND - very loose to loose, grey, fine to medium grained sand, saturated		A	1.0			▼	
				S	1.45		1,1,2 N = 3		
				S	1.5 1.95		2,2,3 N = 5		
		- shell inclusions		S	2.0 2.45		1,2,1 N = 3		
				A	2.45 2.5				
				S	2.5 2.95		1,1,1 N = 2		
				S	3.0 3.45		1,2,1 N = 3		
	3.45	Bore discontinued at 3.45m - target depth reached							

RIG: Auger **DRILLER:** E Grima **LOGGED:** GN **CASING:** Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: 7M
Date: 3/08

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: John Boyd
PROJECT: New Residence
LOCATION: 1015 Barrenjoey Road, Palm Beach

SURFACE LEVEL: 1.50
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 45391
DATE: 13 Feb 08
SHEET 1 **OF** 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - dark brown clayey sand filling, with some organic matter and roots, moist		A	0.0 – 0.05				
1	0.5	SAND - very loose, yellow fine to medium grained sand, damp		A	0.5 – 1.0				
		- yellow sand, saturated		A	1.0			▼ (1.0)	
				S	1.0 – 1.45		2,2,1 N = 3		
0				S	1.5 – 1.95		1,0,1 N = 1		
				A	1.95 – 2.0				
	2.0	SAND - very loose, grey fine to medium grained sand with some shells, saturated		S	2.0 – 2.45		1,1,2 N = 3		
-1				S	2.5 – 2.95		1,1,2 N = 3		
				S	3.0 – 3.45		1,1,0 N = 1		
-2	3.45	Bore discontinued at 3.45m - target depth reached							

RIG: Auger **DRILLER:** E Grima **LOGGED:** GN **CASING:** Uncased

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: TM
Date: 3/08

Douglas Partners
Geotechnics · Environment · Groundwater

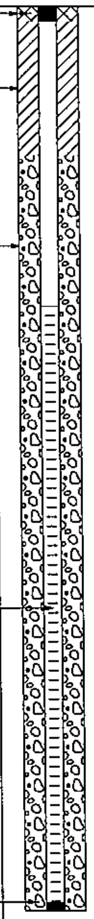
BOREHOLE LOG

CLIENT: John Boyd
PROJECT: New Residence
LOCATION: 1015 Barrenjoey Road, Palm Beach

SURFACE LEVEL: 1.62
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 45391
DATE: 13 Feb 08
SHEET 1 **OF** 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - dark brown silty sand filling, with some organic matter and roots, ceramic and asbestos fragment		A	0.0 – 0.5				Gatic cover; Backfill; Bentonite
	0.5	SAND - very loose, grey fine to medium grained sand, damp							Backfilled with gravel
1	1	- grey sand, saturated		A*	1.0			▼ (1.0)	
				S	1.0 – 1.45		2,2,3 N = 5		
0				S	1.5 – 1.95		1,0,1 N = 1		
	2	- shell inclusions		S	2.0 – 2.45		1,0,0 N = 0		Machine slotted PVC screen
-1				A	2.45 – 2.5				
				S	2.5 – 2.95		1,0,1 N = 1		
	3			S	3.0 – 3.45		1,1,1 N = 2		End cap (3)
-2	3.45	Bore discontinued at 3.45m - target depth reached			3.45				
	4								
-3									



RIG: Auger **DRILLER:** E Grima **LOGGED:** GN **CASING:** Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling
REMARKS: *Replicate sample BD1/130208 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 3/08

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: John Boyd
PROJECT: New Residence
LOCATION: 1015 Barrenjoey Road, Palm Beach

SURFACE LEVEL: 1.64
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 45391
DATE: 13 Feb 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - dark brown silty sand filling, with some organic matter and rootlets, moist		A	0.0 – 0.5				
	0.5	CLAYEY SAND - very loose, black clayey sand, damp		A	0.5 – 1.0				
	1	- clayey sand, saturated		S	1.0 – 1.45		1,0,1 N = 1	▼ (1.0)	
0				S	1.5 – 1.95		1,1,2 N = 3		
	2	- shell inclusions		S	2.0 – 2.45		1,1,0 N = 1		
-1				A S	2.5 – 2.95		1,0,1 N = 1		
	3			S	3.0 – 3.45		1,1,1 N = 2		
	3.45	Bore discontinued at 3.45m - target depth reached			3.45				
-2									
	4								
-3									

RIG: Auger **DRILLER:** E Grima **LOGGED:** GN **CASING:** Uncased
TYPE OF BORING: Solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED	
Initials:	[handwritten initials]
Date:	3/08

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CONE PENETRATION TEST

CLIENT: JOHN BOYD

PROJECT: NEW RESIDENCE

LOCATION: 1015 BARRENJOEY ROAD, PALM BEACH

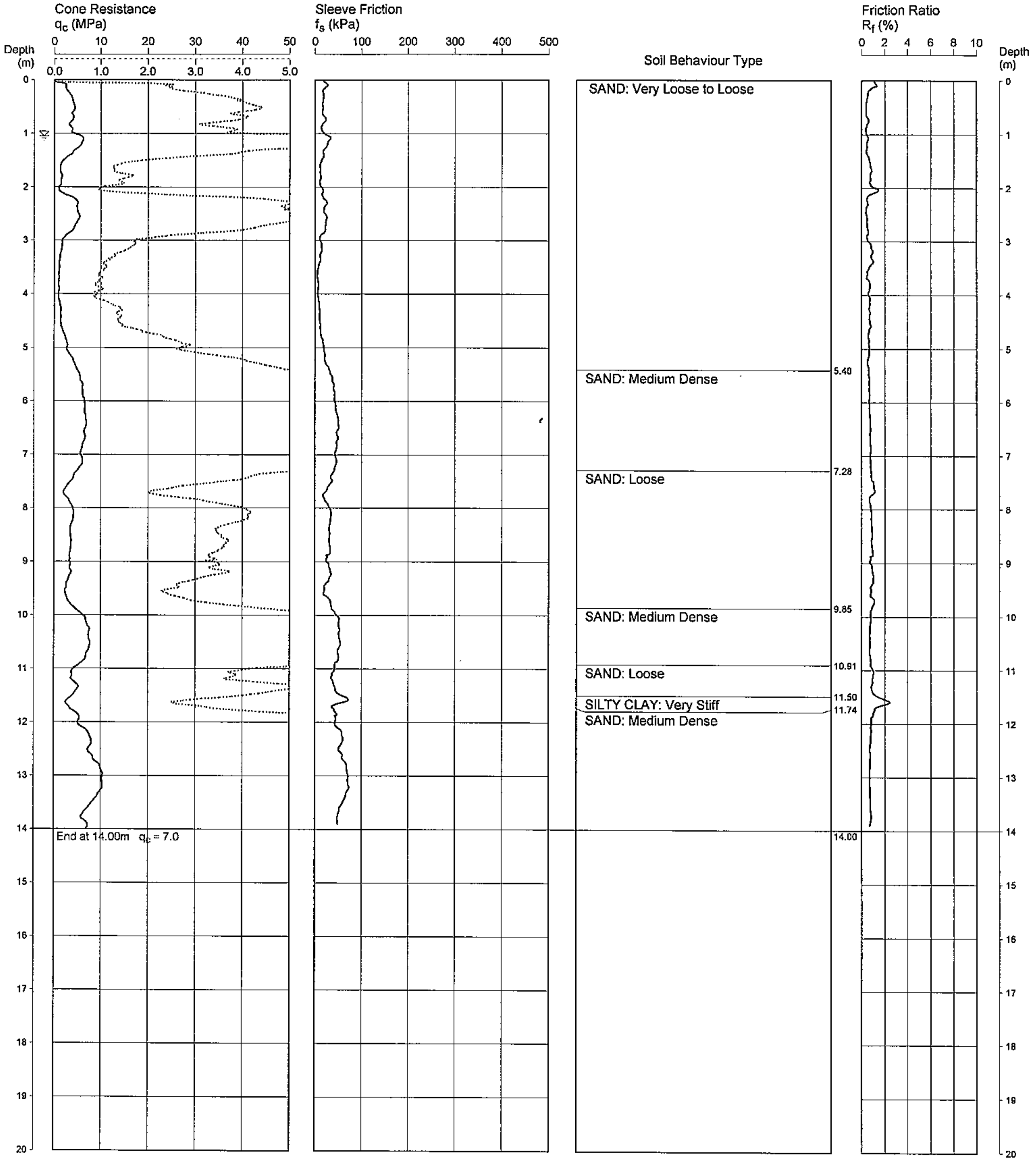
PROJECT No: 45391

CPT 1

Page 1 of 1

DATE 20/02/2008

SURFACE RL: 1.50



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST: 1.05 m

Date	
Plotted	
Checked	

File: P:\45391 PALM BEACH, 1015 Barrenjoey Road - Geotech & Prelim. Contam & AS[redacted]Fi[redacted]\45391-01.CP5
Cone ID: CONE-411 **Type:** 2 Standard

ConePlot Version 5.8.1

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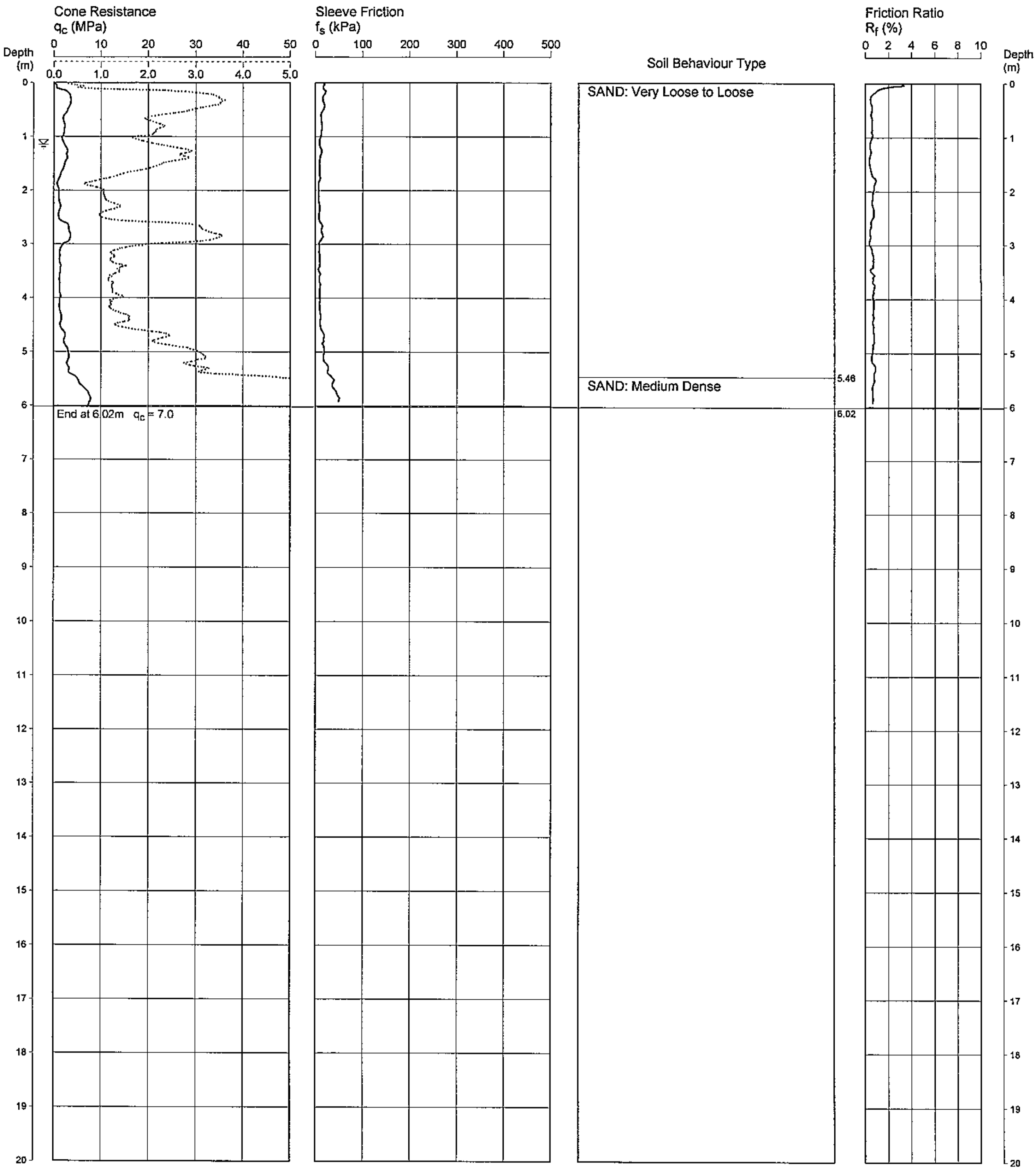
CONE PENETRATION TEST		**CPT 2**
CLIENT: JOHN BOYD	**PROJECT:** NEW RESIDENCE	Page 1 of 1
	LOCATION: 1015 BARRENJOEY ROAD, PALM BEACH	**DATE** 20/02/2008
	PROJECT No: 45391	**SURFACE RL:** 1.57



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST: 1.15 m

Date
Plotted
Checked

File: P:\45391 PALM BEACH, 1015 Barrenjoey Road - Geotech & Prelim. Contam & AS Fi \45391-02.CP5
Cone ID: CONE-411 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
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CONE PENETRATION TEST

CLIENT: JOHN BOYD

PROJECT: NEW RESIDENCE

LOCATION: 1015 BARRENJOEY ROAD, PALM BEACH

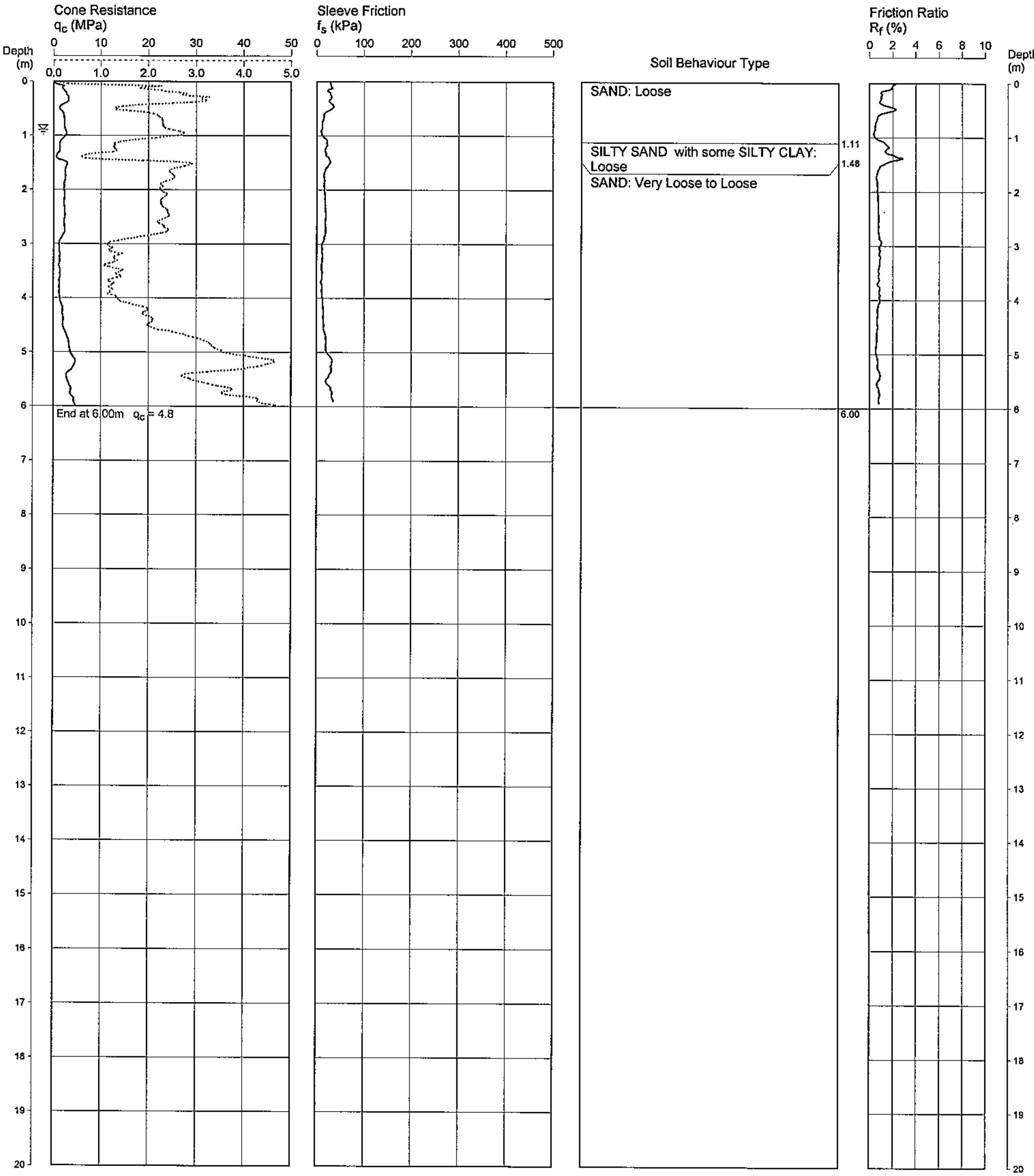
PROJECT No: 45391

CPT 3

Page 1 of 1

DATE 20/02/2008

SURFACE RL: 1.40



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST: 0.9 m

Date
Plotted
Checked

File: P:\45391 PALM BEACH, 1015 Barrenjoey Road - Geotech & Prelim. Contam & AS[redacted]Fi[redacted]\45391-03.CP5
Cone ID: CONE-411 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: JOHN BOYD

PROJECT: NEW RESIDENCE

LOCATION: 1015 BARRENJOEY ROAD, PALM BEACH

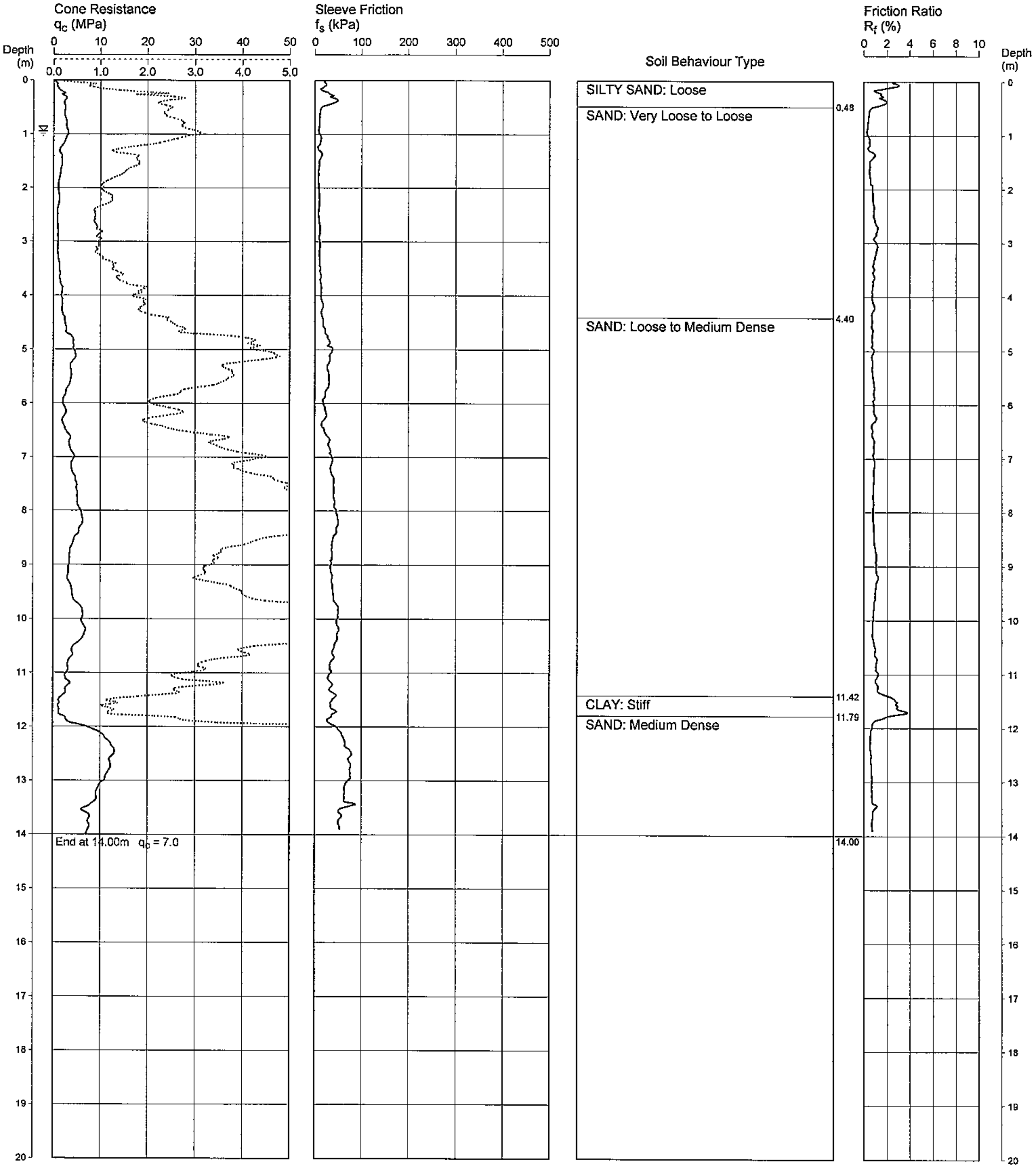
PROJECT No: 45391

CPT 4

Page 1 of 1

DATE 20/02/2008

SURFACE RL: 1.50



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST: 0.95 m

Date	
Plotted	
Checked	

File: P:\45391 PALM BEACH, 1015 Barrenjoey Road - Geotech & Prelim. Contam & AS[redacted]Fie[redacted]\45391-04.CP5
Cone ID: CONE-411 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: JOHN BOYD

PROJECT: NEW RESIDENCE

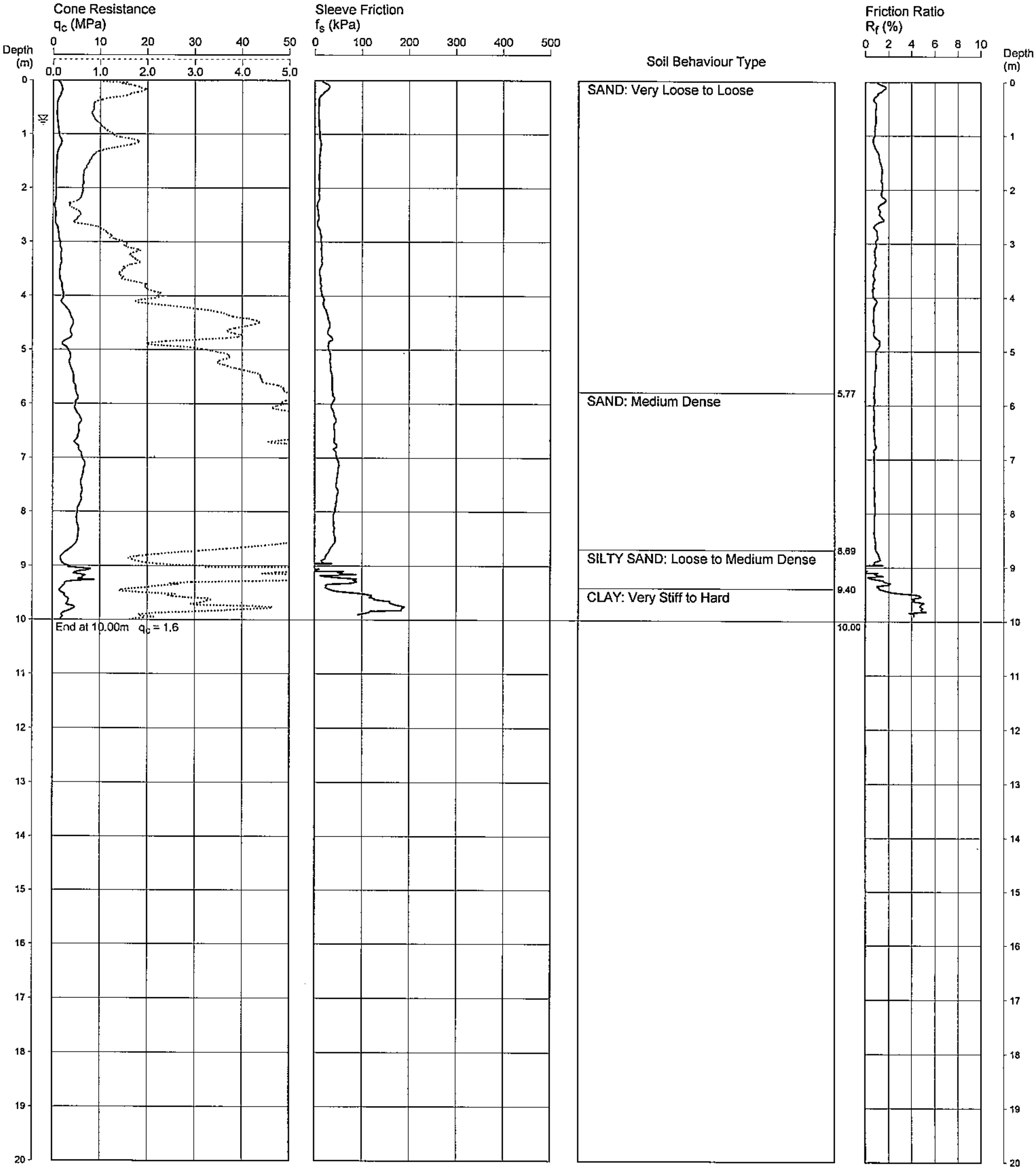
LOCATION: 1015 BARRENJOEY ROAD, PALM BEACH

PROJECT No: 45391

CPT 5

DATE 20/02/2008

SURFACE RL: 1.62



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST: 0.75 m

Date
Plotted
Checked

File: P:\45391 PALM BEACH, 1015 Barrenjoey Road - Geotech & Prelim. Contam & AS[redacted]Fi[redacted]\45391-5A.CP5
Cone ID: CONE-411 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: JOHN BOYD

PROJECT: NEW RESIDENCE

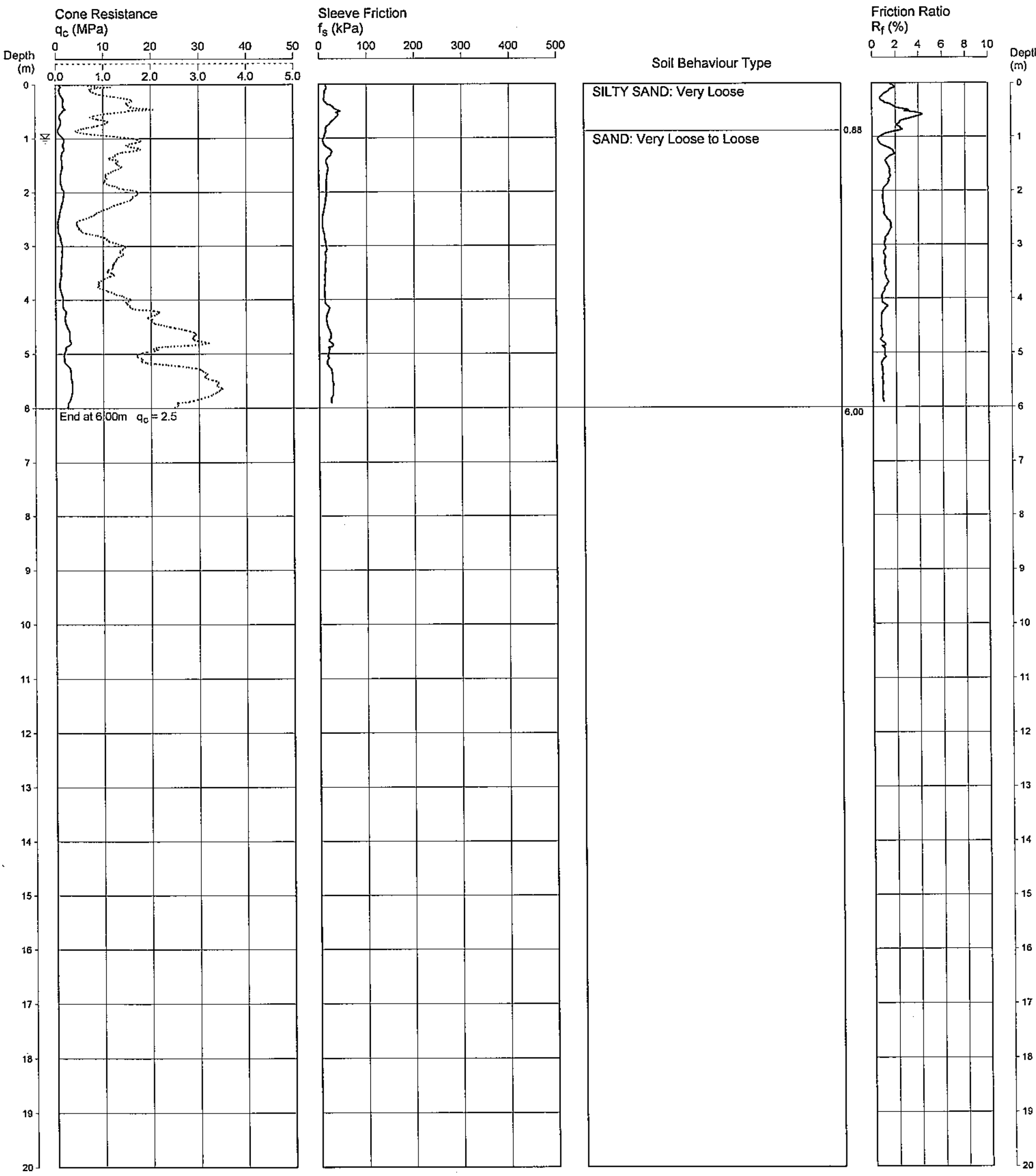
LOCATION: 1015 BARRENJOEY ROAD, PALM BEACH

PROJECT No: 45391

CPT 6

DATE 20/02/2008

SURFACE RL: 1.64



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST: 1.0 m

Date
Plotted
Checked

File: P:\45391 PALM BEACH, 1015 Barrenjoey Road - Geotech & Prelim. Contam & AS[illegible] Fi[illegible]\45391-06.CP5
Cone ID: CONE-411 **Type:** 2 Standard

ConePlot Version 5.8.1

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Douglas Partners
Geotechnics · Environment · Groundwater

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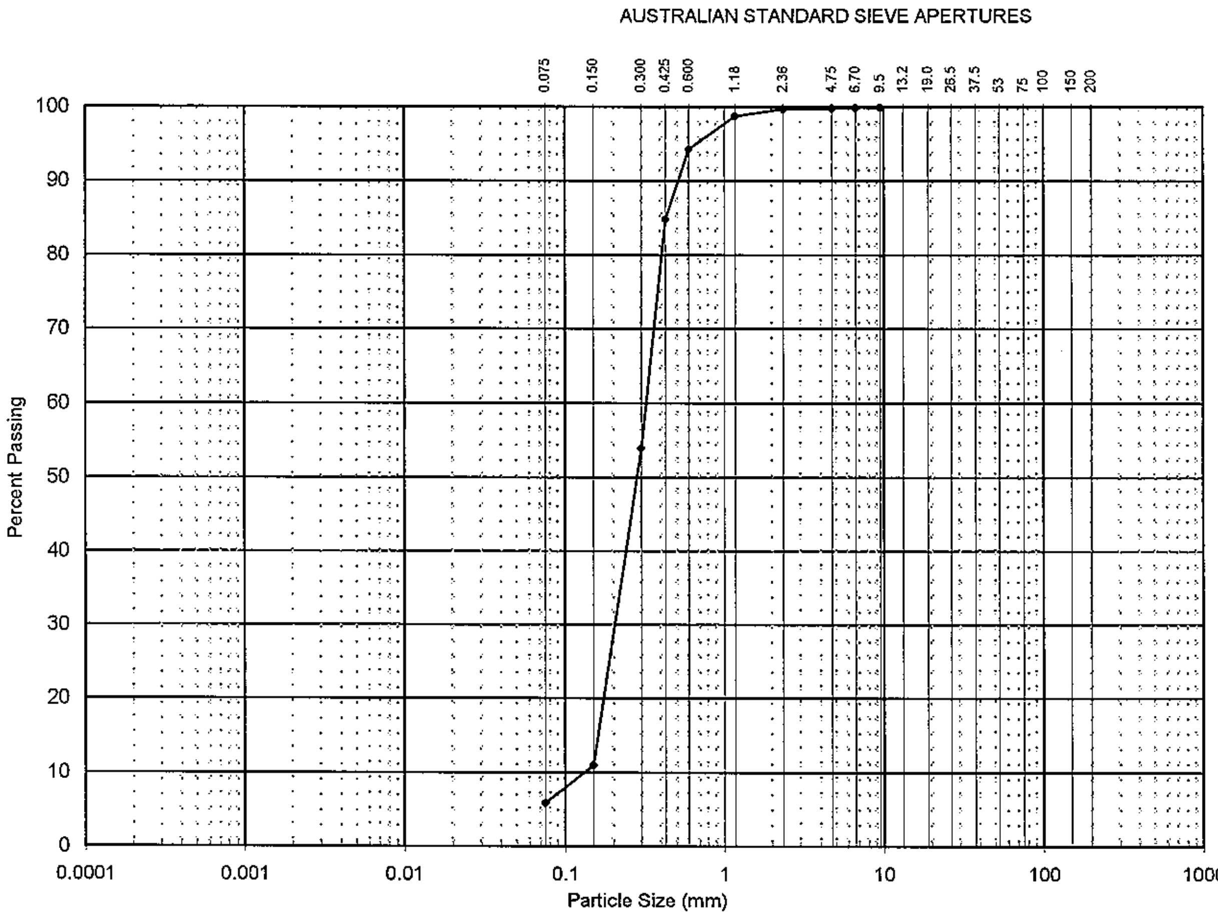
sydney@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	JOHN BOYD			**Project No. :**	45391
				Report No. :	S08-033 A
Project :	C/TAYLOR THOMSON WHITTING			**Report Date :**	21-Feb-08
				Date Sampled:	13-Feb-08
Location :	PALM BEACH			**Date of Test:**	20-Feb-08
Road No:	-	**Sample / Pit No:**	3	**Depth / Layer:**	1.0 - 1.45m
Chainage:	-	**Section / Lot No:**	-	**Test Request No:**	-
				Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	~
9.5	100%
6.7	100%
4.75	100%
2.36	100%
1.18	99%
0.600	94%
0.425	85%
0.300	54%
0.150	11%
0.075	6%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: SAND - Brown medium grained sand with some clay fines

Test Method(s): AS 1289.3.6.1 - 1995, AS 1289.3.6.3 - 1995

Sampling Method(s): AS 1289.1.2.1 ( ) - 1998, AS1289.1.1 - 2001

Remarks: -

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	AI
Checked:	NW

Norman Weimann
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

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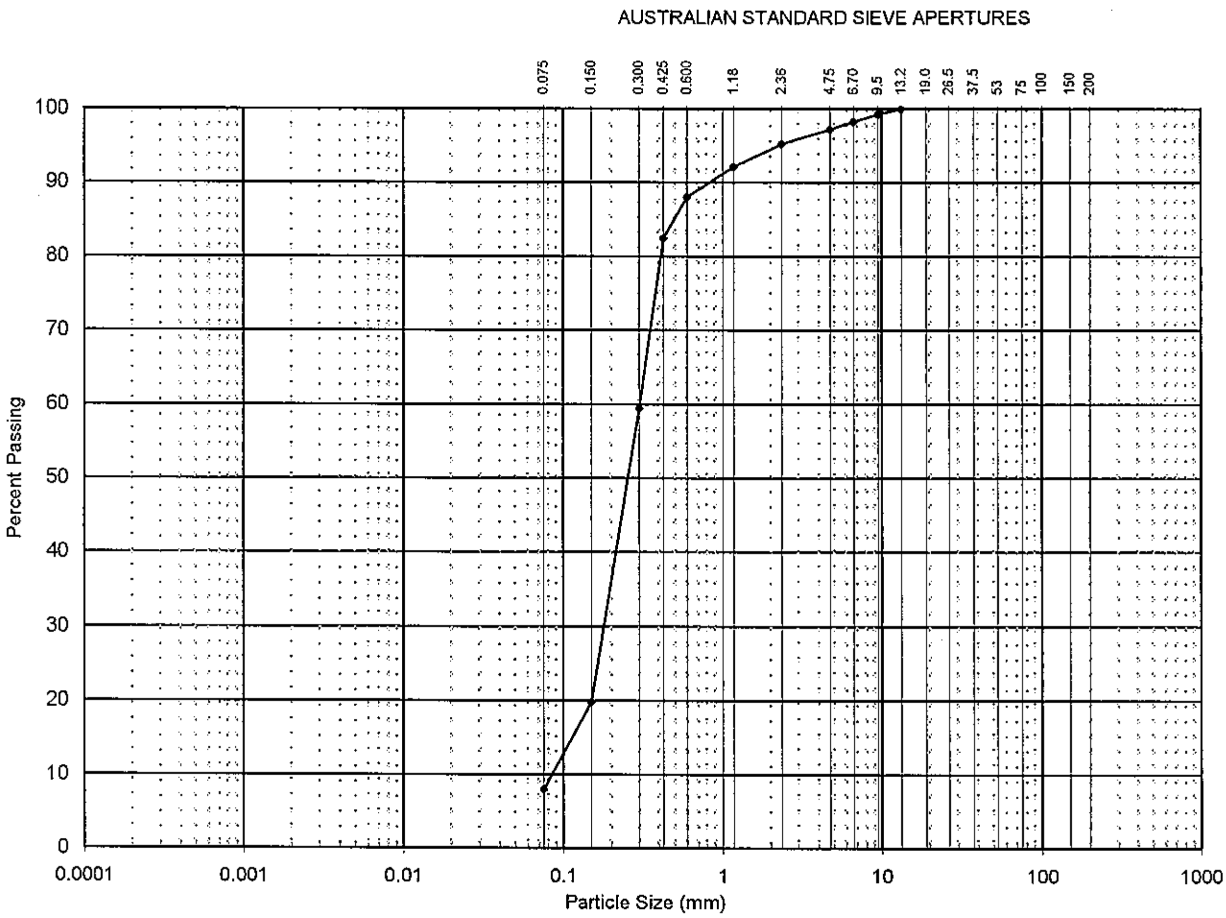
RESULTS OF PARTICLE SIZE DISTRIBUTION

Client :	JOHN BOYD	**Project No. :**	45391
		Report No. :	S08-033 B
Project :	C/TAYLOR THOMSON WHITTING	**Report Date :**	21-Feb-08
		Date Sampled:	13-Feb-08
Location :	PALM BEACH	**Date of Test:**	20-Feb-08
Road No:	- **Sample / Pit No:** 5	**Depth / Layer:**	2.5 - 2.95m
Chainage:	- **Section / Lot No:** -	**Test Request No:**	-
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	~
13.2	100%
9.5	99%
6.7	98%
4.75	97%
2.36	95%
1.18	92%
0.600	88%
0.425	82%
0.300	59%
0.150	20%
0.075	8%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: SAND - Dark grey and brown medium grained sand with some gravel and clay fines

Test Method(s): AS 1289.3.6.1 - 1995, AS 1289.3.6.3 - 1995

Sampling Method(s): AS 1289.1.2.1 ( ) - 1998, AS1289.1.1 - 2001

Remarks: -

NATA
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NATA Accredited Laboratory Number: 828
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Approved Signatory:

Tested:	AI
Checked:	NW

Norman Weimann
Laboratory Manager

PITTWATER COUNCIL

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER
FORM NO. 1 – To be submitted with Development Application

Development Application for Mr John Boyd	
Name of Applicant	
Address of site 1015 Barrenjoey Road, Palm Beach	

Declaration made by geotechnical engineer or engineering geologist or coastal engineer (where applicable) as part of a geotechnical report

I, Luke James-Hall on behalf of Douglas Partners P/L
(Insert Name) (Trading or Company Name)

on this the 6 September 2022 certify that I am a geotechnical engineer or engineering geologist or coastal engineer as defined by the Geotechnical Risk Management Policy for Pittwater - 2009 and I am authorised by the above organisation/company to issue this document and to certify that the organisation/company has a current professional indemnity policy of at least $2million.
I have:

Please mark appropriate box

- ☐ Prepared the detailed Geotechnical Report referenced below in accordance with the Australia Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ I am willing to technically verify that the detailed Geotechnical Report referenced below has been prepared in accordance with the Australian Geomechanics Society's Landslide Risk Management Guidelines (AGS 2007) and the Geotechnical Risk Management Policy for Pittwater - 2009
- ☐ Have examined the site and the proposed development in detail and have carried out a risk assessment in accordance with Section 6.0 of the Geotechnical Risk Management Policy for Pittwater - 2009. I confirm that the results of the risk assessment for the proposed development are in compliance with the Geotechnical Risk Management Policy for Pittwater - 2009 and further detailed geotechnical reporting is not required for the subject site.
- ☐ Have examined the site and the proposed development/alteration in detail and am of the opinion that the Development Application only involves Minor Development/Alterations that do not require a Detailed Geotechnical Risk Assessment and hence my report is in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009 requirements for Minor Development/Alterations.
- ☐ Provided the coastal process and coastal forces analysis for inclusion in the Geotechnical Report

Geotechnical Report Details:

Report Title:	Proposed Alterations + Additions (45391.04, R.001.Rev0)
Report Date:	6 September 2022
Author:	David Murray
Author's Company/Organisation:	Douglas Partners P/L

Documentation which relate to or are relied upon in report preparation:

Arch. Dwgs A-100, A-111, A-130, A-190 Walter Barda Design (Rev A)
Survey J-CMS Surveyors 2125I Issue 1 - 7/4/22
St. Drawings S0-S3 Nimes Fong - Issue B - 29/1/15

I am aware that the above Geotechnical Report, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Geotechnical Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature ……[signature]……

Name …… Luke James-Hall ……

Chartered Professional Status…… CPEng ……

Membership No. …… 3403382 ……

Company…… Douglas Partners P/L ……

PITTWATER COUNCIL

GEOTECHNICAL RISK MANAGEMENT POLICY FOR PITTWATER

FORM NO. 1(a) - Checklist of Requirements For Geotechnical Risk Management Report for Development Application

Development Application for Mr John Boyd
Name of Applicant

Address of site 1015 Barrenjoey Rd, Palm Beach

The following checklist covers the minimum requirements to be addressed in a Geotechnical Risk Management Geotechnical Report. This checklist is to accompany the Geotechnical Report and its certification (Form No. 1).

Geotechnical Report Details:

Report Title: Proposed Alterations + Additions
Report Date: 6 Sept 2022
Author: David Murray
Author's Company/Organisation: Douglas Partners P/L

Please mark appropriate box

- ☑ Comprehensive site mapping conducted 2008 + 2022 (date)
- ☑ Mapping details presented on contoured site plan with geomorphic mapping to a minimum scale of 1:200 (as appropriate)
- ☐ Subsurface investigation required
  - ☑ No Justification Previously undertaken in 2008
  - ☐ Yes Date conducted ……
- ☑ Geotechnical model developed and reported as an inferred subsurface type-section
- ☐ Geotechnical hazards identified
  - ☑ Above the site
  - ☐ On the site
  - ☐ Below the site
  - ☐ Beside the site
- ☑ Geotechnical hazards described and reported
- ☑ Risk assessment conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
  - ☑ Consequence analysis
  - ☐ Frequency analysis
- ☑ Risk calculation
- ☑ Risk assessment for property conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ Risk assessment for loss of life conducted in accordance with the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ Assessed risks have been compared to "Acceptable Risk Management" criteria as defined in the Geotechnical Risk Management Policy for Pittwater - 2009
- ☑ Opinion has been provided that the design can achieve the "Acceptable Risk Management" criteria provided that the specified conditions are achieved.
- ☐ Design Life Adopted:
  - ☑ 100 years
  - ☐ Other …… specify
- ☐ Geotechnical Conditions to be applied to all four phases as described in the Geotechnical Risk Management Policy for Pittwater - 2009 have been specified N/A
- ☐ Additional action to remove risk where reasonable and practical have been identified and included in the report. N/A
- ☐ ~~Risk assessment within Bushfire Asset Protection Zone.~~

I am aware that Pittwater Council will rely on the Geotechnical Report, to which this checklist applies, as the basis for ensuring that the geotechnical risk management aspects of the proposal have been adequately addressed to achieve an "Acceptable Risk Management" level for the life of the structure, taken as at least 100 years unless otherwise stated, and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Signature [signature]
Name Luke James-Hall
Chartered Professional Status CPEng
Membership No. 3403382
Company Douglas Partners Pty Ltd