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Integrated Practical Solutions

Report on
Geotechnical Investigation

Sutherland Hospital Planning Project
Kareena Road, Caringbah

Prepared for
Health Infrastructure

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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.

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NCS INTERNATIONAL CERTIFIED QUALITY MANAGEMENT SYSTEM

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Report on Geotechnical Investigation
Sutherland Hospital Planning Project
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1. Introduction

This report presents the results of a geotechnical investigation undertaken for the Sutherland Hospital Planning Project, Kareena Road, Caringbah. The work was commissioned by Health Infrastructure, in consultation with TSA Management Pty Ltd, project managers.

The project involves the construction of a new building at the north-western corner of the main hospital building and associated civil works to reconfigure the carpark and entrance roads into the facility. It is understood that the new building will be constructed at or close to the existing ground surface levels; a basement is not proposed.

Geotechnical investigation was undertaken to provide information on the subsurface conditions on the site and included the drilling of three augered boreholes and six cored boreholes, laboratory testing and engineering analysis. Details of the field work and comments relevant to design and construction are given in this report.

A Preliminary Site Investigation for contamination purposes was undertaken at the same time as the geotechnical investigation and is reported separately.

2. Site Description

The Sutherland Hospital campus is located at the corner of the Kingsway and Kareena Road, Caringbah. It is bounded by the Kingsway to the north, residential dwellings to the east, the Sutherland-Cronulla railway line to the south, and Kareena Road to the west. The main hospital buildings are located in the central portion of the site. The surrounding areas contain smaller satellite buildings, on-grade parking areas and open space. The north-western portion of the site is relatively level; the remaining areas slope gently downwards to the east and south.

The portion of the campus on which the development is proposed is shown on Drawing G1 in Appendix B.

3. Regional Geology and Hydrogeology

The *Wollongong-Port Hacking 1:100 000 Geological Series Sheet* indicates that the site is underlain by Hawkesbury Sandstone which typically comprises medium to coarse-grained quartz sandstone with minor shale and laminite lenses.

The groundwater table is likely to be well below the bedrock surface. Near-surface Hawkesbury Sandstone generally exhibits low permeabilities which result in very low groundwater yields. Groundwater use from this aquifer is therefore unlikely to be significant. Surface water is likely to follow the surface topography and flow to the south and east.

An extract from the geological map is shown in Figure 1.

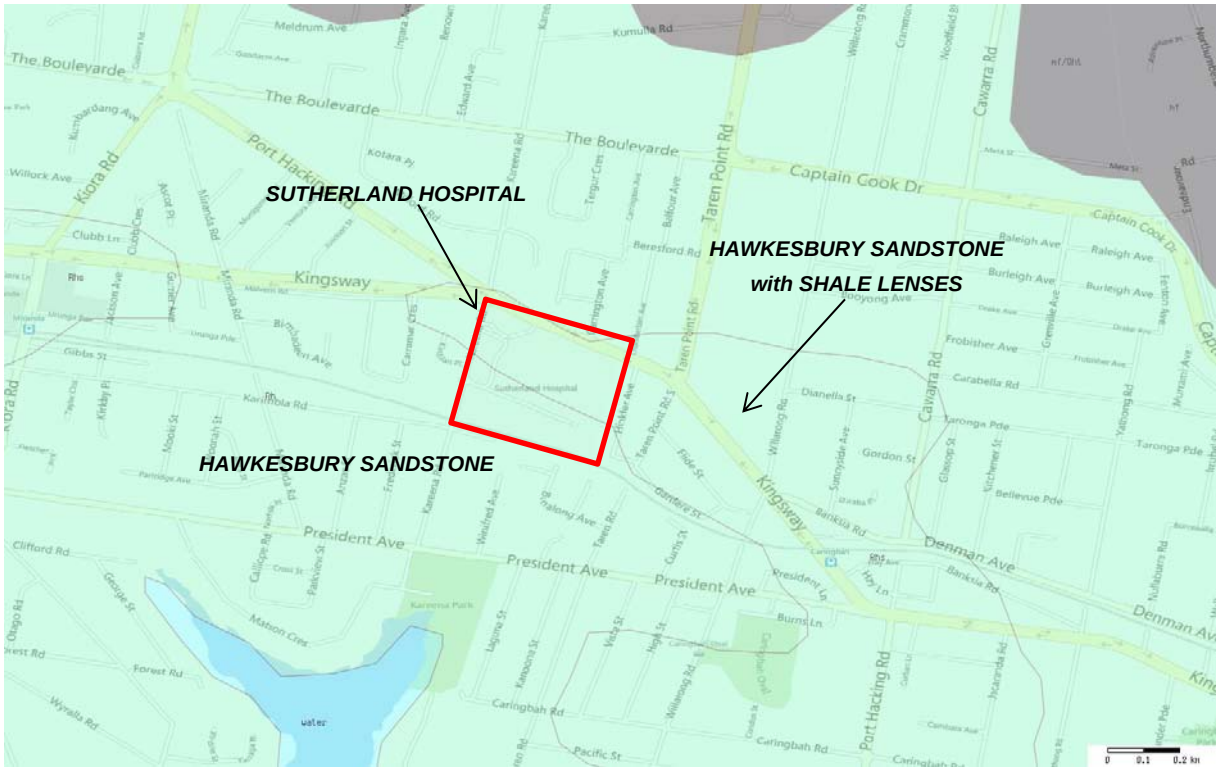

Figure 1: Extract from geological map

4. Field Work Methods

The field work included the drilling of three augered boreholes (BH1 to BH3) to depths of 1.5 m and six cored boreholes (BH4 to BH9A) to depths of 6.0 m to 7.0 m using a DT250 drilling rig. BH9 refused on an obstruction and BH9A was reattempted a short distance away. The augered bores were drilled using solid flight augers. The cored bores were drilled using solid flight augers until weathered rock was encountered, then continued using NMLC-sized diamond core drilling equipment to obtain 50 mm diameter continuous core samples for identification and strength testing purposes.

A groundwater monitoring well was installed in BH7 and BH9A at the completion of drilling to allow groundwater level measurements to be made.

The locations of the boreholes are shown on Drawing G1 in Appendix B. The ground surface levels at the test locations were measured relative to the Australian Height Datum (AHD) using an automatic level.

5. Field Work Results

The subsurface conditions encountered in the boreholes are presented in the borehole logs in Appendix C. Notes defining descriptive terms and classification methods are included in Appendix A.

The augered boreholes encountered asphalt overlying sandy and gravelly filling with brick, concrete, steel, plastic and tile to depths of 0.7 m to 1.5 m. Natural clay soil was encountered below the filling in BH1 and BH3 only.

The cored boreholes encountered:

- FILLING – concrete pavement in the northern area and asphalt pavement in the southern area, underlain by clayey and sandy filling with brick, concrete, sandstone and shale gravel, plastic and tile to depths of 0.4 m to 3.3 m. A concrete slab was encountered below the filling in BH6 and BH9A which is likely to be the remnants of the old building on the site;
- NATURAL SOIL – very stiff to hard clay from depths of 0.4 m and 0.5 m in BH7 and BH8 only. Natural soil was not encountered in the other cored boreholes;
- BEDROCK – weathered shale bedrock below depths of 1.2 m to 3.6 m. The shale was typically extremely low to very low strength initially, grading to medium strength rock with depth. Some high strength bands were also encountered. The rock was fragmented in most of the bores.

Table 1 summarises the levels at which different materials were encountered in the cored boreholes. The rock has been classified in accordance with a system developed by Pells, Douglas et al in the 1970s and updated by Pells et al (1998) which classifies rock strata depending on strength, fracturing and defects. Class V rock is typically very low strength, highly weathered and highly fractured rock whereas Class I rock is typically high strength, fresh and unbroken rock.

Table 1: Summary of Material Strata Levels and Rock Classifications

Stratum	RL of Top of Stratum (m, AHD)					
	BH4	BH5	BH6	BH7	BH8	BH9
Ground Surface/ Filling	41.5	41.3	41.2	41.2	41.1	41.0
Natural Soil	NE	NE	NE	40.8	40.6	NE
Class V/IV Shale	40.3	39.7	37.6	39.6	39.6	38.8
Class III Shale	36.0	35.7	36.9	37.2	35.7	36.7
Base of Borehole	35.4	34.4	34.3	35.1	34.2	35.0

Notes: Rock classification in accordance with Pells et al (1998); NE = not encountered

Free groundwater was not observed during augering and the use of drilling fluid prevented groundwater observations during coring. The water levels in monitoring wells BH7 and BH9A were measured at depths of 3.1 m (RL 38.2 m) and 4.2 m (RL 36.8 m) respectively, on 4 July 2014

6. Laboratory Testing

6.1 Rock Samples

Twenty-one samples selected from the rock core were tested to determine the axial point load strength index (Is_{50}). The results ranged between 0.2 MPa and 2.6 MPa which correspond to low strength and high strength rock, respectively.

6.2 Soil Samples

Three soil samples obtained from the augered bores were tested to determine the California bearing ratio (CBR) of the soil. The samples were compacted to a dry density ratio of 100% relative to Standard compaction, subjected to a 4.5 kg surcharge and were soaked in a water bath for 4 days prior to testing. The results of the analysis are summarised in Table 2.

Table 2: Laboratory Test Results for California Bearing Ratio

Sample/Depth (m)	Material Description	Maximum Dry Density (t/m^3)	California Bearing Ratio (%)	Swell (%)
BH1/0.7-1.5	Clay	1.82	12	0.2
BH2/0.1-1.5	Sandy filling	1.83	110	0
BH3/0.1-1.0	Sandy filling	1.80	25	0

Two soil samples obtained from the cored bores were tested to determine the plasticity characteristics of the soil. The results of the analysis are summarised in Table 3.

Table 3: Laboratory Test Results for Plasticity

Sample/Depth (m)	Material Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
BH7/0.4-0.5	Clay	58	24	34
BH8/1.0-1.45	Clay	51	24	27

Two soil samples obtained from the cored bores were tested to determine the aggressivity characteristics of the filling. The results of the analysis are summarised in Table 4.

Table 4: Analytical Results for Selected Physical Properties in Soil

Sample/Depth (m)	pH (pH units)	EC (µS/cm)	Chloride ion (mg/kg)	Sulphate ion (mg/kg)
BH6/1.0-1.45	11.1	380	28	320
BH7/1.0-1.45	4.8	78	22	73

Notes: EC = electrical conductivity

The detailed laboratory test results are provided in Appendix D.

7. Geotechnical Model

The site appears to be underlain by filling, natural clayey soils in some areas, and weathered shale bedrock. A hospital building is known to have existed on the site which is understood to have had one basement level. The building was demolished in the early 2000s and it appears as though the basement was filled to form the current ground surface levels. The presence of concrete slabs/footings in bores BH6, BH9 and BH9A suggest that some of the structural elements of the building remain in place.

The filling was typically granular and contained building rubble (i.e. concrete, brick, tile, plastic, glass, steel and timber). Unless there is documentary evidence available to the contrary, it must be assumed that the filling is uncontrolled. The CBR results indicate that the sandy filling exhibits good subgrade strength when compacted to a dry density ratio of 100% relative to Standard compaction.

Natural clayey soil was only encountered in bores BH1, BH3, BH7 and BH8 which indicates that these bores were drilled outside the former basement footprint. The clays are moderately plastic and are likely to be moderately reactive to changes in moisture content.

The shale bedrock was typically extremely low to very low strength initially, grading to medium strength rock with depth. Some high strength bands were also encountered. The rock was fragmented in most of the bores.

Groundwater was observed at RL 38.2 m and RL 36.8 m AHD in the monitoring wells on the site. It is likely that this observed water was seepage rather than the regional groundwater table which is likely to be well below the bedrock surface.

This geotechnical model is shown on Sections A-A and B-B on Drawing G2 in Appendix B.

8. Proposed Development

The project involves the construction of a new building at the north-western corner of the main hospital building and associated civil works to reconfigure the carpark and entrance roads into the facility. It is understood that the new building will be constructed at or close to the existing ground surface levels; a basement is not proposed. Column loads in the order of 6000 kN (working) are proposed.

The geotechnical issues considered relevant to the proposed development include site preparation, excavation, excavation support, groundwater and foundations. Comments on seismicity and aggressivity are also provided.

9. Comments

9.1 Site Preparation

The existing filling is considered to be uncontrolled as there is no evidence to suggest that it has been placed and compacted to an engineering specification. It also contains some deleterious materials such as timber and steel. If the existing filling is required to support new pavements and building slabs then it will need to be reworked. The following process could be undertaken:

- Excavate the existing filling to expose natural clay soil or weathered shale bedrock;
- Prepare the subgrade by rolling with a large roller (e.g. 12 tonne deadweight) and ensure there are no areas that exhibit heaving under the roller;
- Place suitable filling in 250 mm thick layers (loose) and compact to achieve a dry density ratio of at least 98% relative to Standard compaction. This should be increased to 100% relative to Standard compaction for the top 300 mm of pavement subgrade;
- If the filling exhibits clay-like properties then the moisture content should be within 2% of optimum.

It is noted that the existing filling should be suitable for re-use provided that any deleterious materials (e.g. particles larger than 100 mm, waste, organic material etc.) are removed prior to or during placement.

Any new filling could also be placed in accordance with the procedure outlined above.

For pavement design purposes, a design subgrade CBR of 10% is considered appropriate for the materials on which the CBR testing was undertaken. Natural clay elsewhere on the site are likely to exhibit lower CBR values and a design subgrade CBR of 3% would be appropriate in this material.

The site would be classified as Class P in accordance with AS 2870 – 2011 *Residential slabs and footings* due to the presence of uncontrolled filling. The reactivity of the residual soils would be equivalent to those encountered on a Class M site.

9.2 Excavation

Excavation works for the new building and associated infrastructure may be required within filling, clayey soils and weathered shale. Excavation in these materials should be readily achievable using conventional earthmoving equipment such as a hydraulic excavator with bucket attachment. Bulk excavation in bedrock will not be required.

It should be noted that any off-site disposal of spoil will generally require assessment for re-use or classification in accordance with current *Waste Classification Guidelines* (NSW Department of Environment, Climate Change and Water, 2009).

9.3 Excavation Support

Vertical excavations in filling, soil and weathered shale are not expected to be stable. Temporary batters of 1(H):1(V) could be used to support the sides of the excavations in these materials for cuts up to 2 m deep. Permanent batters would need to be flattened to at least 2(H):1(V) and flatter where space permits.

Excavations retained either temporarily or permanently will be subjected to earth pressures down to the base of the excavation. Table 5 outlines material and strength parameters that could be used for the design of excavation support structures.

Table 5: Material and Strength Parameters for Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Filling	20	0.4	0.6	-
Residual Clays	20	0.3	0.45	200[1]
Class V/IV Shale	22	0.2	0.3	700[1]

Notes: [1]Only below bulk/detailed excavation/ground level

The lateral earth pressure distribution for cantilevered walls and for walls with a single row of support could be assumed to be triangular (i.e. increase with depth). Lateral pressures due to surcharge loads from adjacent buildings, the existing road corridors, sloping ground surfaces and construction machinery should be included where relevant. Hydrostatic pressure acting on retaining walls should also be included in the design where adequate drainage is not provided behind the full height of the walls.

9.4 Groundwater

Although free groundwater was not observed during augering, seepage was observed in the monitoring wells which would be expected to occur through joints in the rock and along strata boundaries. Seepage inflows into footing excavations, pile holes etc. will need to be managed appropriately during construction.

9.5 Foundations

As discussed previously, the existing filling is considered to be uncontrolled and is therefore unsuitable for supporting structures in its current state. If the filling is required to support building slabs then it will need to be reworked in accordance with Section 9.1 of this report.

The proposed column loads of 6000 kN (working) are relatively high and will therefore need to be supported on piles founded in the shale bedrock. Bored piles would be appropriate for this site and could be design using the parameters shown in Table 6. Parameters for both the working-stress and limit-state design approaches have been provided.

Table 6: Design Parameters for Bored Piles

Material Description	Allowable End-Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)*	Ultimate End-Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)*	Young's Modulus, E (MPa)
Class V/IV Shale	700	50	3000	200	100
Class III Shale	3500	350	20000	600	500

Notes: *Reduce by 50% for uplift loads and ensure cone-pullout criteria are met

It should be noted that the serviceability limit-state is likely to govern the design of the piles and the ultimate bearing pressures provided in Table 6 are unlikely to be achieved. An appropriate geotechnical strength reduction factor should be applied when using the limit-state approach as outlined in AS 2159 – 2009 *Piling – Design and installation*.

Settlement of a pile is dependent on the loads applied to the pile and the foundation conditions in the socket zone and below the pile toe. The settlement of a pile designed using the allowable parameters provided in Table 6 would be expected to be less than 10 mm. Serviceability analysis is needed to predict settlements if the limit-state design approach is used.

All bored pile excavations should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material, shaft roughness and socket cleanliness.

9.6 Seismicity

A Hazard Factor (*Z*) of 0.08 would be appropriate for the development site in accordance with Australian Standard AS 1170.4 – 2007 *Structural design actions – Part 4: Earthquake actions in Australia*. The site sub-soil class would be Class C_e.

9.7 Aggressivity

The laboratory test results for soil aggressivity were compared with the exposure classifications outlined in Australian Standard AS 2159 – 2009 *Piling – Design and installation*. The results indicate that the soils are mildly aggressive to buried concrete elements.

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the Sutherland Hospital Planning Project in accordance with agreement HI14186 with Health Infrastructure. The report is provided for the use of Health Infrastructure for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party.

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

DPs advice is based upon the conditions encountered during this investigation. 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 testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes 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 given 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.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk.

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Appendix A

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.

Copyright

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.

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 based on Australian Standard AS 1726, Geotechnical Site Investigations Code. 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	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

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

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

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	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

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;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and 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 test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

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

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

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 some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

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

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

where 'sound' rock is assessed to be rock of low strength or better. 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

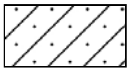
Soils


Topsoil

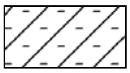

Peat


Clay

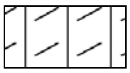

Silty clay

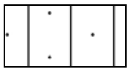

Sandy clay

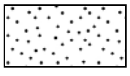

Gravelly clay

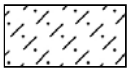

Shaly clay

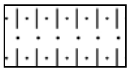

Silt


Clayey silt


Sandy silt

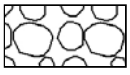

Sand

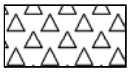

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

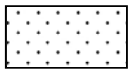

Talus

Sedimentary Rocks

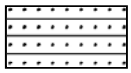

Boulder conglomerate

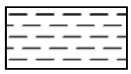

Conglomerate


Conglomeratic sandstone

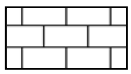

Sandstone


Siltstone


Laminite

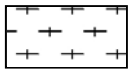

Mudstone, claystone, shale

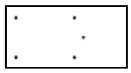

Coal


Limestone

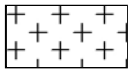
Metamorphic Rocks

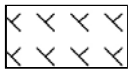

Slate, phyllite, schist

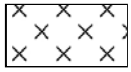

Gneiss

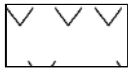

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

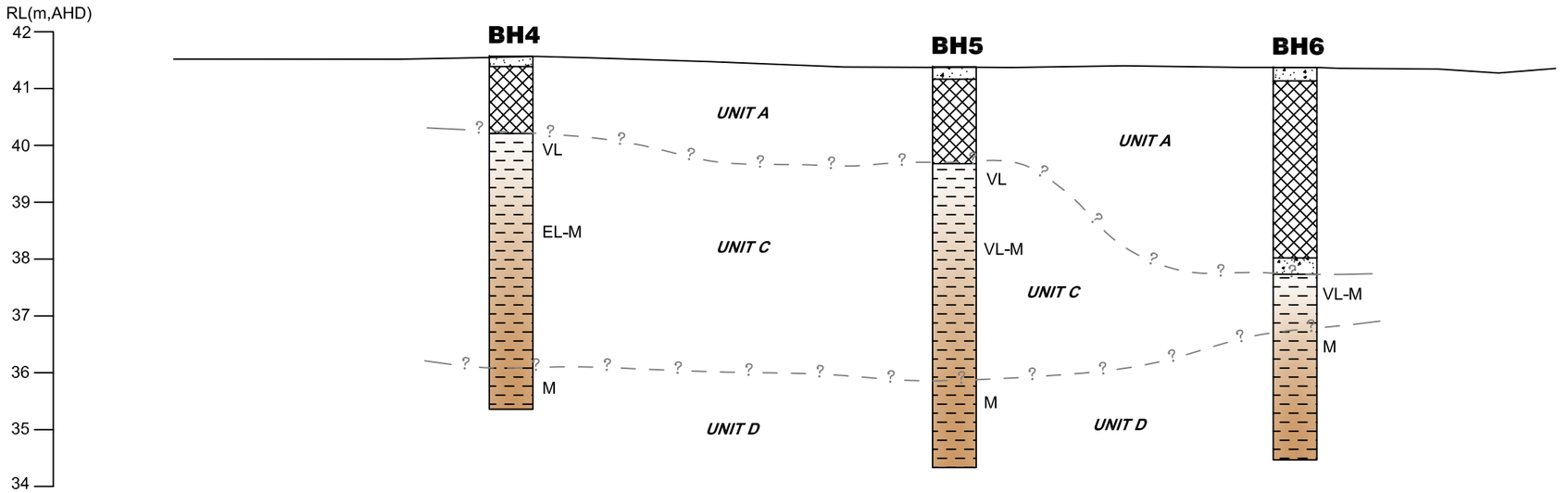
Appendix B

Drawings

Augered borehole

Cored borehole

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Health Infrastructure	**Locations of Tests**	PROJECT No: 84311
	OFFICE: Sydney	**Sutherland Hospital Planning Project**	DWG No: G1
	DATE: 7 Jul 2014	**Kareena Road, Caringbah**	REVISION: 0



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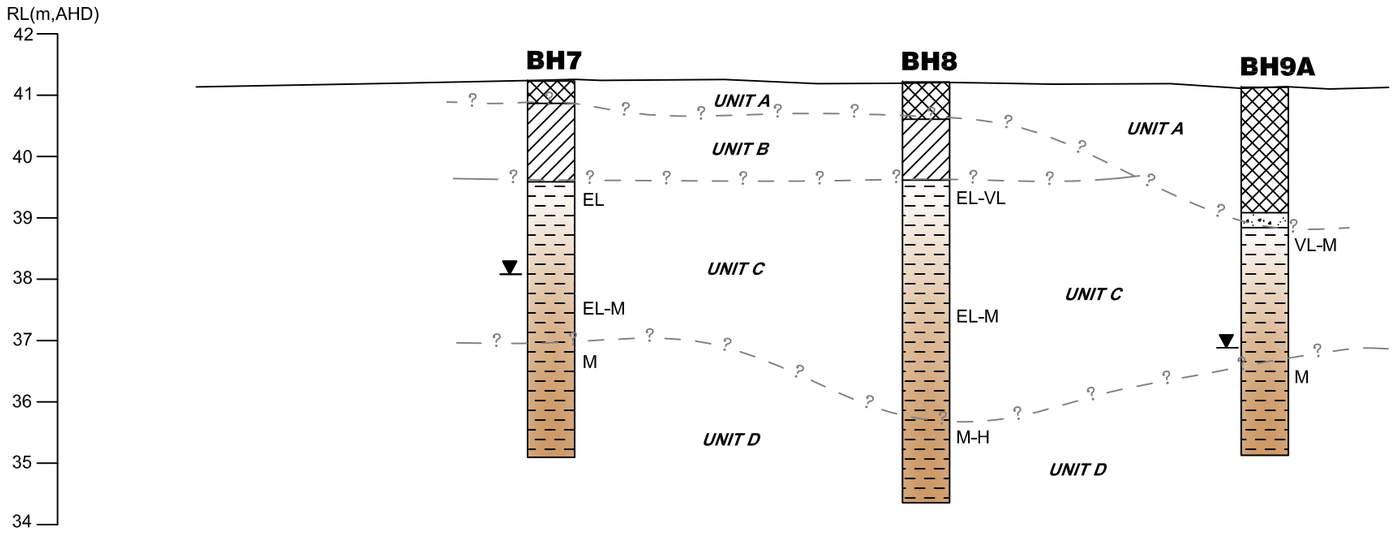
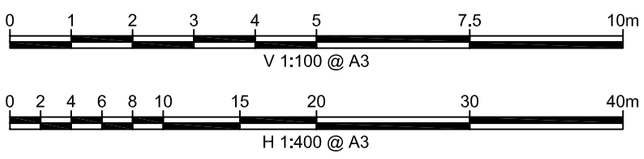


SECTION B-B



LEGEND

- CONCRETE
- FILLING
- CLAY
- SHALE
- INFERRED STRATA BOUNDARY
- GROUNDWATER

EL Extremely low strength
VL Very low strength
L Low strength
M Medium strength
H High strength

UNIT DESCRIPTIONS

UNIT A Filling
UNIT B Residual Clay
UNIT C Class V/IV Shale
UNIT D Class III Shale

Strata boundaries are inferred. Depths accurate only at test locations.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Health Infrastructure		TITLE: **Geotechnical Sections**	PROJECT No: 84311
OFFICE: Sydney	DRAWN BY: PSCH	**Sutherland Hospital Planning Project**	DRAWING No: G2
SCALE: As shown	DATE: 7.7.2014	**Kareena Road, CARINGBAH**	REVISION: 0

Appendix C

Results of Field Work

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.4 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 84311
DATE: 13/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.04	ASPHALT										
	0.2	FILLING - grey, fine to medium-grained sandy gravel filling, moist (roadbase)										
	0.7	FILLING - brown, fine to medium-grained sand filling with shale and ironstone gravel, and concrete and tile fragments, moist							B			
40	1	CLAY - brown clay, moist										
	1.5	Bore discontinued at 1.5m										
39	2											
38	3											
37	4											
36	5											
35	6											
34	7											
33	8											
32	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.1 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 84311
DATE: 13/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.04	ASPHALT										
		FILLING - brown, fine-grained sand filling with shale gravel, concrete fragments, some plastic and a trace of glass, moist							B			
40	1	0.7m: steel wire fragments										
	1.5	Bore discontinued at 1.5m										
39	2											
38	3											
37	4											
36	5											
35	6											
34	7											
33	8											
32	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 40.4 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 84311
DATE: 13/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
40	0.04	ASPHALT										
		FILLING - brown and dark brown, fine to medium-grained sand filling with shale and ironstone gravel, brick fragments, concrete fragments, some steel fragments and a trace of plastic							B			
39	1.0	0.7m: timber fragments										
	1.5	CLAY - orange-brown, clay with some ironstone gravel										
		Bore discontinued at 1.5m										
38	2											
37	3											
36	4											
35	5											
34	6											
33	7											
32	8											
31	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 84311
DATE: 11/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.14	CONCRETE							D			
	0.3	FILLING - grey, medium-grained gravelly sand filling, damp							D			
1		FILLING - brown, fine to medium-grained clayey sand filling with brick and concrete fragments, moist to damp							D			
	1.2	SHALE - very low strength, red and orange-grey shale							S			3,5,10 N = 15
40								Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
2									S			16,25/100mm refusal
	2.9	SHALE - extremely low and very low strength, extremely to highly weathered, fractured, grey and red-grey shale with some medium strength bands							C	100	0	PL(A) = 0.6
39								3.4m: J75°, cln, ro, 100mm				
3								3.73m: J90°, 40mm, cly co, 1-2mm	C	100	0	
								4.0-4.07m: B0°, cly co, 1-2mm				
38								4.11m: J85°, cln, ro				
4								4.14m: J30°, cln, sm				
	4.34	SHALE - medium strength, highly and moderately weathered, fragmented to fractured, grey-brown shale with some extremely low strength bands						4.25m: CORE LOSS: 90mm				PL(A) = 0.4
37								4.82m: CORE LOSS: 680mm	C	50	0	
5												
	5.5	6.0-6.1m: high strength sandstone band						5.72m: J90°, cln, ro, 50mm	C	83	0	PL(A) = 0.7
36	6.1	Bore discontinued at 6.1m										PL(A) = 2.6
6												
35												
7												
34												
8												
33												
9												
32												

RIG: DT250 **DRILLER:** LC **LOGGED:** AL/SI **CASING:** HW to 2.9m

TYPE OF BORING: Diatube to 0.14m; Solid flight auger to 2.9m; NMLC-Coring to 6.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 84311
DATE: 11/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.18	CONCRETE										
	0.3	FILLING - grey, fine to medium (shale) gravel filling, damp							D			
		FILLING - brown clay filling with sandstone gravel and a trace of plastic, damp							D			
40	1	0.6-0.9m: with medium red-brown sand							D			
									S			4,5,3 N = 8
	1.6	SHALE - very low strength, red and orange-grey shale						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
39	2								S			20,25/100mm refusal
	3											
	3.1	SHALE - low then very low strength, highly to moderately weathered, fragmented to fractured, grey brown shale						2.9m: CORE LOSS: 200mm	C	65	0	PL(A) = 0.2
38								3.49m: J90°, cln, ro, 40mm				
	3.86							3.63m: CORE LOSS: 230mm	C	92	0	
	4							3.86-4.0m: B0°, cly co, 1mm				
37								4.16m: B0°, cly co, 5mm				
	4.6	SHALE - medium strength, highly to moderately then moderately weathered, fragmented to fractured, grey-brown shale with some extremely low strength bands						4.52m: J40°, cln, ro	C	100	0	PL(A) = 0.6
	5							4.85m: J15°, fe stn, sm				
36								5.15m: J90°, cln, sm, 100mm				
								5.27m: J20°, fe stn, sm				
	5.6							5.37m: CORE LOSS: 230mm	C	66	0	PL(A) = 0.5
	6							5.6-6.0m: B0°- 5°, fe stn				
	6.0	SHALE - medium strength, slightly weathered, fractured and slightly fractured, grey-brown shale						6m: J55°, cln, ro				
35								6.38m: J15°, fe stn, sm	C	100	75	
								6.67m: J10°, cln, ro				
	6.95	Bore discontinued at 6.95m						6.81-6.85m: J10°- 20°, cln, ro				PL(A) = 0.5
	7											
34												
	8											
33												
	9											
32												

RIG: DT250 **DRILLER:** LC **LOGGED:** AL/SI **CASING:** HW to 2.9m

TYPE OF BORING: Diatube to 0.18m; Solid flight auger to 2.9m; NMLC-Coring to 6.95m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 84311
DATE: 12 - 13/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.21	CONCRETE										
		FILLING - brown, sandy clay filling with ironstone gravel and some concrete fragments, moist							D			
40	1	From 1.0m: with brick, tile and concrete fragments							D			
									S			10,24,21 N = 45
39	2							Note: Unless otherwise stated, rock is fractured along planar bedding dipping at 0°- 10°				
									S			10,12,7 N = 19
38	3											
	3.3	CONCRETE										
	3.6	SHALE - medium strength, moderately to slightly weathered, highly fractured to fractured, grey-brown shale with some very low strength bands						3.75m: CORE LOSS: 250mm	C	65	0	
37	4							4m: CORE LOSS: 100mm	A	0	0	
	4.32							4.1m: CORE LOSS: 220mm	C	0	0	PL(A) = 0.5
36	5							4.71m: J90°, cln, sm, 100mm 4.91m: J90°, cln, sm, 20mm 5.05m: J15°, cln, sm 5.1m: B5°, cly vn 5.13m: J90°, cln, sm, 20mm 5.37m: J50°, fe stn, 20mm 5.4m: B10°, cly co, 1mm 5.4-5.49m: B0°, cly co, 1mm 5.61m: J90°, cln, sm, 10mm 5.62-6.5m: B0°- 10°, fe stn 6.52m: J35°, fe stn 6.56m: J90°, fe stn, ro, 40mm 6.63m: J55°, fe stn, ro 6.75-6.81m: B0°, cly co, 1mm	C	100	0	
35	6								C	100	40	PL(A) = 0.6 PL(A) = 0.7
	6.85	Bore discontinued at 6.85m										
34	7											
33	8											
32	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** HW to 4.1m

TYPE OF BORING: Diatube to 0.21m; Solid flight auger to 3.3m; NMLC-Coring to 4.0m; Solid flight auger to 4.1m; NMLC-Coring to 6.85m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 84311
DATE: 13/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.04	ASPHALT							D			
	0.25	FILLING - dark grey, fine to medium-grained sandy gravel filling, damp (roadbase)							D			
	0.4	FILLING - brown, medium-grained clayey sand filling with sandstone and ironstone gravel, moist							D			
40	1	CLAY - very stiff to hard, red and orange-grey clay with some ironstone gravel, moist							S			5,14,20 N = 34
	1.6	SHALE - extremely low strength, grey and brown shale						Note: Unless otherwise stated, rock is fractured along planar bedding dipping at 0°- 10°				
39	2								S			23,25/60mm refusal
	2.9	SHALE - medium strength, highly weathered, fragmented, grey-brown shale with some extremely low and very low strength bands						2.8m: CORE LOSS: 100mm	C	80	0	
38	3							3.68m: J90°, fe stn, ro, 40mm				PL(A) = 0.6
	4.0	SHALE - medium strength, slightly weathered, fragmented to fractured, grey shale						4.25m: J90°, cln, sm, 40mm 4.37m: J60°, fe stn, sm	C	100	0	PL(A) = 0.5
37	4											
	5							4.9m: CORE LOSS: 300mm				
36	5.2							5.3m: J90°, fe stn, ro, 60mm	C	75	0	PL(A) = 0.6
	6											
35	6.1	Bore discontinued at 6.1m										
	7											
34	8											
33	9											
32												

RIG: DT250 **DRILLER:** LC **LOGGED:** AL/SI **CASING:** HW to 2.8m

TYPE OF BORING: Solid flight auger to 2.8m; NMLC-Coring to 6.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater well installed in bore - refer to seperate log

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.2 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7-WELL
PROJECT No: 84311
DATE: 13/6/2014
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
41	0.04	ASPHALT		D	0.05				Gatic Cover
	0.25	FILLING - dark grey, fine to medium-grained sandy gravel filling, damp (roadbase)			0.15				
	0.4	FILLING - brown, medium-grained clayey sand filling with sandstone and ironstone gravel, moist		D	0.4				50mm unslotted PVC pipe
40	1	CLAY - very stiff to hard, red and orange-grey clay with some ironstone gravel, moist			0.5				
				D	0.9				
					1.0				
				S			5,14,20 N = 34		Filling
					1.45				
	1.6	SHALE - extremely low strength, grey and brown shale							
39	2								
					2.5				
				S			23,25/60mm refusal		
					2.71				
	2.9	SHALE - medium strength, highly weathered, fragmented, grey-brown shale with some extremely low and very low strength bands			2.8				Bentonite
38	3			C					
					3.3				
					3.45		PL(A) = 0.6		Gravel backfill
	4.0	SHALE - medium strength, slightly weathered, fragmented to fractured, grey shale		C	4.15		PL(A) = 0.5		
37	4								50mm slotted PVC pipe
					4.9				
36	5								
	5.2			C	5.4		PL(A) = 0.6		
	6								
35	6.1	Bore discontinued at 6.1m			6.1				End Cap
34	7								
33	8								
32	9								

RIG: DT250 **DRILLER:** LC **LOGGED:** AL/SI **CASING:** HW to 2.8m

TYPE OF BORING: Solid flight auger to 2.5m; NMLC-Coring to 6.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.1 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 84311
DATE: 16/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.03	ASPHALT							D			
	0.2	FILLING - dark grey, fine to medium-grained sandy gravel filling, damp (roadbase)							D			
	0.5	FILLING - brown, medium gravelly sand filling with some concrete fragments and a trace of plastic							D			
40	1	CLAY - very stiff to hard, grey-brown clay, moist to damp							S			7,11,20 N = 31
	1.5	SHALE - extremely low to very low strength, grey and brown shale										
39	2	From 2.0m: very low to low strength						Note: Unless otherwise stated, rock is fractured along planar bedding dipping at 0°- 10°	S			18,25/50mm refusal
	2.8	SHALE - medium strength, highly to moderately weathered, fragmented, grey-brown shale with some extremely low strength bands						2.8m: CORE LOSS: 170mm	C	83	0	
38	2.97											
37	4								C	85	0	PL(A) = 0.4
	4.7							4.54m: CORE LOSS: 160mm				
36	5							4.92m: J90°, cln, ro, 40mm 5.25m: J20°, fe stn, sm	C	100	20	PL(A) = 2.4
	5.4	SHALE - high then medium to high strength, slightly weathered, fractured and slightly fractured, grey-brown shale						5.52m: B5°, fe stn 5.63m: B0°, fe stn				
35	6							6.2m: J90°, con, ro, 60mm 6.37m: B6°, fe stn	C	100	60	PL(A) = 1
	6.9	Bore discontinued at 6.9m						6.77m: J20°, cln, ro (x3) 6.87m: B0°, cly co, 2mm				
34	7											
33	8											
32	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** HW to 2.8m

TYPE OF BORING: Solid flight auger to 2.8m; NMLC-Coring to 6.9m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U$_x$	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 84311
DATE: 12/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.05	ASPHALT							D			
	0.25	FILLING - grey, fine to medium-grained sandy gravel filling, moist (roadbase)							D			
40	1	FILLING - brown, medium-grained clayey sand filling with fine to medium shale and sandstone gravel and a trace of plastic, moist From 1.0m: with tile and concrete fragments 1.1-1.2m: steel fragments							D S D			25/50mm refusal
39	2	2.0 Bore discontinued at 2.0m - refusal on obstruction (possible concrete)							D			
38	3											
37	4											
36	5											
35	6											
34	7											
33	8											
32	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 9A
PROJECT No: 84311
DATE: 12/6/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
41	0.05	ASPHALT										
	0.25	FILLING - grey, fine to medium-grained sandy gravel filling, moist (roadbase)										
40	1	FILLING - brown, medium-grained clayey sand filling with fine to medium shale and sandstone gravel, moist From 1.0m: with tile and concrete fragments						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
39	2											
	2.05	CONCRETE										
	2.15	SHALE - medium strength, moderately and highly to moderately weathered, fragmented to fractured, grey brown shale. Some very low strength bands						2.15-2.4m: B0°- 10°, cly vn 2.4m: CORE LOSS: 400mm	C	60	0	
	2.8								D	0	0	
38	3							3.04m: J15°, cly vn, sm 3.13m: J30°, cln, sm 3.16m: J70°, cln, sm, 10mm 3.17m: J90°, cln, ro 3.23m: J45°, cln, sm	C	100	0	PL(A) = 0.6 PL(A) = 0.5
37	4							3.6m: CORE LOSS: 650mm	C	40	0	
	4.25	SHALE - medium strength, highly to moderately then moderately weathered, highly fractured to fractured, grey-brown shale. Some extremely low strength bands						4.25-4.49m: B0°- 10°, fe stn 4.69m: J20°, fe stn				PL(A) = 0.7
36	5							4.84m: J15°, fe, stn 4.88m: J20°, fe stn 4.92m: J90°, cln, ro, 30mm	C	100	0	
	5.33							5.11m: J40°, fe stn, sm 5.17m: J90°, fe stn, sm, 40mm 5.24m: CORE LOSS: 90mm	C	100	0	PL(A) = 0.4
35	6							5.76m: J90°, fe stn, 80mm				
	6.0	Bore discontinued at 6.0m										
34	7											
33	8											
32	9											

RIG: DT250 **DRILLER:** LC **LOGGED:** AL/SI **CASING:** HW to 2.8m

TYPE OF BORING: Solid flight auger to 2.05m; NMLC-Coring to 2.6m; Rotary to 2.8m; NMLC-Coring to 6.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Groundwater well installed in bore - refer to seperate log

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Health Infrastructure
PROJECT: Sutherland Hospital Planning Project
LOCATION: Kareena Road, Caringbah

SURFACE LEVEL: 41.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 9A-WELL
PROJECT No: 84311
DATE: 12/6/2014
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
41	0.05	ASPHALT							Gatic Cover
	0.25	FILLING - grey, fine to medium-grained sandy gravel filling, moist (roadbase)							
		FILLING - brown, medium-grained clayey sand filling with fine to medium shale and sandstone gravel, moist							50mm unslotted PVC pipe
40	1	From 1.0m: with tile and concrete fragments							Filling
39	2				2.05				
	2.05	CONCRETE							
	2.15	SHALE - medium strength, moderately and highly to moderately weathered, fragmented to fractured, grey brown shale. Some very low strength bands		C					
				C	2.6				
	2.8				2.8				
38	3				2.95		PL(A) = 0.6		Bentonite
				C	3.25		PL(A) = 0.5		
					3.6				Gravel backfill
37	4			C					
	4.25	SHALE - medium strength, highly to moderately then moderately weathered, highly fractured to fractured, grey-brown shale. Some extremely low strength bands			4.5		PL(A) = 0.7		50mm slotted PVC pipe
					4.7				
36	5			C					
	5.33				5.24				
				C	5.7		PL(A) = 0.4		
35	6								End Cap
	6.0	Bore discontinued at 6.0m			6.0				
34	7								
33	8								
32	9								

RIG: DT250 **DRILLER:** LC **LOGGED:** AL **CASING:** HW to 2.8m

TYPE OF BORING: Solid flight auger to 2.05m; NMLC-Coring to 2.6m; Wash boring to 2.8m; NMLC-Coring to 6.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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DOUGLAS PARTNERS PTY LTD

SUTHERLAND HOSPITAL PLANNING PROJECT - CARINGBAH

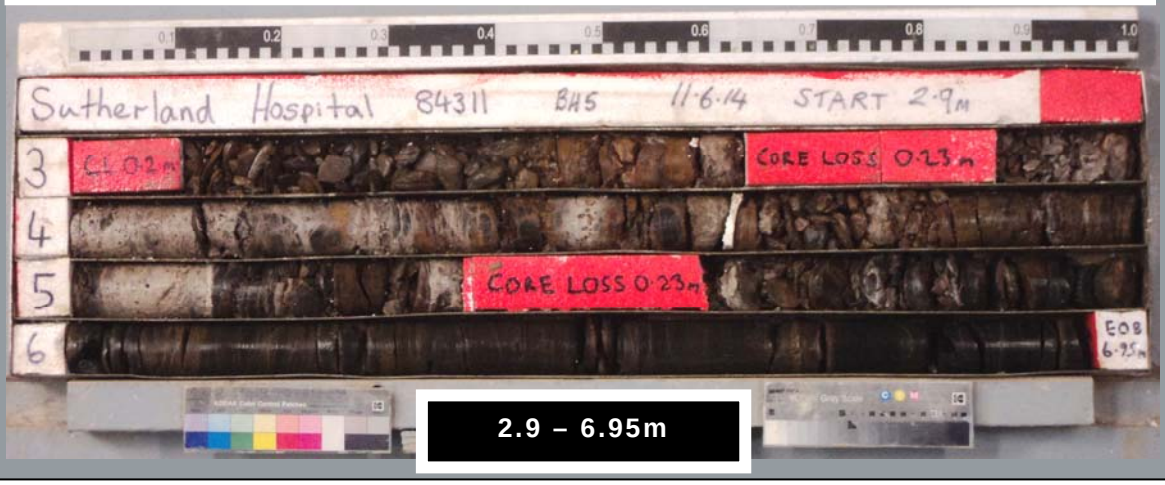
BORE 4 PROJECT 84311 JUN 2014

2.9 – 6.1m

DOUGLAS PARTNERS PTY LTD

SUTHERLAND HOSPITAL PLANNING PROJECT – CARINGBAH

BORE 5 PROJECT 84311 JUN 2014



2.9 – 6.95m

DOUGLAS PARTNERS PTY LTD

SUTHERLAND HOSPITAL PLANNING PROJECT - CARINGBAH

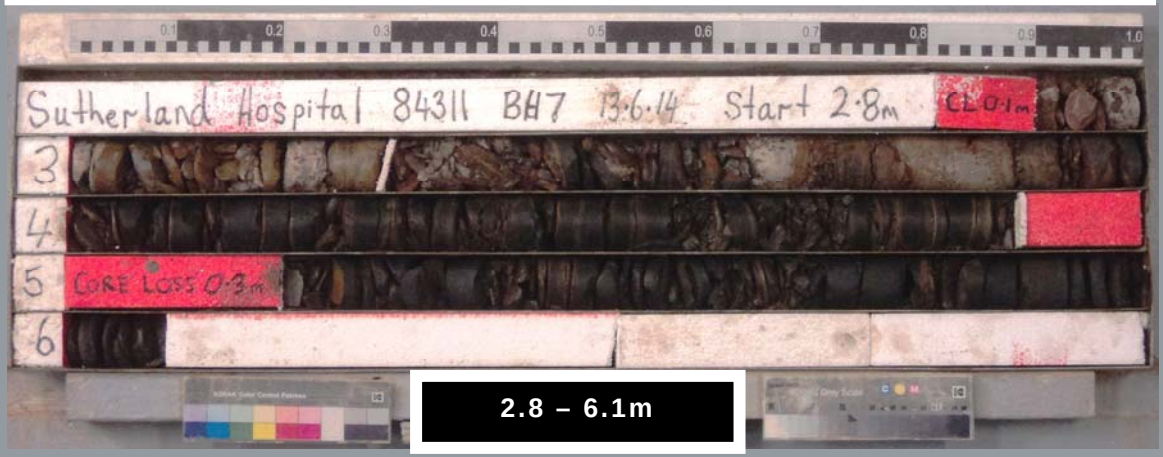
BORE 6 PROJECT 84311 JUN 2014

3.3 - 6.85m

DOUGLAS PARTNERS PTY LTD

SUTHERLAND HOSPITAL PLANNING PROJECT - CARINGBAH

BORE 7 PROJECT 84311 JUN 2014

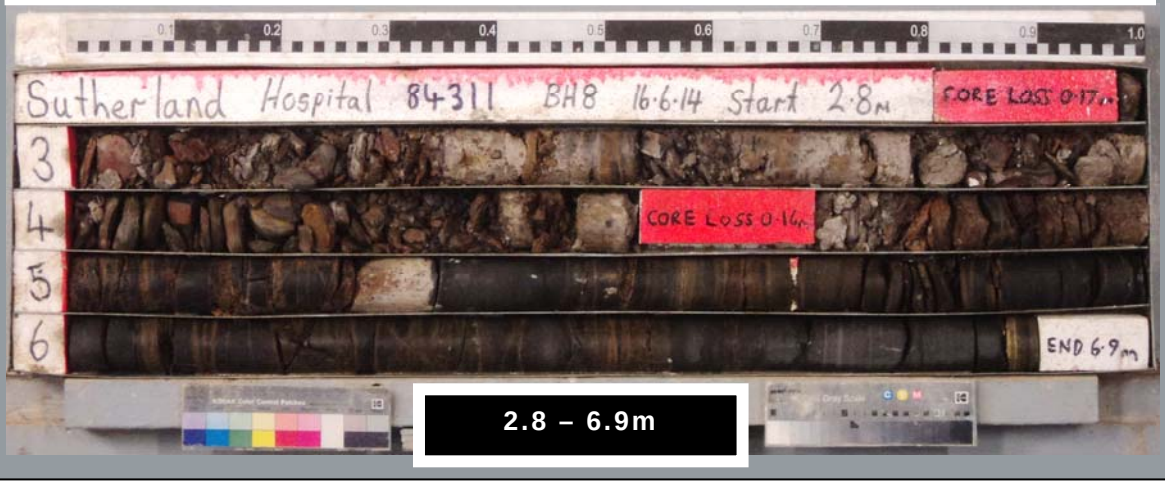


2.8 – 6.1m

DOUGLAS PARTNERS PTY LTD

SUTHERLAND HOSPITAL PLANNING PROJECT – CARINGBAH

BORE 8 PROJECT 84311 JUN 2014

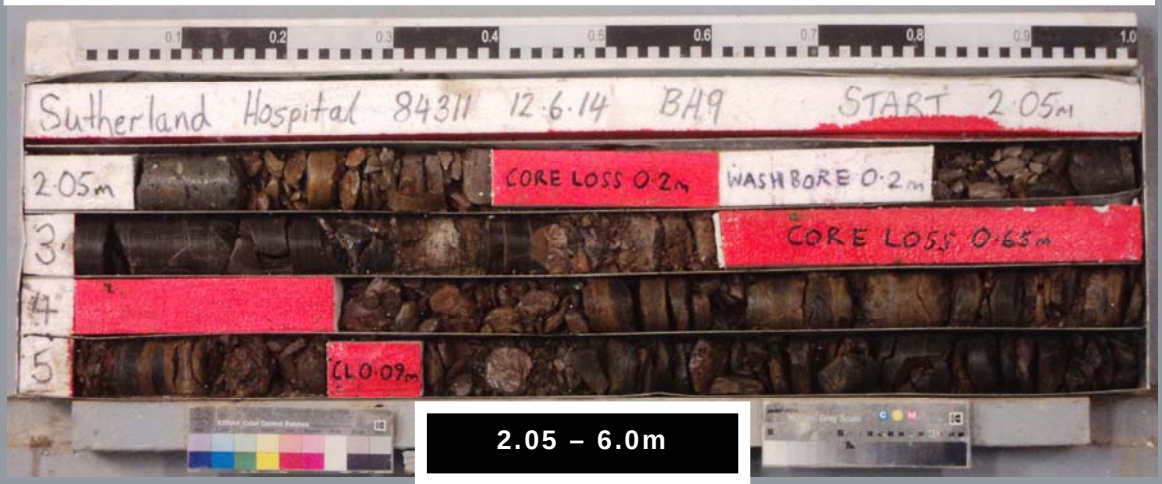


2.8 – 6.9m

DOUGLAS PARTNERS PTY LTD

SUTHERLAND HOSPITAL PLANNING PROJECT - CARINGBAH

BORE 9A PROJECT 84311 JUN 2014



2.05 – 6.0m

Appendix D

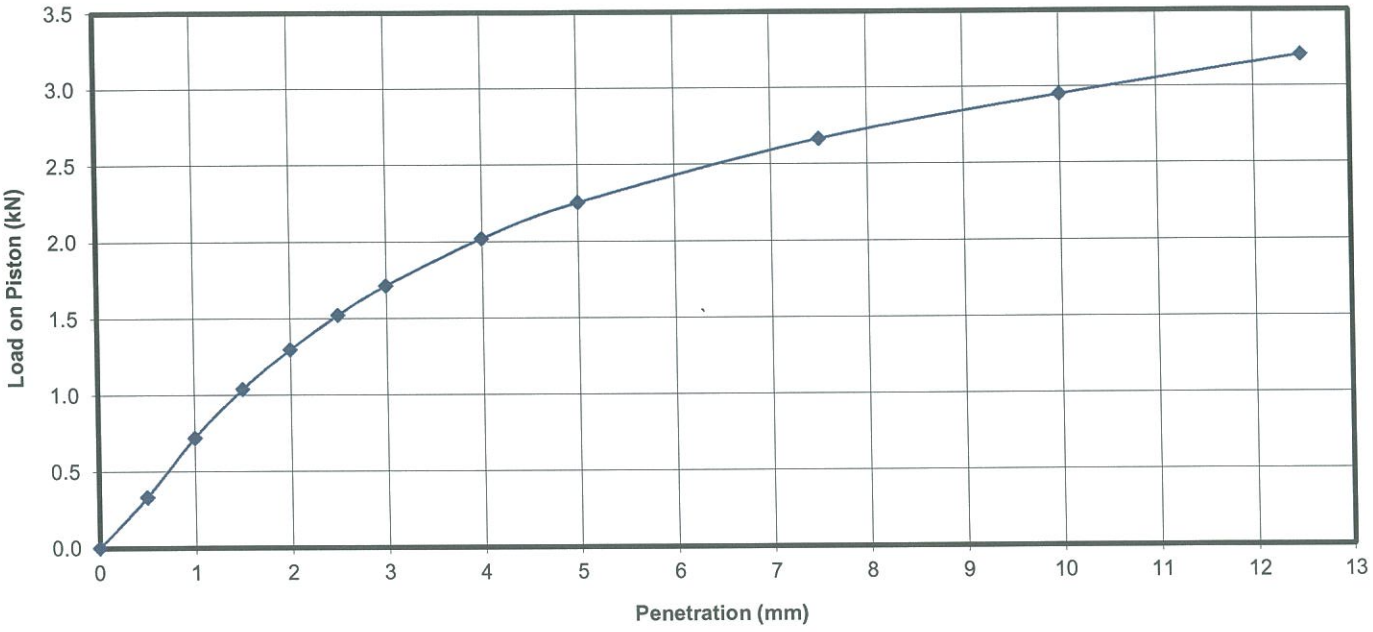
Laboratory Test Results

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde
NSW 2114Phone (02) 9809 0666
Fax (02) 9809 4095

Results of California Bearing Ratio Test

Client :	Health Infrastructure (ABN 89600377397)	**Project No. :**	84311.00
		Report No. :	3
Project :	CARINGBAH - Sutherland Hospital	**Report Date :**	30/06/2014
		Date Sampled :	13/06/2014
Location :	Kareena Road, Caringbah	**Date of Test:**	27/06/2014
Test Location :	BH1		
Depth / Layer :	0.7 - 1.5m	**Page:**	1 of 1



Description: Brown clay with some gravel

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 0%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 102% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: 0.2%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		16.4	1.82
After soaking		18.7	1.82
After test	Top 30mm of sample	18.8	-
	Remainder of sample	17.8	-
Field values		18.9	-
Standard Compaction		16.2	1.82

RESULTS		
TYPE	PENETRATION	CBR (%)
TOP	2.5 mm	12

NATA Accredited Laboratory No 828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025

Mark Matthews
Assistant Laboratory Manager

Douglas Partners
Geotechnics / Environment / Groundwater

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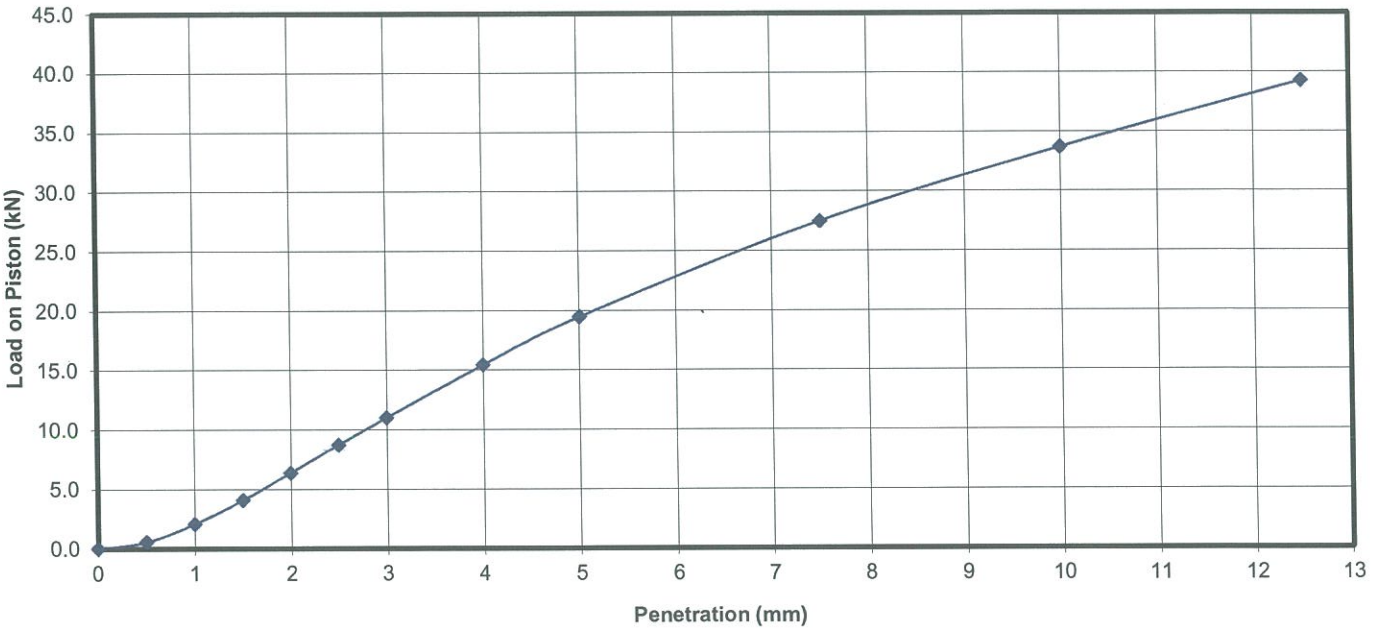
Results of California Bearing Ratio Test

Client :	Health Infrastructure (ABN 89600377397)	**Project No. :**	84311.00
		Report No. :	1
Project :	CARINGBAH - Sutherland Hospital	**Report Date :**	27/06/2014
		Date Sampled :	13/06/2014
Location :	Kareena Road, Caringbah	**Date of Test:**	24/06/2014
Test Location :	BH2		
Depth / Layer :	0.1 - 1.5m	**Page:**	1 of 1



Description: Filling brown sand

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 1% Excluded

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 100% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: -0.1%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		14.7	1.82
After soaking		16.5	1.82
After test	Top 30mm of sample	16.6	-
	Remainder of sample	15.2	-
Field values		9.0	-
Standard Compaction		14.6	1.83

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**5.0 mm**	**110**

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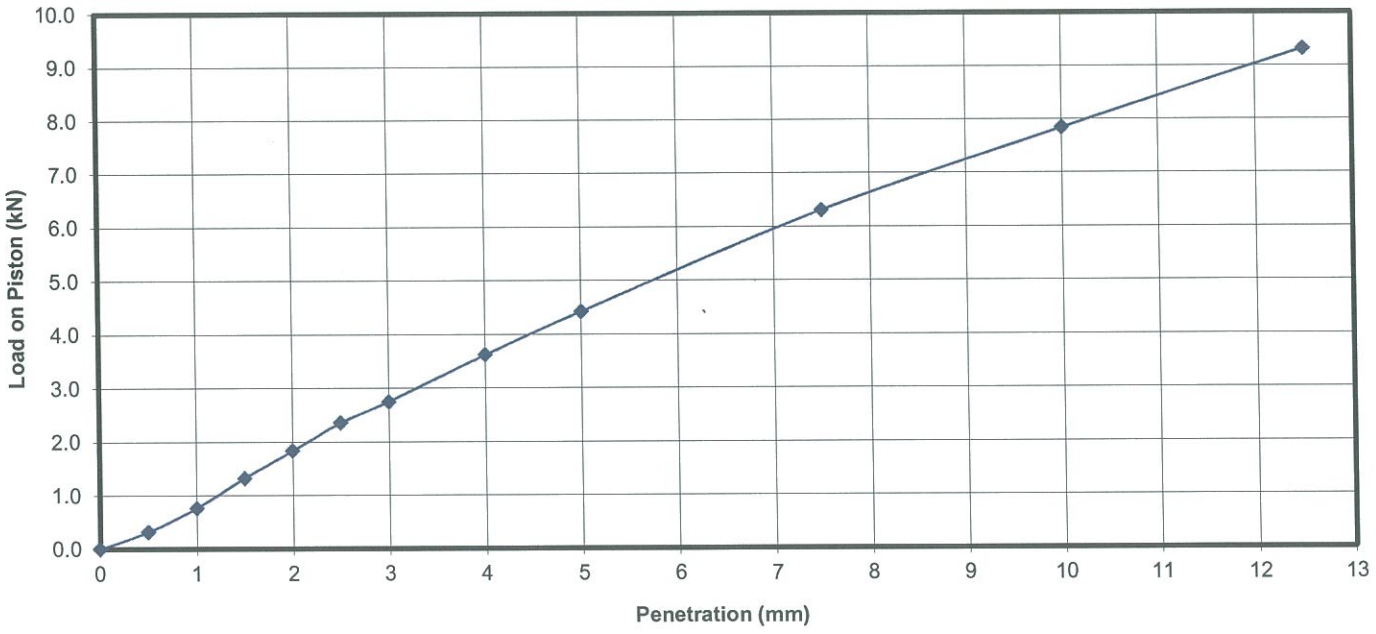
Results of California Bearing Ratio Test

Client :	Health Infrastructure (ABN 89600377397)	**Project No. :**	84311.00
		Report No. :	2
Project :	CARINGBAH - Sutherland Hospital	**Report Date :**	27/06/2014
		Date Sampled :	13/06/2014
Location :	Kareena Road, Caringbah	**Date of Test:**	24/06/2014
Test Location :	BH3		
Depth / Layer :	0.1 - 1.0m	**Page:**	1 of 1



Description: FIlling brown and dark brown sand

Test Method(s): AS1289 6.1.1, AS1289 5.1.1, AS1289 2.1.1

Sampling Method(s): Sampled by Engineering Department

Percentage > 19mm: 1%

LEVEL OF COMPACTION: 100% of STD MDD
MOISTURE RATIO: 100% of STD OMC
SURCHARGE: 4.5 kg
SOAKING PERIOD: 4 days
SWELL: -0.1%

CONDITION		MOISTURE CONTENT %	DRY DENSITY t/m^3
At compaction		16.5	1.80
After soaking		17.7	1.80
After test	Top 30mm of sample	18.3	-
	Remainder of sample	17.4	-
Field values		13.4	-
Standard Compaction		16.5	1.80

RESULTS		
TYPE	**PENETRATION**	**CBR (%)**
TOP	**5.0 mm**	**25**

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Mark Matthews
Laboratory Manager

Douglas Partners
Geotechnics / Environment / Groundwater

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Results of Moisture Content, Plasticity and Linear Shrinkage Tests

Client: Health Infrasturcture

Project: CARINGBAH - Sutherland Hospital

Location: Kareena Road, Caringbah

Project No: 84311
Report No: 4
Report Date: 03/07/2014
Date Sampled: 13/6,16/6
Date of Test: 25/06/2014
Page: 1 of 1

Test Location	Depth (m)	Description	Code	W_F %	W_L %	W_P %	PI %	*LS %
BH7	0.4-0.5	Red and orange-grey clay	2,5	-	58	24	34	-
BH8	1.0-1.45	Grey brown clay	2,5	-	51	24	27	-

Legend:

W_F Field Moisture Content
W_L Liquid limit
W_P Plastic limit
PI Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length125mm)

Test Methods:

Moisture Content: AS 1289 2.1.1
Liquid Limit: AS 1289 3.1.2
Plastic Limit: AS 1289 3.2.1
Plasticity Index: AS 1289 3.3.1
Linear Shrinkage: AS 1289 3.4.1

Code:

Sample history for plasticity tests

1. Air dried
2. Low temperature (<50ºC) oven dried
3. Oven (105ºC) dried
4. Unknown

Method of preparation for plasticity tests

5. Dry sieved
6. Wet sieved
7. Natural

*Specify if sample crumbled CR or curled CU

Sampling Methods: Sampled by Engineering Department

Remarks:

NATA Accredited Laboratory Number: 828

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Tested: LW
Checked: MM

Mark Matthews
Assistant Laboratory Manager

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 111850

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: Peter Oitmaa

Sample log in details:

Your Reference:	**84311, Caringbah**		
No. of samples:	2 Soils		
Date samples received / completed instructions received	19/06/14	/	19/06/14

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	26/06/14	/	25/06/14
Date of Preliminary Report:			

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Results Approved By:

Jacinta Hurst
Laboratory Manager

Miscellaneous Inorg - soil			
Our Reference:	UNITS	111850-1	111850-2
Your Reference	----------	BH6	BH7
Depth	----------	1.0-1.45	1.0-1.45
Date Sampled		12/06/2014	13/06/2014
Type of sample		Soil	Soil
Date prepared	-	23/06/2014	23/06/2014
Date analysed	-	24/06/2014	24/06/2014
pH 1:5 soil:water	pH Units	11.1	4.8
Chloride, Cl 1:5 soil:water	mg/kg	28	22
Sulphate, SO4 1:5 soil:water	mg/kg	320	73
Electrical Conductivity 1:5 soil:water	µS/cm	380	78

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			23/06/2014	[NT]	[NT]	LCS-1	23/06/2014
Date analysed	-			24/06/2014	[NT]	[NT]	LCS-1	24/06/2014
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	100%
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	LCS-1	103%
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	LCS-1	109%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	98%

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.