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Report Type:
Geotechnical Investigation Report

Project Name:
Proposed School Building Development

Project Address:
268 – 272 Fitzgerald Ave., Maroubra NSW 2035

Client Name:
Sydney Catholic Schools c/o JDH Architects

6 May 2020
Report No: 9194.2-GR-1-1 (Rev B)

We give you the right information to make the right decisions

Alliance Geotechnical Pty Ltd | ABN: 62 106 885 214
PO Box 275, Seven Hills NSW 1730 - 10 Welder Road, Seven Hills, NSW
Phone: 1800 288 188 - Office Email: office@allgeo.com.au - Web: allgeo.com.au

DOCUMENT CONTROL

Revision	Date	Description	Author	Reviewer
0	25 October 2019	Issued to client	AA	TD
A	24 April 2020	Updated with the revised architectural design plans	AA	SM
B	06 May 2020	Amended based on Client's comment	AA	SM

	Author	Reviewer
Signature		
Name	Arash (Ash) Afzali	Sahar Mamouri
Title	BE (Civil), ME (Geotech.), MIEAust Senior Geotechnical Engineer	BE(Civil), ME (Geotech.), CPEng(Civil), NER Senior Geotechnical Engineer

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APPENDIX

1. INTRODUCTION

This report presents the findings of a geotechnical investigation undertaken by Alliance Geotechnical Pty Ltd (AG) for Sydney Catholic Schools c/o JDH Architects (the client) based on AG's fee proposal reference No. 2631, dated 26 August 2019 at the location of 268 – 272 Fitzgerald Avenue, Maroubra NSW 2035 (the site). This revised report has been issued based on the client request to update the initial geotechnical report based on the latest architectural drawings received on 16/04/2020.

To aid in with the preparation of this report, AG have been supplied with the following documents:

- Demolish and Proposed Site Plans and Analysis Plan, Prepared by JDH Architects P/L (Project No.: 1076, Drawings DA-01 & DA-02, Dated 26 September 2019);
- Architectural Site and Floor Plans, Prepared by JDH Architects P/L (Project No.: 1076, Drawings CBGA-01 to CBGA-05, dated 24 April 2019);
- Survey Plan Showing Detail & Levels Over Lots 4370 & 4916 In D.P.752015 & LOT 1 IN D.P.121298 268-272 Fitzgerlad Avenue, Maroubra NSW 2035 – Issue 3, prepared by C.M.S. Surveyors Pty Limited (Drawing No.: 13203detail, dated 25 September 2019) and,
- Revised Preliminary Architectural Plans, Prepared by JDH Architects P/L (Project No.: 1076, Drawings DA-00 to DA-18, Dated: 16 April 2020).

A previous geotechnical investigation report (9194-GR-1-1, dated 25 October 2019) was prepared for the development of a new school building identified as Block I based on the provided preliminary architectural plan (dated 26/09/2019). The preliminary development was proposed to be constructed on the north-eastern side of the site. Extensions to the buildings labelled as Block D and E located at the southern part of the site were also proposed to be undertaken as part of the development. Some of the existing buildings (indicated as Blocks A, and C in the provided plans) were proposed to be demolished and replaced with the new playgrounds and building extensions.

The architectural plans were revised later and was supplied to AG for the preparation of an updated geotechnical report. Based on the latest drawings, the following changes should be considered in the updated report:

- The proposed development location has been moved to the north-western part of the site (Western section of the existing playground);
- Filling with an approximate height of 1.5m is partially required for the proposed ground floor level; and,
- Excavations to an approximate depth of 1.5m is required for the construction of the lift shaft.

As such, this revised report provides the necessary updates on the geotechnical comments and recommendations associated with the latest changes of the architectural drawings.

The geotechnical investigation has been carried out to provide comments and recommendation for the following project objectives:

- Existing subsurface and groundwater conditions;
- Site Classification in accordance with AS2870-2011;

- Suitable footing system and geotechnical parameters for structural design including the allowable bearing capacity for shallow and deep footings;
- Earthquake site soil class in accordance with AS1170.4;
- Temporary and permanent batter slopes and temporary excavations;
- Soil infiltration rate for the design on-site stormwater detention systems;
- Soil aggressivity against concrete and steel; and,
- CBR design values and sub-grade preparation for car park pavement design purposes.

In order to achieve the project objectives, the following scope of work was carried at the location of the proposed school building:

- Obtain DBYD plans and engage on-site accredited service clearance subcontractor;
- Perform four (4) Piezocone Penetration Tests (CPTu) to the maximum depth of 12.0m below Existing Surface Level (ESL);
- Drill three (3) boreholes across the site to the maximum depth of 4.5m below ESL;
- Perform two (2) infiltration tests; and,
- Collect soil samples from selected locations for geotechnical and environmental laboratory purposes.

2. SITE DESCRIPTION AND REGIONAL GEOLOGY

2.1. Site Location

The site comprises a part of the existing yard of St. Mary St. Joseph Catholic Primary School with approximate dimensions of 35m by 20m which is proposed to be used for the new school building development. The site is located 500m to the West of Maroubra Beach and is bounded by the Fitzgerald Avenue to the south, Malabar Road to the West, Mons Avenue to the North and Broadarrow Reserve to the East.

At the time of the investigation, the site was occupied by several single-story brick buildings and synthetic turf playgrounds. There was an existing retaining wall along the western boundary of the site which provides lateral support to a 2m of elevation difference of the site and Malabar Road. The vegetation condition of the site comprises mature trees along the perimeter of the site.

The proposed borehole and CPTu locations were located within the footprint of the proposed building (indicated as Block I in the provided plans). The locations were mostly covered by synthetic turf overlying compacted fill at the time of investigations.

Based on the supplied site survey provided by the client, the site Reduced Level (RL) varies in a range of 7.0m to 8.2m AHD with a gentle slope dipping down to the east. The site locality is shown in Figure 1 and the investigation area is shown in Figure 2.

Figure 1 - Site Locality in Satellite View (Source: Six Maps)

Figure 2 – Investigation area and the new building location in Satellite View (Source: Six Maps)

2.2. Regional Geology

The 1:100,000 NSW Department of Mineral Resources Geological Map of the Sydney region (Geological Series Sheet 9130, Edition I – 1983) indicates that the site is underlain by Quaternary Period Alluvium (Qhd). This formation is described as *medium to fine-grained "Marine" sand with deposits.* The site is located in close proximity to Qhf Alluvium unit which is described as *medium to fine-grained "Marine" sand*. It is expected the alluvial unit is underlain by Hawkesbury Sandstone (Rh) of depth of greater than 12m.

3. FIELDWORK

3.1. Methods

The geotechnical site investigation was carried out on 8 October 2019. The proposed borehole and CPTu locations were cleared of underground services using an accredited service location subcontractor prior to the investigation. The boreholes were drilled using AG owned ute-mounted drilling rig (TDLR690) fitted by 100mm TC bit solid flight auger. Three (3) boreholes to the maximum depth of 4.5m were drilled in the pre-indicated locations.

CPTu tests were conducted by a track-mounted CPTu unit operated by NEWSYD Geotechnical Testing (Subsidiary of Newcastle University). The CPTu test comprises the continuous sounding of a 35.7mm diameter cone using a hydraulic ram system. Multiple sensors fitted in the cone continuously measure the following parameters and transfer the data to a data logger on the rig:

1- Cone Tip Resistance (q_c)
2- Sleeve Friction Resistance (f_s)
3- Induced Pore Water Pressure (u_2)

The data logger records the variation of parameters with depth. Based on the standard correlations, subsoil physical and mechanical parameters can be interpreted based on the recorded subsoil information. The CPTu were sounded to the maximum depth of 12 m before encountering refusal on very dense cemented sand or inferred bedrock.

AG's geotechnical engineer was onsite to observe the CPTu soundings and direct the drilling of the boreholes, perform infiltration tests and collect soil samples for the required laboratory testings. Two (2) Perth Sand Penetrometer (PSP) tests were also conducted in the southern part of Block D to assess the shallow subsoil consistency.

Select site photographs taken during the fieldwork are presented in Attachment A. The locations of the boreholes are indicated on the Borehole Location Plan (9194.2-GR-1-A) provided in Attachment B.

3.2. Subsurface Condition

A summary of the subsurface conditions is presented in Table 1 based on the visual observations made on the drilled boreholes and interpretations of the CPTu results. For full details of the subsurface

conditions encountered, reference should be made to the borehole logs and CPTu test results in Appendix C and Appendix D.

Table 1 - Summary of Subsurface Condition

Test		CPT1	CPT2	CPT3	CPT4
Surface Level (m)*		RL 7.3	RL 7.4	RL 8.0	RL 8.2
Soil Profile		Depth below the ground surface			
Fill	SAND, medium grained, poorly graded, with gravel, trace fines, Appears well compacted	0.0 – 0.5	0.0 – 1.0	0.0 – 0.9	0.0 – 1.0
Alluvium	SAND to silty SAND, fine to medium grained, poorly graded, Medium Dense	0.5 – 1.8 6.2 – 7.0	1.0 – 1.8 6.2 – 7.8	0.9 – 1.8 5.7 – 8.0	1.0 – 2.0 5.8 – 8.0
	Silty SAND, Loose	1.8 – 4.5	1.8 – 3.8	1.8 – 4.0	2.0 – 3.8
	Sandy CLAY, Firm to Stiff	4.5 – 6.2	3.8 – 6.2	4.0 – 5.7	3.8 – 5.8
	SAND, Dense to Very Dense	7.0 – 9.5	7.8 – 10.0 11.0 – 11.8	8.0 – 9.5 11.6 – 12.0	8.0 – 9.4
	Silty to Clayey SAND, interlayers of fine sediments, Medium Dense to Dense	--	10.0 – 11.0	9.5 – 11.6	--
Refusal Depth on very dense sand or inferred bedrock		9.5 (RL -2.2m AHD)	11.8 (RL -4.4m AHD)	12.0 (RL -4m AHD)	9.4 (RL-1.2m AHD)

*Note: Extracted from supplied site survey plan

The general stratigraphical condition of the site comprises of inferred well-compacted fill down to an approximate depth of 1.0m over subsequent layers of medium dense sand and loose silty sand which is followed by a sandy clay layer starting at the depth in a range of 3.8 to 4.5m. Medium dense to very dense sand layers were interpreted from CPTu results before refusal. The refusal took place on very dense sand or inferred bedrock with more than 40MPa tip resistance. The 110kN reaction force of the CPT unit was not sufficient to push the cone any further.

Based on the regional geology of the site and the encountered subsurface condition across the investigation area, it is inferred that the general stratigraphical condition is relatively consistent across the site. Some variations are expected with the layers' depth and associated thickness.

Based on the variations of the pore pressure registered during the CPTu test, the groundwater is inferred to be in a range of 1.6 to 2.2m below ground level. Slight water seepage was recorded during the drilling of the boreholes based on observed saturated subsoil that was observed from approximately 2m depth of the boreholes.

Based on the visual observation and results of the preformed PSP test adjacent to the existing building in the south of the site, the subsoil consists of uncontrolled fill (appears poorly compacted) overlying loose to medium dense sand to the termination depth of the tests at 2.25m.

4. LABORATORY TESTING

4.1. CBR Test

California Bearing Ratio (CBR) Laboratory tests were carried out in accordance with AS1289-2006 in a NATA-registered soil laboratory on selected soil samples collected during drilling of the boreholes.

The soil test result certificates are included in Appendix E and the results are summarised in Table 2 and below.

Table 2 - Summary of CBR Test Results

Location	Material Type	FMC (%)	OMC (%)	MDD (t/m^3)	CBR (%)
BH1 (0.4m – 0.8m)	SAND, medium grained	4.5	14.5	1.71	30
BH2 (0.2m – 0.8m)	Fill – Sand, fine to medium grained	15.0	13.3	1.84	50

Notes:

FMC Field Moisture Content
OMC Optimum Moisture Content
MDD Maximum Dry Density
CBR California Bearing Ratio

4.2. Atterberg Limit Tests

Atterberg limit tests were conducted on two (2) soil samples collected from BH1 and BH3. Atterberg laboratory test was carried out in accordance with AS 1289 3.1.2, 3.2.1 and 3.3.1. Based on the obtained results, both samples were considered non-plastic.

4.3. Soil Aggressivity Test

Four (4) samples were considered for the aggressivity assessment of the site. All samples were analysed for soil pH, sulphates, chlorides and electrical conductivity tests based on guidelines provided by AS 2159 – 2009 Piling Design and Installation.

Table 3 – Summary of soil aggressivity test results

Location and Depth	Chloride (mg/kg)	pH – 1:5 extract	Sulphate (mg/kg)	Resistivity Ohm.m	Conductivity – 1:5 extract uS/cm
BH1 (0.7 – 1.2 m)	14	7.2	22	4000	13
BH2 (0.3 – 0.4 m)	29	9.6	350	590	84
BH2 (1.1 – 1.2 m)	19	7.4	22	4200	12
BH3 (0.0 – 0.3 m)	<10	6.6	11	2000	25

Based on the results, soil samples are generally classified as “Mild” to concrete and “Non-Aggressive” to steel structures.

All soil laboratory test certificates are provided in Appendix E.

5. GEOTECHNICAL RECOMMENDATIONS

5.1. Geotechnical Constraints

The general geotechnical constraints of the site comprise the partly uncontrolled surface fill, high water table and sandy subsoil profile observed in the site. The uncontrolled fill observed in the eastern part of the site is not suitable as a foundation material and should be replaced or reworked if is to be considered as a bearing material to support shallow footings. The sandy subsoil profile and high water table should be considered in the design and construction of footing systems.

5.2. Site Classification

Based on the site's current condition and the uncontrolled shallow surface fill over medium dense sand subsoil profile, the site is classified as Class P in accordance with AS2870-2011 “Residential Slabs and Footings”. The underlying natural material would be Class S with the movement below 20mm from moisture changes. Wherever earthworks comprising cut and fill are proposed or soil remediation takes place, the site classification may change.

5.3. Geotechnical Design Parameters

The subsoil and bedrock geotechnical parameters are provided in Table 4. The fill layer is not suitable as an engineering material and therefore is not included in the table. These parameters are based on the interpretations made on the CPTu results, borehole observations and AG’s past experience with similar soil profiles.

Table 4 – Geotechnical Subsoil Parameters

Unit	Description	γ (kN/m^3)	Cu (kPa)	C’ (kPa)	ϕ’	E’ (MPa)	ν'
1	Silty SAND to SAND – Medium Dense	19	-	0	30	35	0.3
2	Silty SAND, Loose	18	-	0	28	15	0.3
3	Sandy CLAY, Firm to Stiff	18	35	0	24	10	0.3
4	SAND, Dense to Very Dense	20	-	0	35	50	0.3
5	Silty to Clayey SAND, interlayers of fine sediments, Medium Dense to Dense	19	5	0	28	25	0.3

Legend:
γ: Bulk Unit Density
C_u: Undrained Cohesion
C’: Drained Cohesion
ϕ’: Drained Internal Friction Angle
E’: Long Term Elastic Modulus
ν': Long Term Poisson’s ratio

5.4. Groundwater

The existing groundwater table should be considered during the excavations required for the lift shaft. It is possible that the lift shaft excavations to an approximate depth of 1.5m below the ground surface encounter groundwater seepage. Therefore, it might be required to dewater the groundwater within the excavation to a minimum depth of 0.5m below the excavation base. The groundwater control measures can be incorporated with a properly designed shoring system (e.g. sheet piled wall).

Dewatering during the construction can be undertaken by wellpoint method. However, it is recommended the dewatering details be assessed by a geotechnical engineer prior to the dewatering to confirm it has no impact on the adjacent structures of infrastructure. For the building lifetime, it is suggested to tank the lift shaft base to avoid groundwater inflow.

The provided recommendations are based on the short term groundwater monitoring during the fieldwork. If a long term groundwater information is required, consideration should be given to installation of groundwater monitoring wells.

Bored piles are not considered suitable for the purpose of deep footings due to the need for casing and the potential for groundwater blow at the base. CFA or screw piling can be adopted to minimise the effect of high water level on footing constructions.

5.5. Temporary Unsupported Excavations

Based on the provided architectural plans, it is understood that no basement is considered for the proposed development. However, some excavations are required for the construction of the lift shaft and general earthworks during construction. The practicality of unsupported excavations above water level using batter slopes is subject to the available setback of the excavation to adjacent boundaries and underground services considering the allowable batter gradient provided in Table 5 below.

Table 5 – Maximum Recommended Batter Gradient

Material	Maximum Batter Slope (H : V)
Moderately Compacted Fill	2 : 1
Medium Dense Sand	2 : 1

It is noted that unsupported excavations in soil should not extend below the ‘zone of influence’ of any adjacent structures (i.e. a 30° line drawn from the foundation level of the adjacent structure). If the excavation extends below the zone of the influence of adjacent structures, it is recommended to design a retaining structure to support the excavation and confirm the conditions of the adjacent structure footings before excavating.

Based on the observed sandy subsoil, unsupported excavations below the water seepage level is not recommended. Driving sheet piles with a socket depth of 0.5 excavation depth can provide a temporary shoring system during excavation. However, struts must be installed immediately after completion of the excavation to provide lateral support to the shoring system. Any excavation of greater than 1.5m depth should be assessed for stability by an experienced geotechnical engineer.

Alternatively, shore boxes can be considered as an option for the shoring system. Trench boxes are considered cost-effective but they limit the excavation and constructability to some extent due to the horizontal braces. It is essential that the shore boxes are 'dug-in' or if it is feasible to install the shore box in an open temporary vertical excavation, the cavity between the shore box and the excavation face should be backfilled.

The following lateral earth pressure coefficients can be used for the short term and long term retaining structures of the lift shaft:

- At rest lateral earth pressure coefficient (k_0): 0.53
- Active lateral earth pressure coefficient (ka): 0.36
- Passive lateral earth pressure coefficient (kp): 2.77

5.6. Fill Placement and Compaction

It is recommended that any fill to be placed at the site be subject to a site-specific earthworks specification, which would incorporate information provided in the relevant Australian Standard (AS3798 – 2007: Earthworks for residential and commercial developments).

All fill should be placed in a controlled manner as defined in the Australian Standard. Fill materials shall not contain vegetation or other organic matter. In situ fill material should be placed and compacted to achieve the density ratio and moisture content as specified in Table 6 below.

Filling within 1.5m of the rear of retaining structures (if any) should be compacted using light-weight equipment (e.g. hand-operated plate compactor or static roller of not more than 3 tonnes gross weight) in order to limit compaction-induced lateral pressures. It is recommended that all compaction control testing in areas that will support buildings and pavements be undertaken under the supervision of a suitable geotechnical inspection testing authority (GITA).

Table 6 - Compaction Specifications for Fill Material

Filling	Loose layer thickness (mm)	Minimum density ratio (cohesive soils)	Minimum density index (granular soils)	Moisture Content when compacted
General Filling	250	95%	70	±2% OMC
Engineered Filling	250	98%	75	±2% OMC
Within 1.5m of rear of retaining walls	200	95%	80	±2% OMC

OMC –Optimum Moisture Content (for compaction).

5.7. Subgrade Preparation

The following recommendations are provided for subgrade preparation for earthworks, pavements and slab-on-ground construction:

- Strip unsuitable topsoil or fill (e.g. soil containing deleterious matter and boulders/floaters). Subject to waste classification of the unsuitable materials. Stock remainder for re-use as landscaping material or remove from site.
- If alluvial soils are excavated, they can be stockpiled for re-use as engineered fill or remove to spoil.
- Where soil is exposed at bulk excavation level, compact the upper 150mm depth to a dry density ratio (AS1289.5.4.1–2007) not less than 100% SMDD.
- Areas which show visible heave under compaction equipment be over-excavated a further 0.3m and replaced with approved fill compacted to a dry density ratio not less than 100% SMDD.

5.8. Shallow Foundation

Shallow footings might be considered for the new awning and additions to the existing building in the southern part of the site. The fill material observed adjacent to the proposed development is not suitable for the shallow foundation. If the construction of shallow footing on general fill is required, it should be replaced by engineered fill or be reworked to the 98% of Standard Maximum Dry Density (SMDD). Table 7 provides a bearing capacity for two typical footing dimensions and embedment depths. Allowable bearing capacity is calculated based on the general failure criteria and allowable settlement of 25mm. Due to susceptibility of loose silty sands to vibrations, higher safety factors have been applied to the ultimate bearing capacities to result allowable values.

Table 7 – Allowable Bearing Capacity of Shallow Footings

Footing Dimensions (m)	Footing Embedment (m)	Allowable Bearing Capacity (kPa)
1 x 1	0.5	80
1.5 x 1.5	1.0	140

Geotechnical inspection be undertaken no less than 24 hours prior to footings concrete pour for a confirmation of the design allowable bearing pressures.

5.9. Deep Footings

It is understood that deep footings will be required for the new building development. As discussed in section 5.1, the construction of bored piles is not considered practical. The following options can be considered for the deep footing constructions. The advantages and limitations of each method are briefly provided based on the specific site condition and anticipated structural design loads.

1- Continuous Flight Auger (CFA): Can be used to construct deep footings in high water level situations and collapsible soil. However, this method is potentially expensive and may not be economical for a project with this scale;

2- Driven Piles: Fast method to construct a deep footing. The effect of induced vibration on the adjacent structures and underground assets and the noise level should be considered; and,

3- Screw piles: Screw piles are considered the best method for the site.

An allowable end bearing of 650kPa can be adopted for piles (with maximum 500mm diameter) with an embedment depth of about 6.5m in the medium dense sand. A higher value of 1000kPa can be achieved at approximate depths of 7.5 to 8.0m within the dense to very dense sand if the pile tip sits at least three pile diameters above the observed silty/clayey sand layer observed at nominal depth of 10m below ESL. It is recommended the pile settlement be assessed based on the piles dimensions and service loads following finalising the structural designs.

As a general recommendation, the allowable end bearing capacity of the medium dense to dense sand (between 6m to about 7.5m below ESL) increases with a rate of 100kPa per meter of increase of embedment depth. In order to minimise the effect of group installations, the edge to edge distance of the adjacent piles should be greater than 3 piles diameters.

The shaft capacity of the screw piles should be ignored due to the small shaft diameter to the base area as the process of the piling highly disturbs the surrounding soil.

The recommendations are provided based on the interpretations made on the CPTu test results on the investigation area in the north-eastern section of the site. Based on the observed subsurface condition and the general geology of the site, it is inferred that the recommendations could be applied for the revised location of the development with some allowance for potential changes in layer's depth. The structural design should consider enough flexibility to accommodate these potential changes for the design and construction stages.

AG suggests additional investigation be considered prior to construction stage if these assumptions are not satisfactory for the structural design of the development.

It is recommended that the pile foundations be designed in accordance with Australian Standard AS 2159-2009 Piling – Design and Installation.

5.10. Earthquake Loading Factors

In Accordance with AS1170.4 – 2007, the following factors are considered appropriate to Sites:

- Hazard Factor (Z): 0.08
- Site Sub-Soil Class: C_e

5.11. Car Park CBR Design Parameters

Based on the obtained results of CBR tests on the collected samples from the site, design CBR value of 10% is recommended for pavement design purposes. The recommended design values are lower than the obtained laboratory results, but it takes into account the presence of the uncontrolled fill at the site AG's experience with similar materials and probable variety of the parameters.

To prepare the subgrade, the recommended treatment consists of stripping or removing organic material such as roots, grass and stumps, wood, construction debris including concrete, wood and other unsuitable materials. Compact the exposed surface using 8 passes with a minimum 10-tonne roller to 100% SMDD followed by a proof roll observed by a geotechnical engineer or senior geotechnician to identify any zones heaving or rutting. If any soft or loose zones are encountered, they should be excavated to the observed depth of heaving/rutting before being replaced in maximum

250mm thick compacted layers. The fill layers should also be compacted to at least 95% SMDD within 2% of the optimum moisture content. It is also important that a site drainage system is designed and installed to prevent any saturation of subgrade or pavement materials, with an allowance for long term run-off control.

The site won material comprising may be re-used as a fill. However, it should be inspected for the organic materials.

5.12. Infiltration Test Results

The permeability test was carried out in accordance with AS/NZS 1547:2012. The result of the test undertaken at a depth of 600mm is summarised in Table 8 below. Detailed test results are presented in Appendix F.

Table 8 - Infiltration test result

Parameters	Unit	Test Location
Groundwater level	m	Below a depth of 1.6m
Permeability	m/sec	1.1E-4
	cm/min	6.7E-1
	mm/hr	400
Nominal Absorption rate	$L/m^2/sec$	0.163
Design Absorption rate	$L/m^2/sec$	0.082

6. LIMITATIONS

Alliance Geotechnical Pty Ltd (AG) has prepared this report for the site located at 268 – 272 Fitzgerald Ave., Maroubra NSW 2035 in accordance with AG's fee proposal and Terms of Engagement. This geotechnical report has been prepared for Sydney Catholic Schools c/o JDH Architects for this project and for the purposes outlined in this report. This report cannot be relied on for other projects, other parties on this site or any other site. The comments and recommendations provided in this report are based on the assumption that the geotechnical recommendations contained in this report will be fully complied with during the design and construction of the proposed site development.

The testing results provided in this report are indicative of the subsurface conditions at the site only at the specific sampling and testing locations, and to the depths drilled at the time of the investigation. Subsurface conditions can change significantly due to geological and human processes. Where variations in conditions are encountered further geotechnical advice should be sought from AG.

REFERENCES

- Australian Standard *AS1726-1993 - Geotechnical Site Investigations*
- Australian Standard *AS 1289 – 2006 - Method of testing soils for engineering purposes*
- Australian Standard *AS 3798 – 2007 - Piling – Guidelines on Earthworks for Commercial and Residential Developments*
- Australian Standard *AS 2870– 2011 – Residential Slabs and Footings*
- The 1:100,000 NSW Department of Mineral Resources Geological Map of Sydney Region
- Pile Foundation Analysis and Design – 1980 – H.G. Poulos and E.H. Davis

APPENDIX A: Selected Site Photographs

Photo 1 – General Site Overview – Looking West

Photo 2 – Drilling in the location of BH3 and performing CPT4

Photo 3 – Site features in the western side of the existing buildings

Photo 4 – Soil cuttings retrieved from drilling of BH2

APPENDIX B – Drawing: 9194.2-GR-1-A

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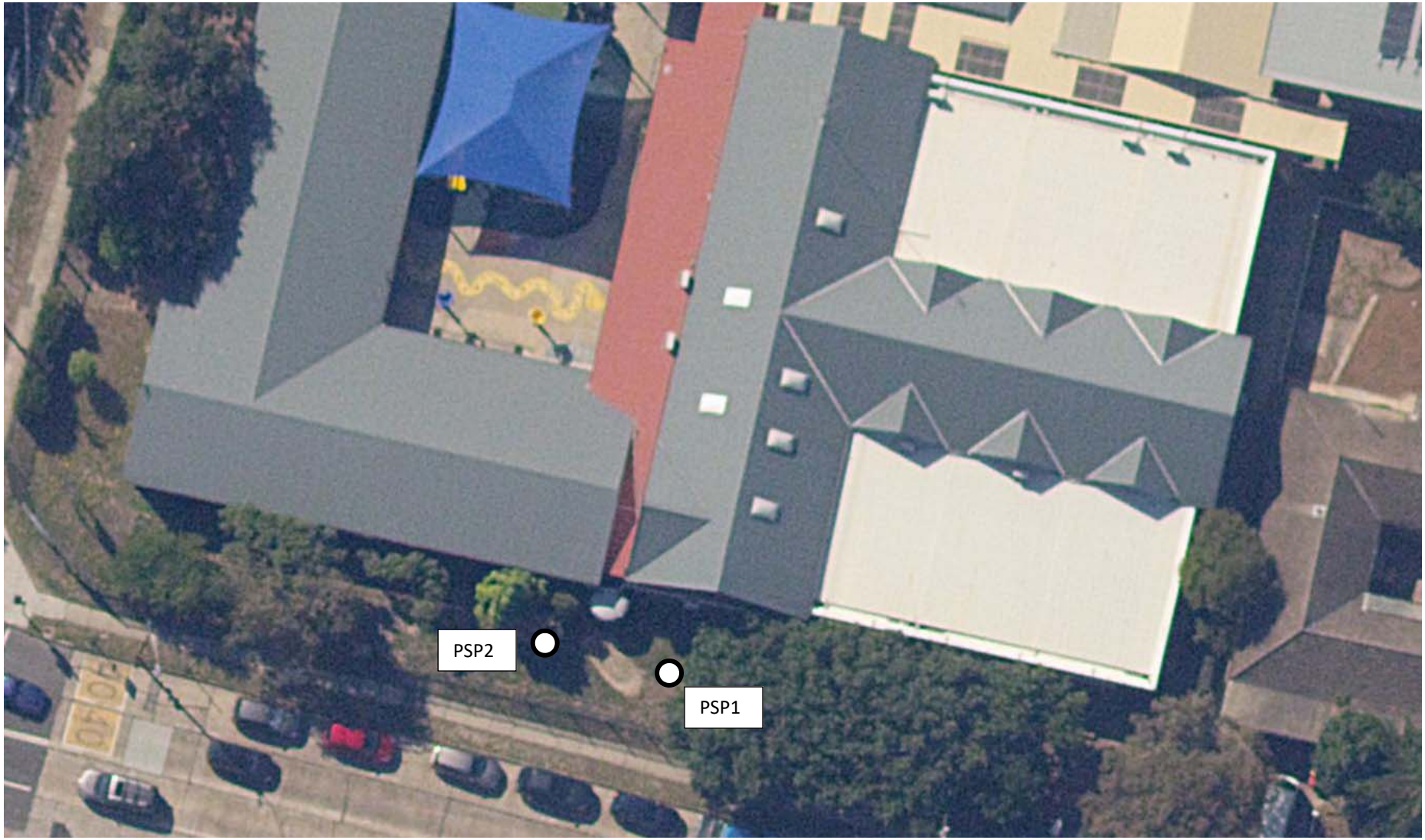
Geotechnical Investigation Plan (1/2)

Client Name:	Sydney Catholic Schools c/o JDH Architects	Figure / Drawing Number:	9194.2-GR-1-A
Project Name:	Proposed School Building Development	Figure / Drawing Date:	18/10/2019
Project Location:	268 – 272 Fitzgerald Avenue, Maroubra NSW 2035	Report Number:	9194.2-GR-1-1

N



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Geotechnical Investigation Plan (2/2)

Client Name:	Sydney Catholic Schools c/o JDH Architects	N	Figure / Drawing Number:	9194.2-GR-1-A
Project Name:	Proposed School Building Development		Figure / Drawing Date:	18/10/2019
Project Location:	268 – 272 Fitzgerald Avenue, Maroubra NSW 2035		Report Number:	9194.2-GR-1-1

APPENDIX C – Brehole Logs and PSP Results

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Alliance Geotechnical Pty Ltd
T: 1800 288 188
E: office@allgeo.com.au
W: www.allgeo.com.au

BH No: BH 1
Sheet: 1 of 1
Job No: 9194.2

Borehole Log

Client: Sydney Catholic Schools c/o JDH Architecs
Project: Proposed School Building Development
Location: 268 - 272 Fitzgerald Ave., Maroubra NSW 2035

Started: 8/10/19
Finished: 8/10/19
Borehole Size 100mm

Rig Type: TDLR690 **Hole Location:** Refer Drawing 9194.2-GR-1-A **Driller:** AH **Logged:** AA
RL Surface: 7.3 **Contractor:** AG Pty Ltd **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT		7.0	0.0		--	FILL: Sand, fine to medium grained, poorly graded, dark brown. (Appears moderately compacted)		M	--	FILL
	Seepage	6.5	0.5		SP	SAND, fine to medium grained, poorly graded, pale brown to brown.	BS	M	L - MD	ALLUVIUM
		6.0	1.0							
		5.5	1.5							
		5.0	2.0							
		4.5	2.5			- As above, wet, trace silt and clay, pale grey		W	MD	
		4.0	3.0							
		3.5	3.5			- As above, medium to coarse grained		W	MD	
		3.0	4.0							
		2.5	4.5			Borehole BH 1 terminated at 4.3m				
			5.0							

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BH No: BH 2
Sheet: 1 of 1
Job No: 9194.2

Borehole Log

Client: Sydney Catholic Schools c/o JDH Architecs
Project: Proposed School Building Development
Location: 268 - 272 Fitzgerald Ave., Maroubra NSW 2035

Started: 8/10/19
Finished: 8/10/19
Borehole Size 100mm

Rig Type: TDLR690 **Hole Location:** Refer Drawing 9194.2-GR-1-A **Driller:** AH **Logged:** AA
RL Surface: 8.0 **Contractor:** AG Pty Ltd **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT					--	FILL: Gravelly Sand, fine to medium grained, medium to coarse gravel, dark brown. (Appears well compated)		M	--	FILL
					--	FILL: SAND, fine to medium grained, with medium to coarse gravel, brown. (Appears well compacted)		M	--	ALLUVIUM
		7.5	0.5				BS			
		7.0	1.0		SP	SAND, fine to medium grained, poorly graded, pale brown to pale grey, trace silt and clay.		M	L - MD	
		6.5	1.5							
		6.0	2.0							
	▼ Seepage	5.5	2.5			- As above, becomes wet		W	MD	
		5.0	3.0							
		4.5	3.5			- As above, trace of weakly cemented sand		W	MD	
		4.0	4.0							
						Borehole BH 2 terminated at 4m				
		3.5	4.5							
		3.0	5.0							

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BH No: BH 3
Sheet: 1 of 1
Job No: 9194.2

Borehole Log

Client: Sydney Catholic Schools c/o JDH Architecs
Project: Proposed School Building Development
Location: 268 - 272 Fitzgerald Ave., Maroubra NSW 2035

Started: 8/10/19
Finished: 8/10/19
Borehole Size 100mm

Rig Type: TDLR690 **Hole Location:** Refer Drawing 9194.2-GR-1-A **Driller:** AH **Logged:** AA
RL Surface: 8.0 **Contractor:** AG Pty Ltd **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT					--	FILL: Gravelly Sand, fine to medium grained, medium to coarse gravel, dark brown. (Appears well compated)		M	--	FILL
					--	FILL: SAND, fine to medium grained, trace medium to coarse gravel, trace clay, brown. (Appears well compacted)		M	--	ALLUVIUM
		7.5	0.5							
		7.0	1.0		SP	SAND, fine to medium grained, poorly graded, pale brown.	BS	M	L - MD	
		6.5	1.5							
		6.0	2.0							
		5.5	2.5			- As above, becomes medium to coarse grained, plae grey to pale brown			MD	
	Seepage	5.0	3.0			- As above, becomes wet, trace rootlets, trace clay and silt		W	MD	
		4.5	3.5							
		4.0	4.0							
		3.5	4.5							
		3.0	5.0			Borehole BH 3 terminated at 4.5m				

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EXPLANATORY NOTES - DRILL & EXCAVATION LOGS

General

Information obtained from site investigations is recorded on log sheets. Soils and very low strength rock are commonly drilled using a combination of solid-flight augers with a Tungsten-Carbide (TC) bit. Descriptions of these materials presented on the "Borehole Log" are based on a combination of regular sampling and in-situ testing. Rock coring techniques commences once material is encountered that cannot be penetrated using a combination of solid-flight augers and Tungsten-carbide bit. The "Cored Borehole Log" presents data from drilling where a core barrel has been used to recover material - commonly rock.

The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits or trenches.

The heading of the log sheets contains information on Project Identification, Hole or Test Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The scale is presented in the depth column as metres below ground level.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is included in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures, and geological unit. Material description and classifications are based on Australian Standard Geotechnical Site Investigations: AS 1726 - 2017 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

Drilling

Drilling, Casing and Excavating

Drilling methods deployed are abbreviated as follows

AS	Auger Screwing
ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
BH	Backhoe
E	Excavator
HA	Hand Auger
HQ	HQ core barrel (~63.5 mm diameter core) *
HMLC	HMLC core barrel (~63.5 mm diameter core) *
NMLC	NMLC core barrel (~51.9 mm diameter core) *
NQ	NQ core barrel (~47.6 mm diameter core) *
RR	Rock Roller
WB	Wash-bore drilling

* Core diameters are approximate and vary due to the strength of material being drilled.

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage. It is introduced to assist with the drill process, in particular, when core drilling. The introduction of drill fluid/water does not allow for accurate identification of water seepages.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
F	Firm
H	Hard
VH	Very Hard

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

Groundwater inflow water level

Samples/Tests

Samples collected and testing undertaken are abbreviated as follows

ES	Environmental Sample
DS	Disturbed Sample
BS	Bulk Sample
U50	Undisturbed (50 mm diameter)
C	Core Sample
SPT	Standard Penetration Test
N	Result of SPT (*sample taken)
VS	Vane Shear Test
IMP	Borehole Impression Device
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test
HB	Hammer Bouncing

Excavation Logs

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

Material Description – Soil

Material Description - In accordance with AS 1726-2017

Classification Symbol - In accordance with the Unified Classification System (AS 1726-2017).

Abbreviation	Typical Names
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
SM	Silty sand, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
OL	Organic silts and organic silty clays of low plasticity. *
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts.
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity, organic silts. *
Pt	Peat and other highly organic soils. *

* Additional details may be provided in accordance with the Von Post classification system (1922).

Organic Soils - Identification using laboratory testing:

Material	Organic Content - % of dry mass
Inorganic	<2
Organic Soil	<2 ≤ 25
Peat	> 25

Organic Soils - Descriptive terms for the degree of decomposition of peat:

Term	Decomposition	Remains	Squeeze
Fibrous	Little or none	Clearly recognizable	Only water No solid
Pseudo-fibrous	Moderate	Mixture of fibrous and amorphous	Turbid water < 50% solids
Amorphous	Full	Not recognizable	Paste > 50% solids

EXPLANATORY NOTES - DRILL & EXCAVATION LOGS

Particle Characteristics– Definitions are as follows:

Fraction	Component (& subdivision)		Size (mm)
Oversize	Boulders		> 200
	Cobbles		> 63 ≤ 200
Coarse grained soils	Gravel	Coarse	> 19 ≤ 63
		Medium	> 6.7 ≤ 19
		Fine	> 2.36 ≤ 6.7
	Sand	Coarse	> 0.6 ≤ 2.36
		Medium	> 0.2 ≤ 0.6
		Fine	> 0.075 ≤ 0.21
Fine grained soils	Silt		0.002 ≤ 0.075
	Clay		< 0.002

Secondary and minor soil components

In coarse grained soils – The proportions of secondary and minor components are generally estimated from a visual and tactile assessment of the soils. Descriptions for secondary and minor soil components in coarse grained soils are as follows.

Designation of components	Percentage fines	Terminology (as applicable)	Percentage accessory coarse fraction	Terminology (as applicable)
Minor	≤ 5	Trace clay / silt	≤ 5	Trace sand / gravel
	> 5 ≤12	With clay / silt	> 5 ≤12	With sand / gravel
Secondary	> 12	Silty or clayey	> 30	Sandy or gravelly

Descriptions for secondary and minor soil components in fine grained soils are as follows.

Designation of components	Percentage coarse grained soils	Terminology (as applicable)
Minor	≤ 5	Trace sand / gravel / silt / clay
	> 5 ≤12	With sand / gravel / silt / clay
Secondary	> 30	Sandy / gravelly / silty / clayey

Plasticity Terms – Definitions for fine grained soils are as follows:

Descriptive Term	Range of Liquid Limit for silt	Range of Liquid Limit for clay
Low Plasticity	≤ 50	≤ 35
Medium Plasticity	N/A	> 35 ≤50
High Plasticity	> 50%	> 50

Particle Characteristics

Particle shape and angularity are estimated from a visual assessment of coarse-grained soil particle characteristics. Terminology used includes the following:

Particle shape – spherical, platy, elongated,

Particle angularity –angular, sub-angular, sub-rounded, rounded.

Moisture Condition – Abbreviations are as follows:

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Moisture content of fine-grained soils is based on judgement of the soils moisture content relative to the plastic and liquid limit as follows:

MC < PL	Moist, dry of plastic limit
MC ≈ PL	Moist, near plastic limit
MC > PL	Moist, wet of plastic limit
MC ≈ LL	Wet, near liquid limit
MC > LL	Wet of liquid limit

Consistency - of cohesive soils in accordance with AS 1726-2017, Table 11 are abbreviated as follows:

Consistency Term	Abbreviation	Indicative Undrained Shear Strength Range (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**	-

Density Index (%) of granular soils is estimated or is based on SPT results. Abbreviations are as follows:

Description	Abbreviation	Relative Density	SPT N
Very Loose	VL	< 15%	0 - 4
Loose	L	15 - 35%	4 - 10
Medium Dense	MD	35 - 65%	10 - 30
Dense	D	65 - 85%	30 - 50
Very Dense	VD	> 85%	> 50

Structures - Fissuring and other defects are described in accordance with AS 1726-2017 using the terminology for rock defects

Origin - Where practicable an assessment is provided of the probable origin of the soil, e.g. fill, topsoil, alluvium, colluvium, residual soil.

EXPLANATORY NOTES - DRILL & EXCAVATION LOGS

MATERIAL DESCRIPTION - ROCK

Material Description

Descriptions of rock for geotechnics and engineering geology in civil engineering

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-2017.

Rock Naming – Where possible conventional geological names are used within the logs. Engineering properties cannot be inferred directly from the rock names in the table, but the use of a particular name provides an indicative range of characteristics to the reader. Lithological identification of rock is provided to appreciate the geology of an area, to correlate geological profiles seen in boreholes or to distinguish boulders from bedrock.

Grain Size – Grain size is done in accordance with AS1726-2017 as follows:

Coarse grained	Mainly 0.6 to 2 mm
Medium grained	0.2 – 0.6 mm
Fine grained	0.06 – 0.2 mm

Colour – Rock colour is described in the moist condition.

Texture and Fabric - Frequently used terms include:

Sedimentary Rock	Metamorphic Rock	Igneous
Bedded	Cleaved	Massive
Interbedded	Foliated	Flow banded
Laminated	Schistose	Folded
Folded	Banded	Lineated
Massive	Lineated	Porphyritic
Graded	Gneissose	Crystalline
Cross-bedded	Folded	Amorphous

Bedding and Laminated – AS 1726 – 2017 bedding and laminated rock descriptions are provided below with additional detail from BS EN ISO 14689-1 as guidance.

Description	Spacing (mm)
Very Thickly Bedded	> 2000
Thickly Bedded	> 600 ≤ 2000
Medium Bedded	> 200 ≤ 600
Thinly Bedded	> 60 ≤ 200
Very Thinly Bedded	> 20 ≤ 60
Thickly Laminated	> 6 ≤ 20
Thinly Laminated	< 6

Features, inclusions and minor components – Features, inclusions and minor components within the rock material shall be described where those features could be significant such as gas bubbles, mineral veins, carbonaceous material, salts, swelling minerals, mineral inclusions, ironstone or carbonate bands, cross-stratification or minerals the readily oxidise upon atmospheric exposure.

Moisture content – Where possible descriptions are made by the feel and appearance of the rock using one according to following terms:

Dry	Looks and feels dry.
Moist	Feels cool, darkened in colour, but no water is visible on the surface
Wet	Feels cool, darkened in colour, water film or droplets visible on the surface

The moisture content of rock cored with water may not be representative of its in-situ condition.

Durability – Descriptions of the materials durability such as tendency to develop cracks, break into smaller pieces or disintegrate upon exposure to air or in contact with water are provided where observed.

Rock Material Strength – The strength of the rock material is based on uniaxial compressive strength (UCS). The following terms are used:

Rock Strength Class	Abbreviation	UCS (MPa)	Point Load Strength Index, $I_{s\,(50)}$ (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
High	H	> 20 ≤ 60	> 1 ≤ 3
Very High	VH	> 60 ≤ 200	> 3 ≤ 10
Extremely High	EH	> 200	> 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical logs as follows:

D	Diametral Point Load Test
A	Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown. Point Load Strength Index test results are presented as $I_{s\,(50)}$ values in MPa.

Weathering - Weathering classification assists in identification but does not imply engineering properties. Descriptions are as follows:

Term (Abbreviation)	Description
Fresh (F)	No signs of mineral decomposition or colour change.
Slightly Weathered (SW)	partly stained or discoloured. Not or little change to strength from fresh rock.
Moderately Weathered (MW)	material is completely discoloured, little or no change of strength from fresh rock.
Highly Weathered (HW)	material is completely discoloured, significant decrease in strength from fresh rock.
Extremely Weathered (EW)	Material has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Residual Soil (RS)	Material has soil properties. Mass structure and material texture and fabric of original rock not visible, but the soil has not been significantly transported.

Alteration – Physical and chemical changes of the rock material due to geological processes by fluids at depth at pressures and temperatures above atmospheric conditions. Unlike weathering, alteration shows no relationship to topography and may occur at any depth. When altered materials are recognized, the following terms are used:

Term		Abbreviation		Definition
Extremely Altered		XA		Material has soil properties. Structure, texture and fabric of original rock are still visible. The rock name is replaced with the name of the parent material, e.g. Extremely Altered basalt. Soil descriptive terms are used.
Highly Altered	Distinctly altered	HA	DA	The whole of the rock material is discoloured. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be higher or lower due to loss of minerals or precipitation of secondary minerals in pores.
Moderately Altered	Distinctly altered	MA	DA	The whole of the rock material is discoloured Little or no change of strength from fresh rock. The term 'Distinctly Altered' is used where it is not practicable to distinguish between 'Highly Altered' and 'Moderately Altered'. Distinctly Altered is defined as follows: The rock may be highly discoloured; Porosity may be higher due to mineral loss; or may be lower due to precipitation of secondary minerals in pores; and Some change of rock strength.
Slightly Altered		SA		Rock is slightly discoloured Little or no change of strength from fresh rock.

Alteration is only described in the context of the project where it has relevance to the civil and structural design.

Defect Descriptions

General and Detailed Descriptions – Defect descriptions are provided to suit project requirements. Generalized descriptions are used for some projects where it is unnecessary to describe each individual defect in a rock mass, or where multiple similar defects are present which are too numerous to log individually. The part of the rock mass to which this applies is delineated.

Detailed descriptions are given of defects judged to be particularly significant in the context of the project. For example, crushed seams in an apparently unstable slope. As a minimum, general descriptions outlining the number of defect sets within the rock mass and their broad characteristics are provided where it is possible to do so.

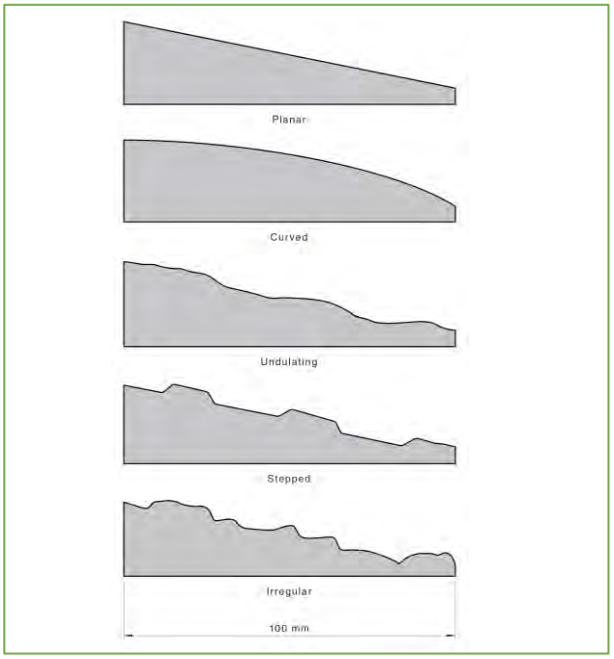
Defect Type – Defect abbreviations are as follows:

BP	Bedding Parting	FL	Foliation	SP	Shear Plane
CL	Cleavage	FZ	Fracture Zone	SZ	Shear Zone
CS	Crushed Seam	HB	Handling break	VN	Vein
DB	Drilling break	JT	Joint		
DL	Drill Lift	SM	Seam		

EXPLANATORY NOTES - DRILL & EXCAVATION LOGS

Defect Orientation – The dip and dip direction are recorded as a two-digit and three-digit number separated by a slash, e.g. 50/240 only when orientated core are collected and there is not core loss that could obscure core orientation. If alternative measurements are made, such as dip and strike or dip direction relative to magnetic north this shall be documented.

Surface Shape –At the medium scale of observation, description of the roughness of the surface shall be enhanced by description of the shape of the defect surface using the following terms, as illustrated below:



Defect Coatings and Seam Composition – Coatings are described using the following terms:

(a) *Clean* No visible coating.
(b) *Stained* No visible coating but surfaces are discoloured.
(c) *Veneer* A visible coating of soil or mineral, too thin to measure; may be patchy.
(d) *Coating* A visible coating up to 1 mm thick. Soil in-fill greater than 1 mm shall be described using defect terms (e.g. infilled seam). Defects greater than 1 mm aperture containing rock material great described as a vein.

Defect Spacing, Length, Openness and Thickness –described directly in millimetres and metres. In general descriptions, half order of magnitude categories are used, e.g. joint spacing typically 100 mm to 300 mm, sheared zones 1 m to 3 m thick.

Depending on project requirements and the scale of observation, spacing may be described as the mean spacing within a set of defects, or as the spacing between all defects within the rock mass. Where spacing is measured within a specific set of defects, measurements shall be made perpendicular to the defect set.

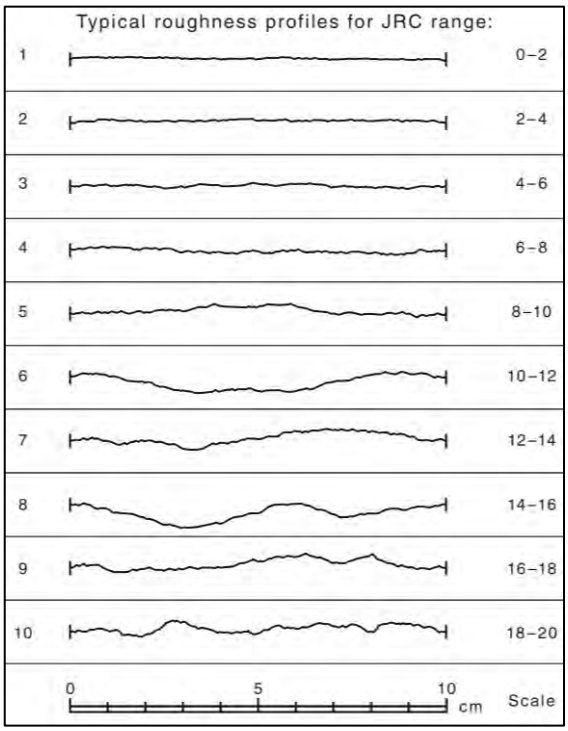
Defect spacing and length (sometimes called persistence), shall be described directly inmillimetres and metres.

Stratigraphic Unit - Geological maps related to the project are used for the designation of lithological formation name and, where possible geological unit name, e.g. Bringelly Shale, Potts Hill Sandstone Member.

Defect Roughness and Shape – Defect surface roughness is described as follows:

Very rough	Many large surface irregularities with amplitude generally more than 1 mm.
Rough	Many small surface irregularities with amplitude generally less than 1 mm.
Smooth	Smooth to touch. Few or no surface irregularities.
Polished	Shiny smooth surface
Slickensided	Grooved or striated surface, usually polished.

Where applicable Joint Roughness Range (JRC) is provided as follows:



Joint roughness profiles and corresponding JRC range based on Barton, N and Choubey, V. The Shear Strength of Rock Joints in Theory and Practice. *Rock Mechanics.* Vol. 10 (1977), pp. 1–54.

Where possible the mineralogy of the coating is identified.

Defect Infilling - abbreviated as follows:

CA	Calcite	KT	Chlorite
CN	Clean	MS	Secondary Mineral
Cy	Clay	MU	Unidentified Mineral
CS	Crushed Seam	Qz	Quartz
Fe	Iron Oxide	X	Carbonaceous

PARAMETERS RELATED TO CORE DRILLING

Total Core Recovery – T

Defect Spacing or Fracture Index – T

Rock Quality Designation – Y

Core Loss – Core loss occurs when material is lost during the drilling process It is shown at the bottom of the run unless otherwise indicated where core loss is known.

Perth Sand Penetrometer (PSP) Test Report

Client:	Sydney Catholic Schools c/o JDH Architects	Report Number:	9194.2-GR-1-1
Project Name:	Proposed Building Development	Project Number:	9194.2
Project Location:	268-272 Fitzgerald Ave., Maroubra NSW 2035	Date Tested:	8/10/2019
Test Method:	AS 1289.6.3.3		

Test Number	PSP-1	PSP-2
Test Locations	Refer to Site Investigation Plan (9194.2-GR-1-A)	
Surface Material	Topsoil	Topsoil
Surface R.L (m)	--	--
Depth (metres)		
0.00 – 0.15	3	2
0.15 – 0.30	>25/80mm	5
0.30 – 0.45	Solid Refusal on inferred Concrete Slab	4
0.45 – 0.60		4
0.60 – 0.75		3
0.75 – 0.90		1
0.90 – 1.05		3
1.05 – 1.20		2
1.20 – 1.35		2
1.35 – 1.50		3
1.50 – 1.65		3
1.65 – 1.80		2
1.80 – 1.95		2
1.95 – 2.10		2
2.10 – 2.25		1

Notes:

1. This penetrometer test report is intended to be read in conjunction with the geotechnical report by Alliance Geotechnical (ref: 9194.2-GR-1-1).

APPENDIX D – CPTu Results

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Seven Hills NSW
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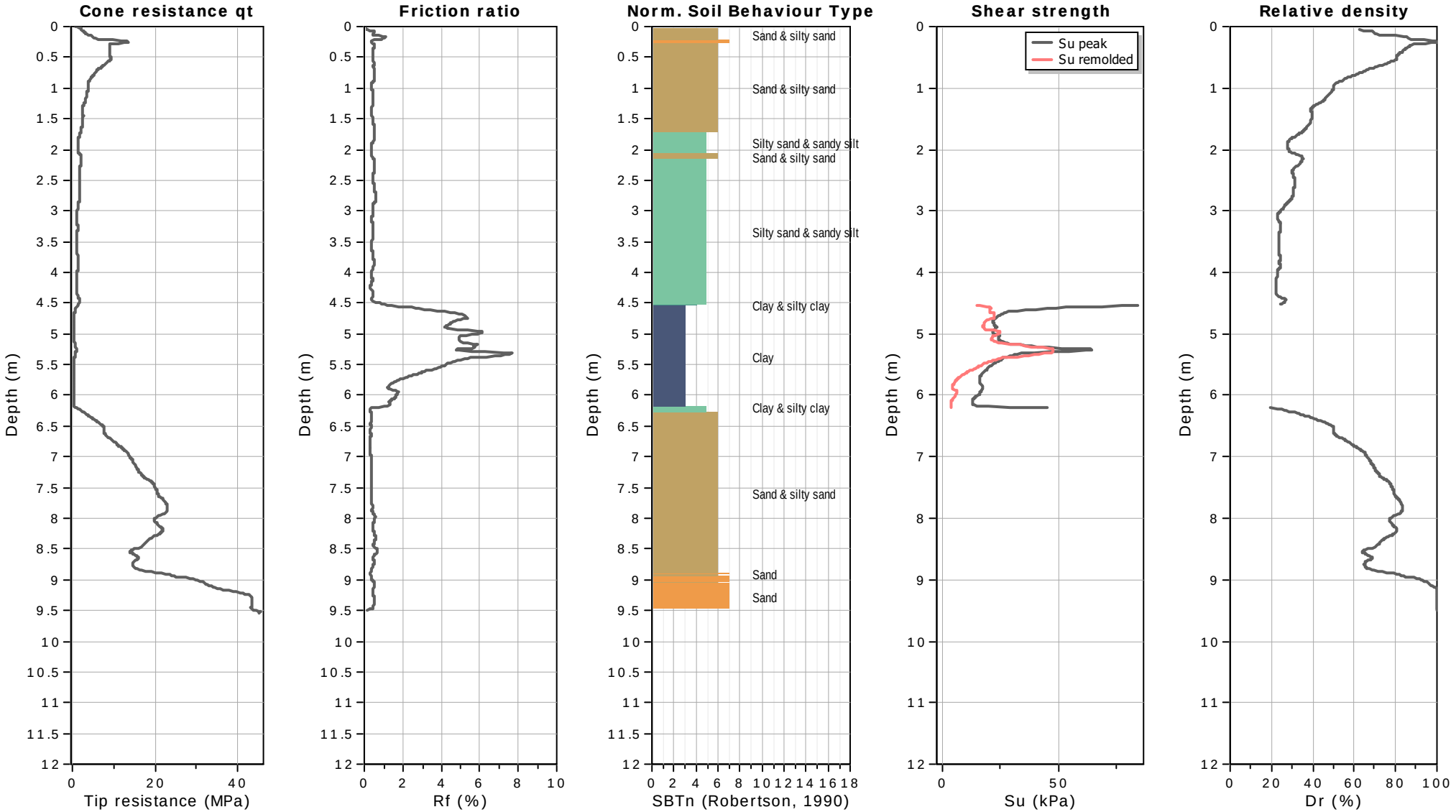
Project: **Proposed School Development**
Location: **268-272 Fitzgerald Ave., Maroubra NSW 2035**

CPT: 9194.2_CPT-01
Total depth: 9.55 m, Date: 11/10/2019
Surface Elevation: 2.40 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



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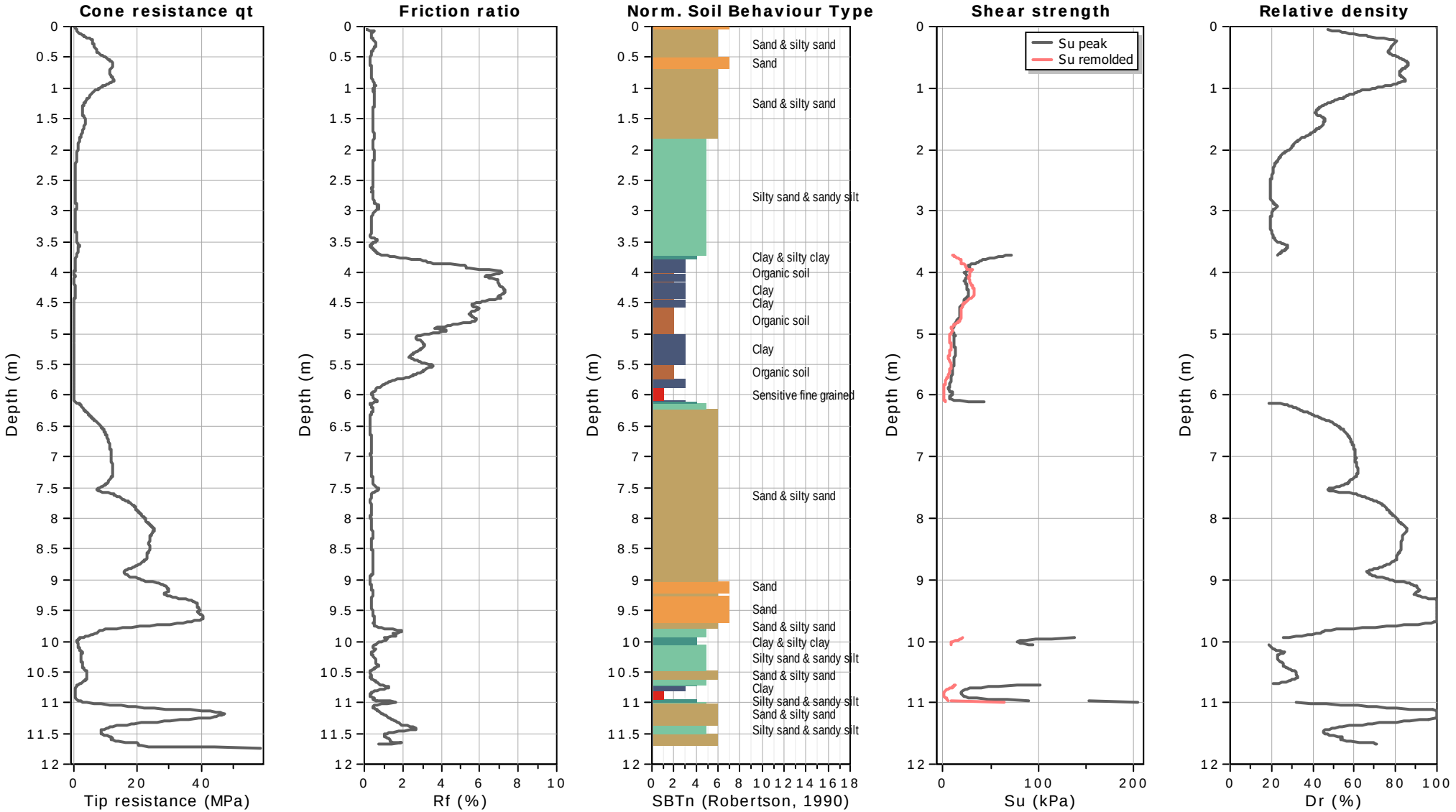
Project: **Proposed School Development**
Location: **268-272 Fitzgerald Ave., Maroubra NSW 2035**

CPT: 9194.2_CPT-02
Total depth: 11.74 m, Date: 11/10/2019
Surface Elevation: 2.40 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



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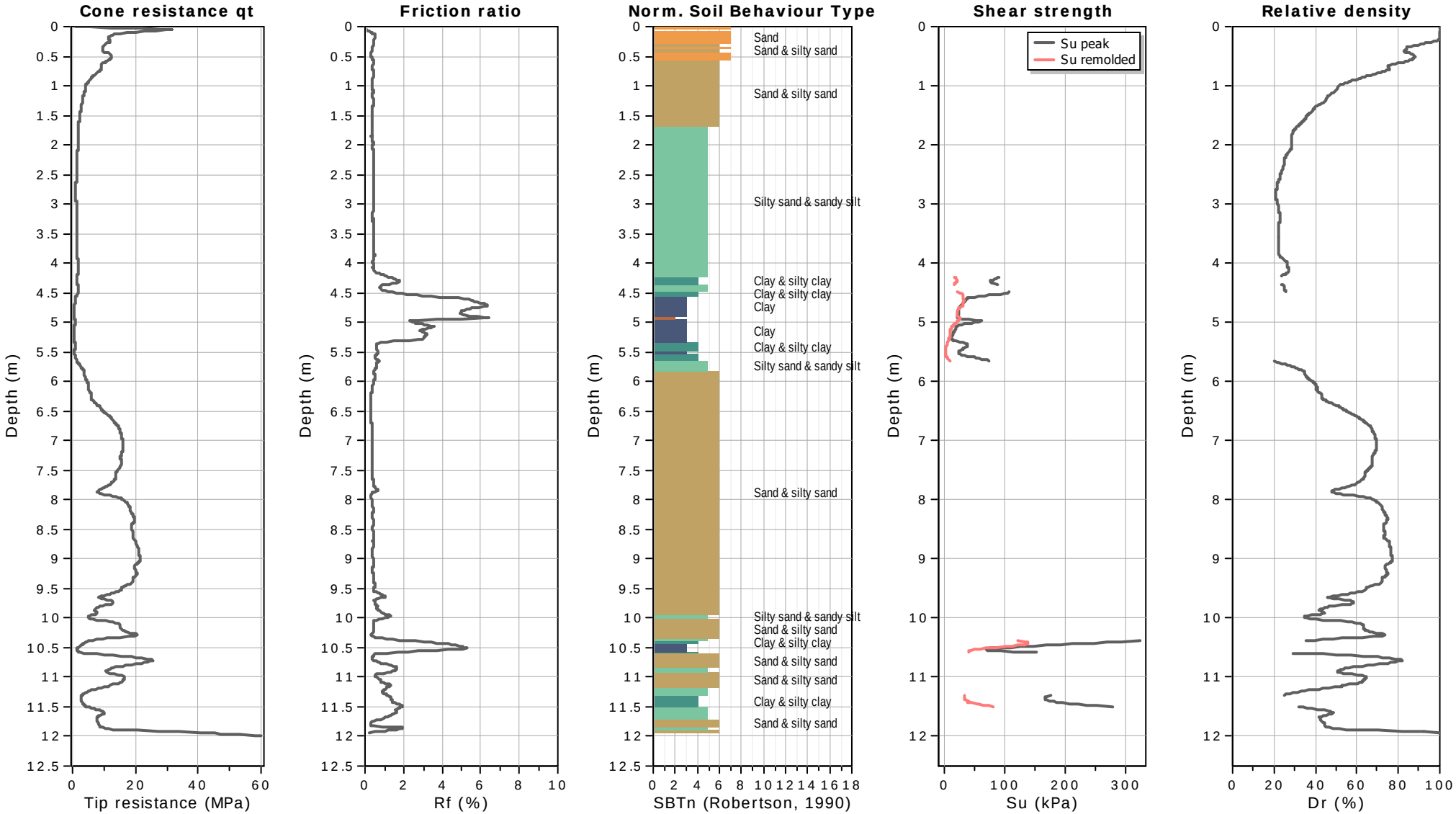
Project: **Proposed School Development**
Location: **268-272 Fitzgerald Ave., Maroubra NSW 2035**

CPT: 9194.2_CPT-03
Total depth: 11.99 m, Date: 11/10/2019
Surface Elevation: 2.40 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



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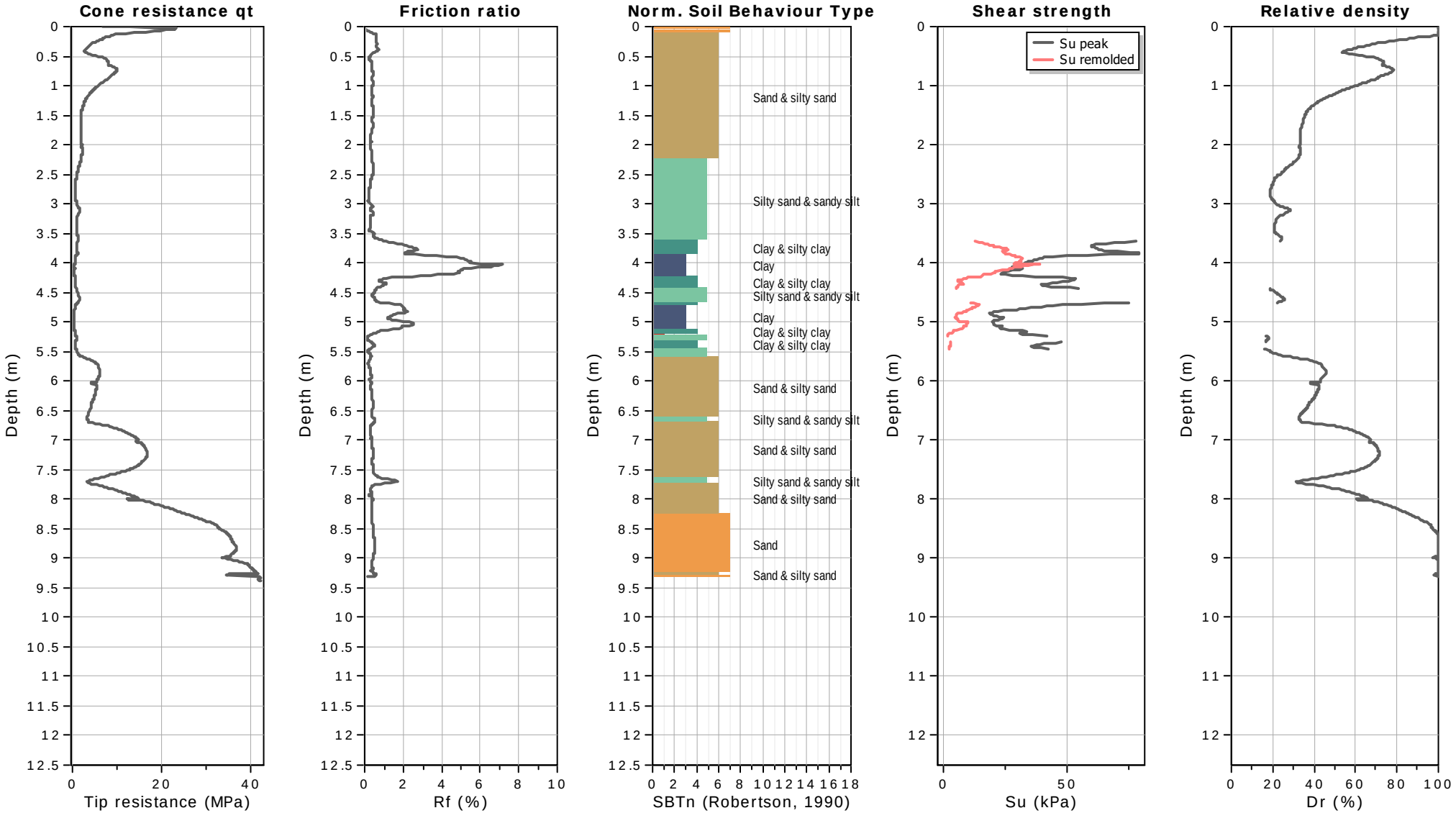
Project: **Proposed School Development**
Location: **268-272 Fitzgerald Ave., Maroubra NSW 2035**

CPT: 9194.2_CPT-04
Total depth: 9.38 m, Date: 11/10/2019
Surface Elevation: 2.40 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



APPENDIX E – Laboratory Test Certificates

Alliance Geotechnical
ENGINEERING | ENVIRONMENTAL | TESTING
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Phone: 1800 288 188
Email: office@allgeo.com.au
Web: allgeo.com.au
Post: PO Box 275, Seven Hills NSW 1730
Lab: 10 Welder Road, Seven Hills NSW 2147

Material Test Report

Report No: MAT:19-1256-S04
Date of Issue: 21/10/2019
Issue Number: 1

Client: Alliance Geotechnical Pty Ltd
10 Welder Road, Seven Hills NSW 2147
Project: St Mary, St Joseph Catholic School
Project No: P191283
Location: 268 Fitzgerald Road, Maroubra

NATA Accreditation: 15100
Approved Signatory: Paul Haslam
Accredited for compliance with ISO/IEC 17025-Testing

Sample Details

Sample ID	19-1256-S04
Date Sampled	8/10/2019
Sampling Method	AS1289.1.2.1 6.2 - Sampling from stockpiles
Sample Description	SAND, medium grained, pale brown
Sample Location	BH 3 (1.2m-1.5m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	15.1	
Date Tested		10/10/2019	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	N/A	
Mould Length (mm)			
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.2	N/A	
Plastic Limit (%)	AS 1289.3.2.1	NP	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Date Tested		11/10/2019	

Comments

NP = Non Plastic

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Post: PO Box 275, Seven Hills NSW 1730
Lab: 10 Welder Road, Seven Hills NSW 2147

Material Test Report

Report No: MAT:19-1256-S02
Date of Issue: 21/10/2019
Issue Number: 1

Client: Alliance Geotechnical Pty Ltd
10 Welder Road, Seven Hills NSW 2147
Project: St Mary, St Joseph Catholic School
Project No: P191283
Location: 268 Fitzgerald Road, Maroubra

NATA Accreditation: 15100

Approved Signatory: Paul Haslam

Accredited for compliance with ISO/IEC 17025-Testing

Sample Details

Sample ID	19-1256-S02
Date Sampled	8/10/2019
Sampling Method	AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Description	SAND, non plastic, medium grained pale brown to brown.
Sample Location	BH 1 (0.8m-1.0m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	4.8	
Date Tested		10/10/2019	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	N/A	
Mould Length (mm)			
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.2	N/A	
Plastic Limit (%)	AS 1289.3.2.1	NP	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Date Tested		11/10/2019	

Comments

NP = Non Plastic

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Post: PO Box 275, Seven Hills NSW 1730
Lab: 10 Welder Road, Seven Hills NSW 2147

California Bearing Ratio Test Report

Report No: CBR:19-1256-S03
Date of Issue: 21/10/2019
Issue Number: 1

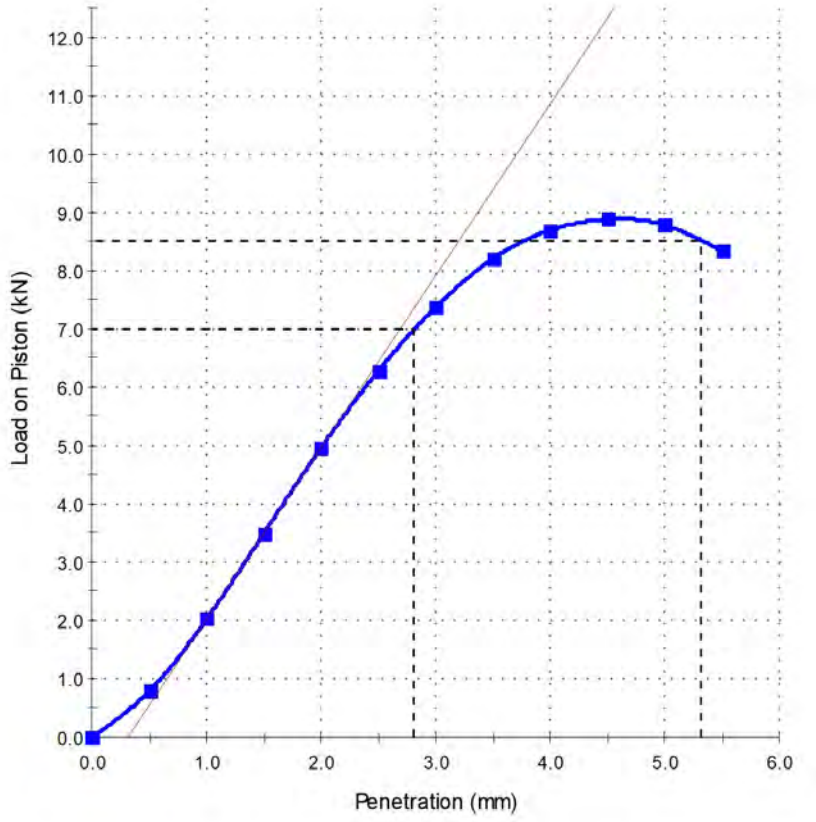
Client: Alliance Geotechnical Pty Ltd
10 Welder Road, Seven Hills NSW 2147
Project: St Mary, St Joseph Catholic School
Project No: P191283
Location: 268 Fitzgerald Road, Maroubra

NATA Accreditation: 15100
Approved Signatory: Paul Haslam
Accredited for compliance with ISO/IEC 17025-Testing

Sample Details

Sample Location:	BH 2 (0.2m-0.8m)	Date Sampled:	8/10/2019
Sample Description:	FILL - SAND, fine to medium grained with medium	Date Tested:	18/10/2019

Load vs Penetration



Test Results

	AS 1289.6.1.1
CBR at 2.5mm (%):	50
Maximun Dry Density(t/m³):	1.84
Optimum Moisture Content(%):	13.3
Dry Density before Soaking (t/m³):	1.85
Density Ratio before Soaking (%):	101.0
Moisture Content before Soaking (%):	12.0
Moisture Ratio before Soaking (%):	90.5
Dry Density after Soaking (t/m³):	1.85
Density Ratio after Soaking (%):	101.0
Swell (%):	0.0
Moisture Content of Top 30mm (%):	14.0
Moisture Content of Remaining Depth (%):	12.9
Compaction Hammer Used:	Standard
	AS 1289.5.1.1
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Retained on 19 mm Sieve (%):	1
CBR Moisture Content Method:	AS 1289.2.1.1
Sample Curing Time (h):	98
Plasticity Determination Method:	Visual/Tactile
——— AS 1289.2.1.1 ———	
In Situ (Field) Moisture Content (%):	15.0

Comments

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Web: allgeo.com.au
Post: PO Box 275, Seven Hills NSW 1730
Lab: 10 Welder Road, Seven Hills NSW 2147

California Bearing Ratio Test Report

Report No: CBR:19-1256-S01
Date of Issue: 21/10/2019
Issue Number: 1

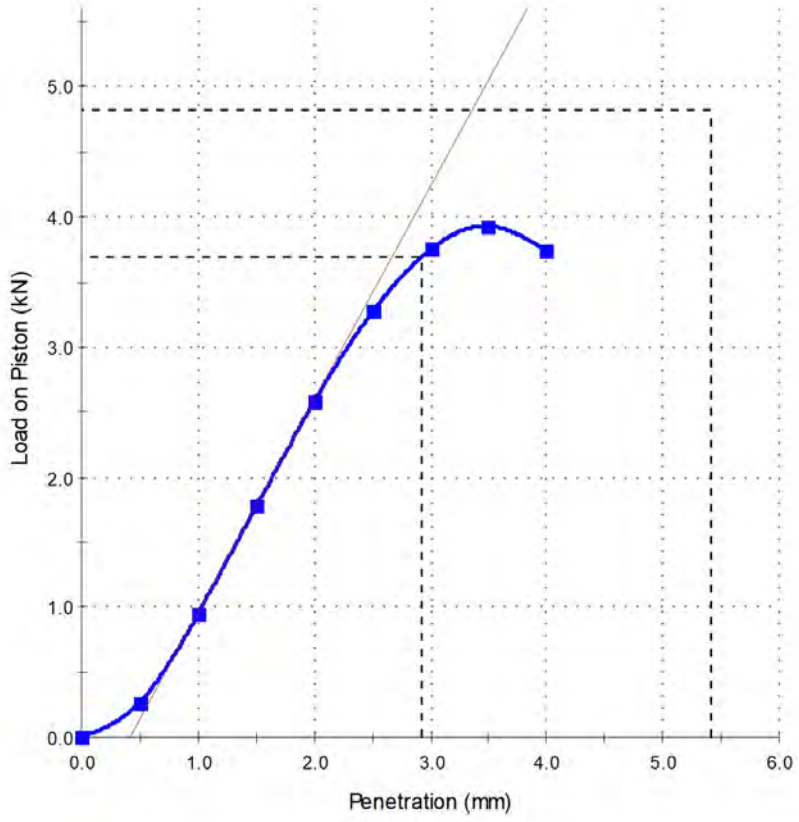
Client: Alliance Geotechnical Pty Ltd
10 Welder Road, Seven Hills NSW 2147
Project: St Mary, St Joseph Catholic School
Project No: P191283
Location: 268 Fitzgerald Road, Maroubra

NATA Accreditation: 15100
Approved Signatory: Paul Haslam
Accredited for compliance with ISO/IEC 17025-Testing

Sample Details

Sample Location: BH 1 (0.4m-0.8m)
Sample Description: SAND, medium grained, pale brown to brown
Date Sampled: 8/10/2019
Date Tested: 18/10/2019

Load vs Penetration



Test Results

	AS 1289.6.1.1
CBR at 2.5mm (%):	30
Maximun Dry Density(t/m³):	1.71
Optimum Moisture Content(%):	14.5
Dry Density before Soaking (t/m³):	1.71
Density Ratio before Soaking (%):	99.5
Moisture Content before Soaking (%):	14.2
Moisture Ratio before Soaking (%):	98.0
Dry Density after Soaking (t/m³):	1.71
Density Ratio after Soaking (%):	99.5
Swell (%):	0.0
Moisture Content of Top 30mm (%):	15.7
Moisture Content of Remaining Depth (%):	15.3
Compaction Hammer Used:	Standard AS 1289.5.1.1
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Retained on 19 mm Sieve (%):	0
CBR Moisture Content Method:	AS 1289.2.1.1
Sample Curing Time (h):	4
Plasticity Determination Method:	Visual/Tactile
——— AS 1289.2.1.1 ———	
In Situ (Field) Moisture Content (%):	4.5

Comments

Alliance Geotechnical
10 Welder Road
Seven Hills
NSW 2147

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Steven Wallace**

Report **681563-S**
Project name ST MARY ST JOSEPH CATHOLIC PRIMARY SCHOOL
Project ID 9194.2
Received Date Oct 09, 2019

Client Sample ID			**BH7_0.0-0.3**	**BH1_0.7-1.2**	**BH2_0.3-0.4**	**BH2_1.1-1.2**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**S19-Oc13470**	**S19-Oc13471**	**S19-Oc13472**	**S19-Oc13473**
Date Sampled			**Oct 08, 2019**	**Oct 08, 2019**	**Oct 08, 2019**	**Oct 08, 2019**
Test/Reference	LOR	Unit				
Chloride	10	mg/kg	< 10	14	29	19
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	25	13	84	12
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	6.6	7.2	9.6	7.4
Resistivity*	0.5	ohm.m	2000	4000	590	4200
Sulphate (as SO4)	10	mg/kg	11	22	350	22
% Moisture	1	%	7.7	15	8.7	16

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Sydney	Oct 11, 2019	28 Days
- Method: E045 /E047 Chloride			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Sydney	Oct 11, 2019	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Sydney	Oct 11, 2019	7 Days
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Sydney	Oct 11, 2019	28 Days
- Method: E045 Anions by Ion Chromatography			
% Moisture	Sydney	Oct 09, 2019	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

ABN – 50 005 085 521
e.mail : EnviroSales@eurofins.com
web : www.eurofins.com.au

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name:	Alliance Geotechnical	**Order No.:**		**Received:**	Oct 9, 2019 5:59 PM
Address:	10 Welder Road	**Report #:**	681563	**Due:**	Oct 16, 2019
	Seven Hills	**Phone:**	1800 288 188	**Priority:**	5 Day
	NSW 2147	**Fax:**	02 9675 1888	**Contact Name:**	Steven Wallace
Project Name:	ST MARY ST JOSEPH CATHOLIC PRIMARY SCHOOL				
Project ID:	9194.2				

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							
Sydney Laboratory - NATA Site # 18217						X	X
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH7_0.0-0.3	Oct 08, 2019		Soil	S19-Oc13470	X	X
2	BH1_0.7-1.2	Oct 08, 2019		Soil	S19-Oc13471	X	X
3	BH2_0.3-0.4	Oct 08, 2019		Soil	S19-Oc13472	X	X
4	BH2_1.1-1.2	Oct 08, 2019		Soil	S19-Oc13473	X	X
Test Counts						4	4

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
ug/L: micrograms per litre
ppm: Parts per million
ppb: Parts per billion
%: Percentage
org/100mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	US Department of Defense Quality Systems Manual Version 5.3
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/kg	< 10			10	Pass	
Sulphate (as SO4)	mg/kg	< 10			10	Pass	
LCS - % Recovery							
Chloride	%	110			70-130	Pass	
Sulphate (as SO4)	%	104			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Chloride	S19-Oc16929	NCP	%	118			70-130	Pass	
Sulphate (as SO4)	S19-Oc16929	NCP	%	110			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1	Result 2	RPD	Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S19-Oc16929	NCP	mg/kg	11	< 10	10	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	S19-Oc16929	NCP	uS/cm	12	< 10	36	30%	Fail	Q15
pH (1:5 Aqueous extract at 25°C as rec.)	S19-Oc16929	NCP	pH Units	5.3	5.1	Pass	30%	Pass	
Sulphate (as SO4)	S19-Oc16929	NCP	mg/kg	33	32	2.0	30%	Pass	
% Moisture	S19-Oc13496	NCP	%	8.3	8.5	3.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Andrew Black	Analytical Services Manager
Gabriele Cordero	Senior Analyst-Inorganic (NSW)

Glenn Jackson
General Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

APPENDIX F – Infiltration Test Results

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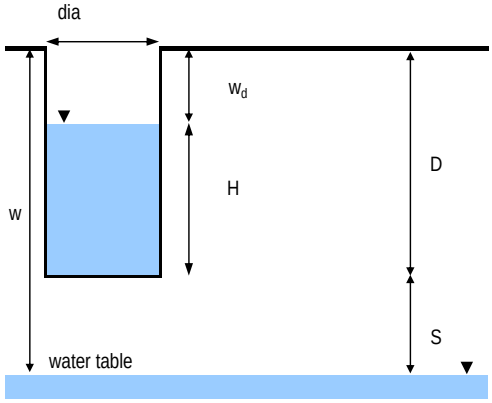
CONSTANT HEAD PERMEAMETER TEST REPORT

Client :	Sydney Catholic Schools c/o JDH Architects	Job Number :	9194.2
Project :	Proposed School Building Development	Test Date :	08/10/2019
Location:	268 - 272 Fitzgerald Ave., Maroubra	Tested By :	AH
Test Location:	BH1		
Test Method :	AS /NZS 1547:2012 Appendix 4.1G Soil Permeability Measurement		

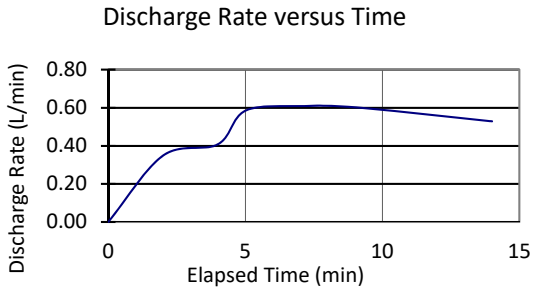
Applies where S > $2H_c$

Test Fluid : Potable water

Hole Radius, r :	7.50	cm
Hole Depth, D :	60.00	cm
Depth to Water, w_d:	10.00	cm
Constant Head, H:	17.00	cm
Depth to Impermeable Layer, S (if known):	N/A	m
Depth to Water Table, w (if known) :	2.00	m



Reading No.	Elapsed Time t (mins)	Accumulated Volume (lit)	Discharge Rate (litres/min)
0	0	0.00	0.0
1	2	0.6	0.3
2	4	1.3	0.4
3	5	2.9	0.6
4	7	4.1	0.6
5	9	5.2	0.6
6	14	7.2	0.5



Site conditions

soil moisture condition :	Moist
vegetaion cover at test site:	Trees
slope:	< 5 Degree
surface cracks:	No
Water logging:	No

Average Discharge Rate Q = 0.6 litres/min
Average Discharge Rate Q = 565.4 cm^3/min

Hydraulic Conductivity

$$K_{sat} = \frac{4.4Q\,[0.5\mathrm{Sinh}^{-1}(H/2r) - \sqrt{[(r/H)^2+0.25]}+r/H]}{2\pi H^2}$$

= 6.7E-01 cm/min
= 1.1E-02 cm/sec
= 4.0E+02 mm/hr
= 1.1E-04 m/s

Nominal Absorption Rate = 0.163 L/m^2/sec
Design Absorption Ratio = 0.082 L/m^2/sec

Notes :

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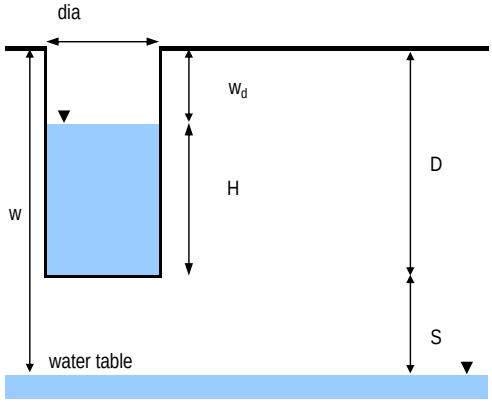
CONSTANT HEAD PERMEAMETER TEST REPORT

Client :	Sydney Catholic Schools c/o JDH Architects	Job Number :	9194.2
Project :	Proposed School Building Development	Test Date :	08/10/2019
Location:	268 - 272 Fitzgerald Ave., Maroubra	Tested By :	AH
Test Location:	BH2		
Test Method :	AS /NZS 1547:2012 Appendix 4.1G Soil Permeability Measurement		

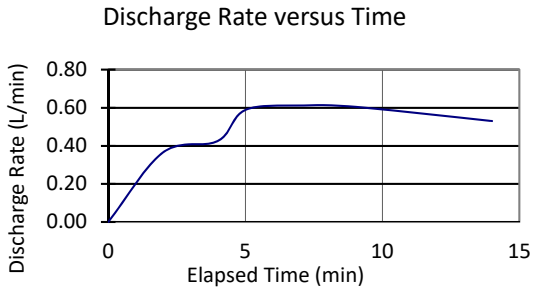
Applies where S > $2H_c$

Test Fluid : Potable water

Hole Radius, r :	7.50	cm
Hole Depth, D :	60.00	cm
Depth to Water, w_d:	10.00	cm
Constant Head, H:	20.00	cm
Depth to Impermeable Layer, S (if known):	N/A	m
Depth to Water Table, w (if known) :	2.00	m



Reading No.	Elapsed Time t (mins)	Accumulated Volume (lit)	Discharge Rate (litres/min)
0	0	0.00	0.0
1	2	0.6	0.4
2	4	1.4	0.4
3	5	2.9	0.6
4	7	4.1	0.6
5	9	5.2	0.6
6	14	7.2	0.5



Site conditions

soil moisture condition :	Moist
vegetaion cover at test site:	Trees
slope:	< 5 Degree
surface cracks:	No
Water logging:	No

Average Discharge Rate Q = 0.5 litres/min
Average Discharge Rate Q = 530.1 cm^3/min

Hydraulic Conductivity

$$K_{sat} = \frac{4.4Q\,[0.5\mathrm{Sinh}^{-1}(H/2r) - \sqrt{[(r/H)^2+0.25]}+r/H]}{2\pi H^2}$$

= 5.1E-01 cm/min
= 8.5E-03 cm/sec
= 3.1E+02 mm/hr
= 8.5E-05 m/s

Nominal Absorption Rate = 0.136 L/m^2/sec
Design Absorption Ratio = 0.068 L/m^2/sec

Notes :