GEOTECHNICAL INVESTIGATION

FOR

DREAMBUILD PTY LIMITED

91 - 93 McIntosh Road, Narraweena, New South Wales

Report No: 18/1552

Project No: 21953/9448C

June 2018

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1. INTRODUCTION

This report presents the results of a geotechnical investigation carried out by STS GeoEnvironmental Pty Limited (STS) for a proposed new mixed-use development to be constructed at 91 – 93 McIntosh Road, Narraweena. Based on the provided Pre-DA architectural drawings provided by Benson McCormack Architecture, we understand that the proposed development comprises construction of a three (3) level mixed use building with a single level of basement car parking. The finished floor level of the basement is RL 71.67, therefore construction of the basement will require excavating to depths of 1.0 to 2.5 metres below existing ground surface levels. We however understand that an additional basement level may be required subject to Council's requirements. In the event that a second basement level is required, the basement excavations are likely to extend to depths of 4.0 to 5.5 metres below exiting ground surface levels.

The purpose of the investigation was to:

- assess the subsurface conditions over the site,
- provide a site classification to AS2870,
- determine the depth to the groundwater level over the site and comment on dewatering requirements,
- provide recommendations regarding the appropriate foundation system for the site including design parameters,
- provide parameters for the temporary and permanent support of the excavation, and
- comment on soil aggressiveness to buried steel and concrete.

The investigation was undertaken at the request of Dreambuild Pty Limited

Our scope of works did not include a contamination assessment of the site.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

Due to restricted site access, the fieldwork consisted of drilling two (2) boreholes numbered BH1 and BH2, at the locations shown on Drawing No. 18/1552. Boreholes were drilled using a track mounted Hanjin DB8 drilling rig supplied and operated by BG Drilling. Soils and weathered bedrock were drilled using rotary solid flight augers until at least very low strength bedrock was encountered. The boreholes were then extended into the underlying bedrock using NMLC sized diamond coring equipment. Soil strengths were determined by undertaking Standard Penetration Tests (SPT) at selected depths in each borehole location. The recovered rock core was logged, boxed and photographed. To assist in determining rock strength, point load index testing was undertaken on the recovered rock core samples from the boreholes.

In order to measure the groundwater levels, a PVC standpipe piezometer was installed in BH1.

Drilling operations were supervised by one of STS's senior technical officers who also logged the subsurface conditions encountered.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A together with the photographs of the recovered rock core and results of the point load testing. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

2.2. Laboratory Testing

In order to assess the soils for their aggressiveness selected representative soil samples were tested to determine the following:

- pH,
- Sulphate Content ($S0_4$),
- Chloride Content (Cl), and
- Electrical Conductivity (EC).

The detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Sydney geological series sheet at a scale of 1:100,000 indicates that the site is underlain by Triassic Age bedrock belonging to the Hawkesbury Sandstone formation. Bedrock within this formation typically comprises fine to medium grained quartz sandstone.

The site is located at the intersection of McIntosh Road and Alfred Street and comprises a roughly rectangular parcel of land with a combined area of approximately 785m^2. At the time of the fieldwork, the site was occupied by a series of single and double storey brick commercial buildings with metal roofs. The building on No.93 has been constructed to the site boundaries, however there is an asphaltic concrete surfaced car park area and concrete driveway at the rear of No.91. Vegetation was not observed on the site.

The ground surface on the site falls to the south from RL74m to RL72.3m.

To the north of the site is McIntosh Street and to the west is Alfred Street. To the south of the site is a double storey brick commercial building with concrete car park and to the east of the site is a single level brick residential dwelling with tile roof.

Reference to available historical aerial imagery from 1947 indicates that a natural water course traversed the rear of the site in west to east direction. The water course drained to the east to an area which is now occupied by Beverly Job Park.

4. SUBSURFACE CONDITIONS

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies.

The subsurface conditions generally consist of asphaltic concrete (AC) overlying fill materials, natural clayey sands, sandy clays, and silty clays. The natural soils overlie sandstone bedrock. AC was encountered at both locations with a thickness of 30mm. Fill materials were encountered below the AC to depths of 1.0 to 2.6 metres with the deeper fill materials being encountered at the rear of the site.

The natural soils encountered in BH1 comprised alluvial clayey sands to a depth of 3.0 metres, overlying residual sandy clays to a depth of 4.2 metres. The natural soils encountered in BH2 comprised an organic silty clays (Peat) to a depth of 4.0 metres, overlying alluvial clayey sands to a depth of 5.5 metres. The alluvial soils in BH1 were loose/medium dense becoming medium dense, and the underlying residual soils were assessed to be very stiff.

The organic Peat materials in BH2 were assessed to be soft and the underlying alluvial clayey sands were assessed to be very loose. Weathered sandstone underlies the site. Table 4.1 below outlines the depth to each rock class as encountered in the boreholes.

Table 4.1 – Rock Class Summary

BH ID	Depth of Class V (m)	Depth of Class IV (m)	Depth of Class III (m)
BH1	4.2 – 6.0m	–	6.0 – 8.9m
BH2	5.5 – 6.0m	–	6.0 – 9.1m

Groundwater seepage was observed during auger drilling of the boreholes. Table 4.2 outlines the depth to groundwater in the boreholes.

Table 4.2 – Groundwater Summary

BH ID	Date	Water table Depth m
BH1	29/5/2015	3.0
	1/6/2015	2.7
BH2	29/5/2015	3.0

5. DISCUSSION

5.1. Site Classification to AS2870

The classification has been prepared in accordance with the guidelines set out in the "Residential Slabs and Footings" Code, AS2870 – 2011.

Because of the fill materials present, the site is classified *a problem site (P).*

5.2. Excavation Conditions and Support

Based on subsurface conditions observed in the boreholes the proposed basement excavation for a single level basement to RL71.67m will encounter AC, fill and alluvial clayey sands. Due to the slope of the site it is unlikely that the single basement excavations will encounter the organic peat material, and are not expected to encounter sandstone bedrock. Excavators without assistance should be able to remove the soils to RL71.67m.

In the event that a second basement level is added the excavation are expected to encounter the organic Peat materials over the southern portion of the site and very low strength sandstone bedrock and residual soils over the northern portion of the site. Excavators without assistance should be able to remove the soils to a depth of 5.5 metres, however some ripping may be required if ironstone or higher strength bands of sandstone are encountered. The use of hydraulic rock hammers is not anticipated.

It is of course important that the onsite excavations are adequately supported at all times and do not endanger the adjacent properties. Temporary slopes in the sandy soils above the water table may be constructed at a maximum angle of 1V to 2H. Where this is not possible it will be necessary to provide temporary support. Support will probably need to be drilled and fixed into the materials below the base of the excavation.

When considering the design of the supports, it will be necessary to allow for the loading from structures in adjoining properties, any ground surface slope and the water table present. Where the structures in adjoining properties are within the zone of influence of the excavation, it will be necessary to adopt K_o conditions when designing the temporary support. Anchors or props can be used to provide the required support. If anchors extend into adjoining property, it will be necessary to obtain the permission of the property owners. When props or anchors are used for support, a rectangular earth pressure distribution should be adopted on the active side of the support. K_o should also be used to design the permanent support.

The parameters given in Table 5.1 below are suggested for the design of the retaining wall system where there is a level ground surface:

Table 5.1 – Retaining Wall Design Parameters

Material Type	Active Earth Pressure Coefficient (K_a)	At Rest Pressure Coefficient (K_o)	Total (Bulk) Density (kN/m^3)	Passive Earth Pressure Coefficient (K_p)
Soft Organic Clay	0.5	0.65	15	2.0
Fill and Loose Sand / Stiff to very stiff natural clay	0.4	0.55	19	2.5
Medium Dense Sand	0.3	0.45	20	3.0
Class V Sandstone	N/A	N/A	20	3.0
Class IV/III Sandstone	N/A	N/A	22	4.5

Based on the groundwater observations in the boreholes, the proposed basement excavations to RL71.67m are not expected to encounter the groundwater table. However, excavations extending below this depth for a second level basement would be expected to encounter the groundwater table. This would have implications for both the construction and long-term phases of the project if a double level basement is proposed.

In the event that the basement extends below the groundwater table the support system selected must be impermeable, otherwise lowering the water table will cause ground settlement and possible damage to the roadways and buildings on adjacent properties. Therefore, it would be prudent to extend the impermeable basement support into rock to control seepage around the base of the support system.

Contiguous pile walls are often used for support, however, experience indicates they are difficult to make watertight if there is considerable water flow. A version of this system is secant piles, where adjoining piles drill into one another. This system would usually be more watertight and has been successfully used in similar ground conditions.

Steel pile walls are often used to support excavations. Because of their nature, they are very difficult to make watertight, however, when used together with shotcrete they may be successfully employed.

Regardless of which system is adopted, if a second level basement is to be constructed a specialist piling contractor should be engaged to carry out the works. The equipment used should also be capable of penetrating the underlying bedrock to the required depths.

Provided that an impermeable support system is used for a double level basement, we have calculated the total volume of water to be extracted during dewatering within the confines of the basement excavation to be less than 3ML. This will be a one off removal. Because there will be an impermeable cut off wall around the site there will be no need for ongoing dewatering during construction. Tanking of the basement will also remove the need for any post construction dewatering.

5.3. Foundation Design

On completion of bulk excavation to RL71.67m the exposed materials will likely comprise medium dense sands or very stiff residual clays over the northern portion of the site and fill materials over the southern portion of the site. Founding the structure on a combination of natural sands and fill materials may result in differential settlement occurring. Further, the presence of the soft organic clay materials over the southern portion of the site suggests that shallow pad/strip type foundations are not suitable for the subsurface conditions. It is recommended that the structural loads be suspended on piles extending to the underlying sandstone bedrock.

Table 5.2 below provides bearing pressures for the various rock classes encountered.

Table 5.2 – Allowable Bearing Pressures for Sandstone

Rock Classification	Allowable End Bearing (kPa)	Allowable Adhesion (kPa)
Sandstone Class V	800	80
Sandstone Class IV	1000	100
Sandstone Class III	3500	350

When piles are founded in rock the adhesion in the overlying soils must be ignored. In order to ensure the bearing values given can be achieved, care should be taken to ensure that the base of excavations are free of all loose material prior to concreting.

Due to the sandy nature of the soils and high water table, the site is not considered suitable for bored cast in-situ piers. In this regard the site would be better suited to either continuous flight auger (CFA) grout injected piers or steel screw piles.

5.4. Soil Aggressiveness

The aggressiveness or corrosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulphates and chlorides. In order to determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling – Design and Installation and Tables 5.1 and 5.2 of AS2870-2011. In regards to the electrical conductivity, the laboratory test results have been multiplied by the appropriate factor to convert the results to EC_e. The test results are summarised in Table 5.3 below.

Table 5.3 – Soil Aggressiveness Summary Table

Sample No.	Location	Depth (m)	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Electrical Conductivity (dS/m)	
						$EC_{1:5}$	EC_e
S1	BH1	1.0 – 1.45	5.4	60	70	0.016	0.2
S2	BH1	2.5 – 2.95	4.9	320	<10	0.160	1.9

The report results range between:

- pH - 4.9 and 5.4
- soluble SO_4 - 60 and 320 mg/kg (ppm)
- soluble Cl - <10 and 70 mg/kg (ppm)
- EC_e - 0.2 and 1.9 dS/m

The soils on the site consist of high permeability sands and piles are likely to extend below the groundwater table. Therefore, the soil conditions A are considered appropriate.

A review of the durability aspects indicates that:

- pH : minimum value of 4.9
- SO_4 : maximum value of 320 mg/kg (ppm) < 5000 ppm
- Cl : maximum value of 70 mg/kg (ppm) < 5000 ppm
- EC_e : maximum value of 1.9 dS/m

The exposure classification for the onsite soils is mildly aggressive for steel and moderately aggressive to concrete in accordance with AS2159-2009. The soils are classified as B1 in accordance with AS2870-2011.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that EC_e values of 0.2 dS/m and 1.9 dS/m are consistent with the presence of non-saline soils.

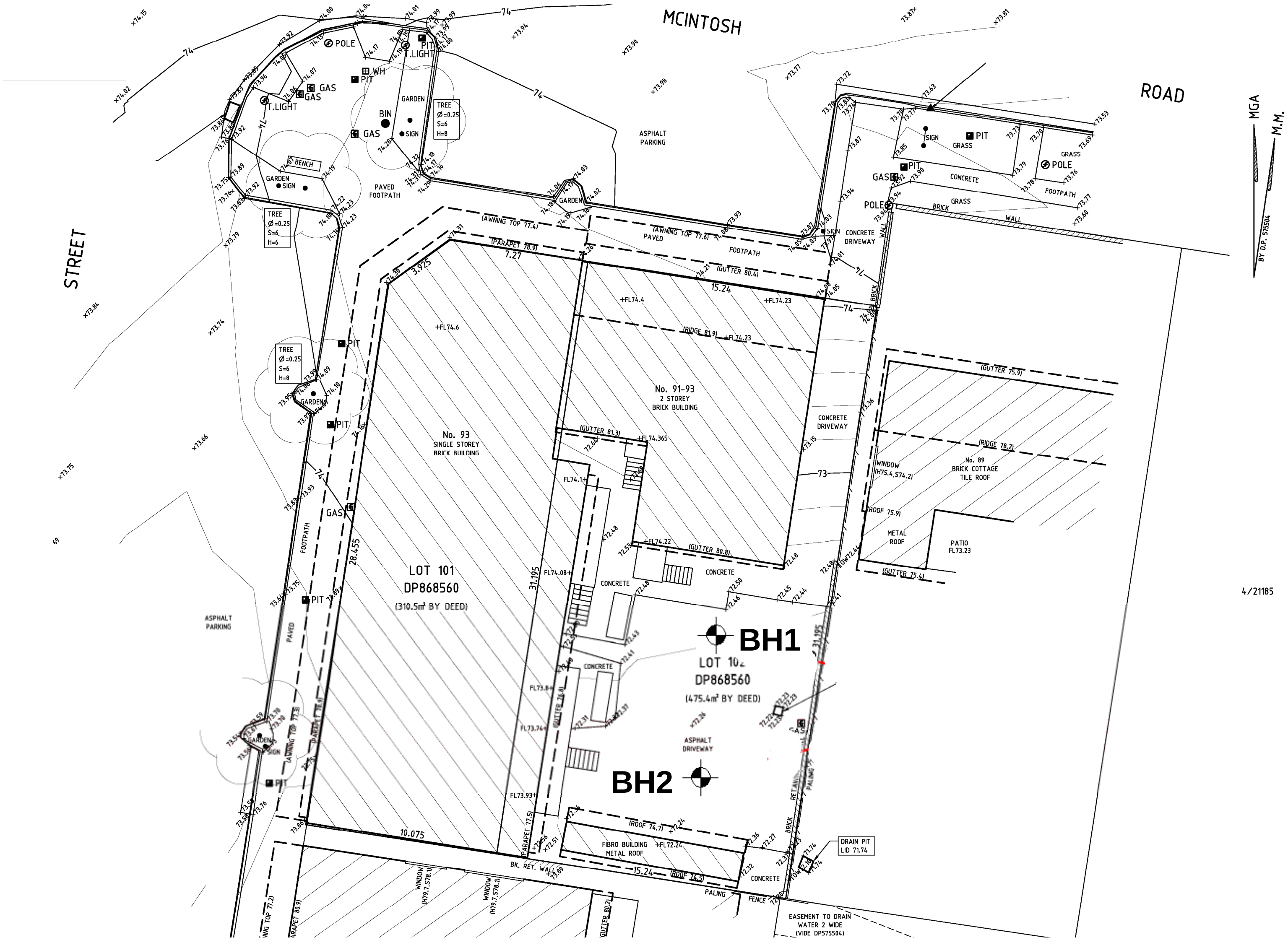
6. FINAL COMMENTS

Should the subsurface conditions vary from those inferred above, we would be contacted to determine if any changes should be made to our recommendations.

The exposed bearing surfaces for footings should be inspected by a geotechnical engineer to ensure the allowable pressure given has been achieved.

Matt Green
Senior Engineering Geologist

Laurie Ihnativ
Principal Geotechnical Engineer



STS GEOENVIRONMENTAL Pty. Ltd.	Scale: Unknown	Date: May 2018
Client: DREAMBUILD		
GEOTECHNICAL INVESTIGATION 91-93 MCINTOSH ROAD, NARRAWEENA BOREHOLE LOCATIONS		Project No. 21953/9448C Drawing No: 18/1552

NOTES RELATING TO GEOTECHNICAL REPORTS

Introduction

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report.

When copies of reports are made, they should be reproduced in full.

Geotechnical Reports

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by SMEC Testing Services Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, SMEC Testing Services Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, SMEC Testing Services Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

Subsurface Information

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

Supply of Geotechnical Information or Tendering Purposes

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

APPENDIX A – BOREHOLE LOGS, CORE PHOTOS, POINT LOAD TEST RESULTS AND EXPLANATION SHEETS

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Dreambuild Pty Limited	Project / STS No.: 21953/9448C	**BOREHOLE NO.: BH 1**
Project: 91-93 McIntosh Road, Narraweena	Date: May 29, 2018	
Location: Refer to Drawing No. 18/1552	Logged: DM Checked By: MG	Sheet 1 of 3

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALT: (30mm thick)			
			GRAVELLY CLAYEY SAND: dark brown and grey, medium to coarse grained sand, fine to coarse gravels FILL	SC	VERY LOOSE TO LOOSE	M
	SPT 1.0-1.45 m 2,2,4 N=6 S1	1.0	CLAYEY SAND: pale grey, medium to coarse grained	SC	LOOSE TO MEDIUM DENSE	M-W
		2.0			MEDIUM DENSE	
WT 1/6/18	SPT 2.5-2.95 4,5,8 N=13 S2					
WT 29/05/18		3.0	SANDY CLAY: Becoming pale grey with red (Residual)		VERY STIFF	W
	SPT 4.0-4.42 m 5,14,30R N>44	4.0				
			WEATHERED SANDSTONE: pale grey with orange spotting, medium to coarse grained		EXTREMELY LOW STRENGTH	
		5.0				
			AUGER DISCONTINUED AT 5.8 M ON WEATHERED SANDSTONE For core details, refer to core log sheets			

D - disturbed sample U - undisturbed tube sample B - bulk sample

WT - level of water table or free water N - Standard Penetration Test (SPT)

S - jar sample

Contractor: BG Drilling
Equipment: Hanjin DB8
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Two Prong

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Dreambuild Pty Limited — Project / STS No.: 21953/9448C — **BOREHOLE NO.: BH 1**

Project: 91-93 McIntosh Road, Naraweena — Date : May 29, 2018

Location: Refer to Drawing No. 18/1552 — Logged: DM — Checked By: MG — Sheet 2 of 3

DRILLING				MATERIAL STRENGTH										DISCONTINUITIES						
						Estimated Rock Strength							Joint Spacing (mm)						
Method	**Water**	**Recovery**	**Depth (m)**	**Rock Type** (Color, Grain Size, Structure & Minor Components)	**Weathering**	Extremely Low	Very Low	Low	Medium	High	Very High	Extremely High	20	40	100	300	1000		**Visual**	**Additional Data** (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
			1.0																	
			2.0																	
			3.0																	
			4.0																	
			5.0	For non core details, refer to non core log sheets																
				CORE START AT 5.8 M																
	100%	100%		WEATHERED SANDSTONE: pale grey with red staining	HW															5.88m, DB, (120mm)

Notes:

Contractor: BG DRILLING

Equipment: Hanjin DB8

Hole Diameter (mm): NMLC

Angle from Vertical (°): 0

See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Dreambuild Pty Limited | Project / STS No.: 21953/9448C | **BOREHOLE NO.: BH 1**

Project: 91-93 McIntosh Road, Narraweena | Date : May 29, 2018

Location: Refer to Drawing No. 18/1552 | Logged: DM | Checked By: MG | Sheet 3 of 3

DRILLING				MATERIAL STRENGTH			DISCONTINUITIES		
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength (Extremely Low, Very Low, Low, Medium, High, Very High, Extremely High)	Joint Spacing (mm) (20, 40, 100, 300, 1000)	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
NMLC CORING	100% RETURN	100% RECOVERY	7.0, 8.0	WEATHERED SANDSTONE: pale grey with minor orange staining, horizontal bedding	SW / FR				6.09m, SM(Wt), 1mm 6.17m, SM(Wt), 1mm 6.42m, SM(Wt), 1mm 6.65m, DB 7.46, DB 8.65m, SM(Cy), 2mm 8.74m, SM(Cy), 2mm
			9.0, 10.0, 11.0	CORE END AT 8.90 M ON SANDSTONE (TARGET DEPTH) STANDPIPE PIEZOMETER INSTALLED					

Notes:

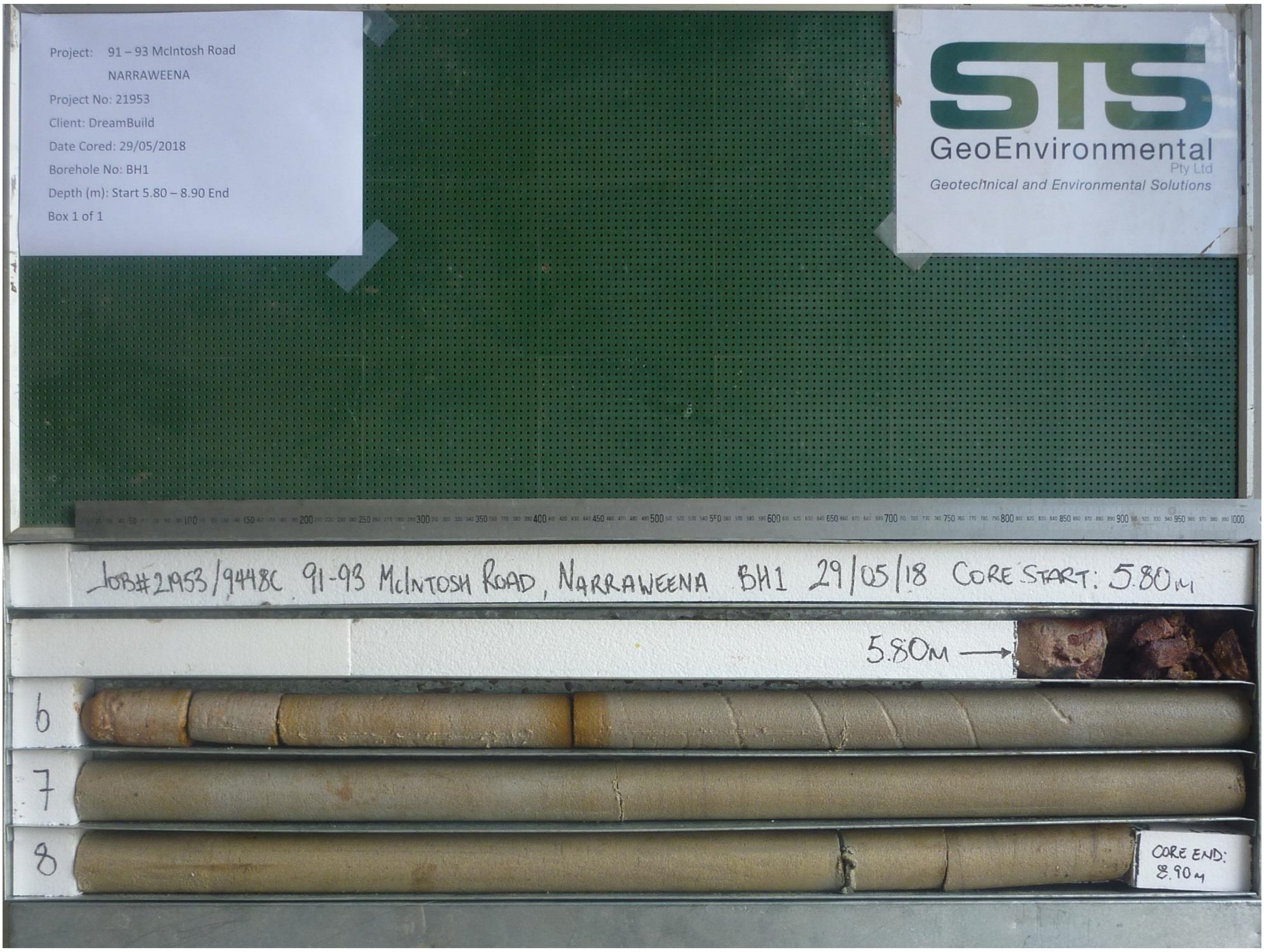
Contractor: BG DRILLING

Equipment: Hanjin DB8

Hole Diameter (mm): NMLC

Angle from Vertical (°): 0

See explanation sheets for meaning of all descriptive terms and symbols


Project: 91 – 93 McIntosh Road
NARRAWEENA
Project No: 21953
Client: DreamBuild
Date Cored: 29/05/2018
Borehole No: BH1
Depth (m): Start 5.80 – 8.90 End
Box 1 of 1
STS
GeoEnvironmental
Pty Ltd
Geotechnical and Environmental Solutions
JOB#21953/9448C 91-93 McINTOSH ROAD, NARRAWEENA BH1 29/05/18 CORE START: 5.80m
5.80m
6
7
8
CORE END: 8.90m

STS GeoEnvironmental Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: Dreambuild Pty Limited	Project / STS No.: 21953/9448C	**BOREHOLE NO.: BH 2**
Project: 91-93 McIntosh Road, Narraweena	Date: May 29, 2018	
Location: Refer to Drawing No. 18/1552	Logged: DM Checked By: MG	Sheet 1 of 2

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			ASPHALT: (30mm thick)			M
			CLAYEY GRAVELLY SAND: orange brown with dark brown, medium to coarse grained sand, fine to coarse gravels	SC	VERY LOOSE TO LOOSE	
	SPT 1.0-1.45 1,1,1 N = 3	1.0				
		2.0				
			Becoming grey			
	SPT 2.5-2.95 0,0,0 N = 0		FILL			
			SILTY CLAY: dark grey to black, low to medium plasticity, high percentage of organics (peat)	PT	SOFT	M
WT 29/05/18		3.0				
	SPT 4.0-4.45 0,0,0 N = 0	4.0				
			CLAYEY SAND: grey with dark grey, medium to coarse grained	SC	VERY LOOSE	W
		5.0				
	SPT 5.5-5.7 16, 13R					
			WEATHERED SANDSTONE: pale grey, fine to medium grained		EXTREMELY LOW STRENGTH	
			For core details, refer to core log sheets			
			AUGER DISCONTINUED AT 6.0 M ON WEATHERED SANDSTONE			

D - disturbed sample	U - undisturbed tube sample	B - bulk sample
WT - level of water table or free water		N - Standard Penetration Test (SPT)
S - jar sample		

Contractor: BG Drilling
Equipment: Hanjin DB8
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Two Prong

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS GeoEnvironmental Pty Ltd — **GEOTECHNICAL LOG - CORED BOREHOLE**

Client: Dreambuild Pty Limited | Project / STS No.: 21953/9448C | **BOREHOLE NO.: BH 2**

Project: 91-93 McIntosh Road, Narraweena | Date : May 29, 2018

Location: Refer to Drawing No. 18/1552 | Logged: DM | Checked By: MG | Sheet 2 of 2

DRILLING				MATERIAL STRENGTH			DISCONTINUITIES		
Method	Water	Recovery	Depth (m)	Rock Type (Colour, Grain Size, Structure & Minor Components)	Weathering	Estimated Rock Strength (Extremely Low / Very Low / Low / Medium / High / Very High / Extremely High)	Joint Spacing (mm) (20 / 40 / 100 / 300 / 1000)	Visual	Additional Data (Joints, partings, seams, zones etc. Description, orientation, infilling, or coating, shape, roughness, thickness, other)
NMLC CORING	100% RETURN	100% RECOVERY		WEATHERED SANDSTONE: pale grey with orange and red staining, fine to medium grained	MW	Low	40–100		6.05m, SM(Wt), 1mm
					SW	Medium	300–1000		
				For no core details, refer to non core logs					6.73m, HB
			7.0				40–100		7.13m, SM(Wt), 2mm
							100–300		7.20m, SM(Wt), 1mm
							300–1000		7.40m, SM(Wt), 1mm
									7.89m, SM(Wt), 1mm
			8.0						8.37m, SM(Cy), 10mm
									8.38m, HB
					MW		100–300		8.43m, SM(Wt) ,1mm
					SW		300–1000		8.69m, HB
							100–300		8.90m, SM(Wt), 1mm
			9.0						8.97m, HB
					FR	High			9.04m, SM(Wt), 1mm
				CORE END AT 9.14 M ON SANDSTONE (TARGET DEPTH)					
			10.0						
			11.0						

Notes:

Contractor: BG DRILLING

Equipment: Hanjin DB8

Hole Diameter (mm): NMLC

Angle from Vertical (°): 0

See explanation sheets for meaning of all descriptive terms and symbols


Project: 91 – 93 McIntosh Road
NARRAWEENA
Project No: 21953
Client: DreamBuild
Date Cored: 29/05/2018
Borehole No: BH2
Depth (m): Start 6.00 – 9.14 End
Box 1 of 1
STS
GeoEnvironmental
Pty Ltd
Geotechnical and Environmental Solutions
JOB# 21953/9448C 91-93 McINTOSH ROAD NARRAWEENA BH2 29/5/18 CORE START: 6.00m
6
7
8
9
CORE END: 9.14m

SMEC Testing Services Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 Fax: (02)9756 1137 Email: enquiries@smectesting.com.au

Point Load Strength Index Report

Project: 91-93 McINTOSH ROAD, NARRAWEENA
Client: DREAMBUILD
Address: 6/37A King Road, Hornsby
Test Method: AS4133.4.1

Project No.: 21953/9448C
Report No.: 18/1659
Report Date: Juen 7, 2018

Sampling Procedure: AS 1289.1.2.1 Clause 6.5.3 - Power Auger Drilling (Not covered under NATA Scope of Accreditation)

Date Samples Drilled / Taken: 29/5/2018

Borehole No. BH1

Depth	Test Type	Is(50) (Mpa)	Rock Type	Rock Structure	Moisture
6.45	D	**0.18**	SS	MA	M
	A	**0.26**	SS	MA	M
7.4	D	**0.5**	SS	MA	M
	A	**0.51**	SS	MA	M
8.8	D	**1.04**	SS	MA	M
	A	**1.52**	SS	MA	M

Sampling Procedure: AS 1289.1.2.1 Clause 6.5.3 - Power Auger Drilling (Not covered under NATA Scope of Accreditation)

Date Samples Drilled / Taken: 29/5/2018

Borehole No. BH2

Depth	Test Type	Is(50) (Mpa)	Rock Type	Rock Structure	Moisture
6.33	D	**0.17**	SS	MA	M
	A	**0.81**	SS	MA	M
7.4	D	**0.21**	SS	MA	M
	A	**0.31**	SS	MA	M
8.45	D	**0.26**	SS	MA	M
	A	**0.25**	SS	MA	M
9.1	D	**0.38**	SS	MA	M
	A	**0.42**	SS	MA	M

STRUCTURE	TEST TYPE	MOISTURE CONDITION	ROCK TYPE
MA= MASSIVE	A= AXIAL	W= WET	SS= SANDSTONE
BE= BEDDED	D= DIMETRAL	M= MOIST	ST= SILTSTONE
LA= LAMINATED	I= IRREGULAR	D= DRY	SH= SHALE
CR= CRYSTALLINE	C= CUBE		YS= CLAYSTONE
			IG= IGNEOUS

Remarks:

NATA
NATA Accredited Laboratory Number 2750
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The results of tests, calibrations and / or measurements included in this document are traceable to Australian / national standards
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Approved Signatory.......

Technician: DM

Laurie Ihnativ - Manager

E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by SMEC in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-1981, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

(a) Soil Name and Classification Symbol

The USC system is summarized in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).
- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms "some" and "trace" as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - medium to high plasticity	H

(b) Grading

"Well graded" Good representation of all particle sizes from the largest to the smallest.

"Poorly graded" One or more intermediate sizes poorly represented

"Gap graded" One or more intermediate sizes absent

"Uniformly graded" Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as "rounded", "sub-rounded", "sub-angular" or "angular".

Particle **form** can be "equidimensional", "flat" or elongate".

Surface texture can be "glassy", "smooth", "rough", pitted" or striated".

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by "light" or "dark". Borderline colours may be described as a combination of two colours, eg. red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

E1.3 *Soil Condition*

(a) Moisture

Soil moisture condition is described as "dry", "moist" or "wet".

The moisture categories are defined as:
Dry (D) - Little or no moisture evident. Soils are running.
Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 – 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 – 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 – 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 – 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2\ c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q_c (MPa)	DENSITY INDEX (%)
Very Loose	0 – 3	0 - 2	0 - 15
Loose	3 – 8	2 - 5	15 - 35
Medium Dense	8 – 25	5 - 15	35 - 65
Dense	25 – 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample
Lens - discontinuous with lenticular shape
Pocket - irregular inclusion
Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

"Residual Soil" - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

"Colluvium" - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

"Landslide Debris" - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

"Alluvium" - Material which has been transported essentially by water. Usually associated with former stream activity.

"Fill" - Material which has been transported and placed by man. This can range from natural soils which have been placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicted by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes "O" or "H" depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an "organic material" by classification.

Coal and lignite should be described as such and not simply as organic matter.

E2 CLASSIFICATION OF ROCKS

E2.1 Uniform Rock Description

The aim of a rock description for engineering purposes is to give an indication of the expected engineering properties of the material.

In a similar manner to soil materials, the assessment of site conditions where rock is encountered has to be based on the use of a descriptive method which is uniform and repeatable. Description has to:

- provide a clear identification of the rock substance and its engineering properties, and
- include details of the features which affect the engineering properties of the rock mass.

There is no internationally accepted system for rock description but SMEC Testing Services Pty Ltd has adopted a method which incorporates terminology defined by common usage in the engineering geological profession. Most feature definitions are as recommended by the International Society of Rock Mechanics and by the Standards Association of Australia.

For uniform presentation the different features are described in order:

Rock Substance

- NAME (in block letters)
- Mineralogy
- Grain Size
- Colour
- Fabric
- Strength
- Weathering/Alteration

Rock Mass

- Defect type
- Defect orientation
- Defect features
- Defect spacing

E2.2 Rock Substance

(a) Rock name

Each rock type has a specific name which is based on:

- mineralogy
- grain size
- fabric
- origin

The only method of determining the precise rock name is by thin section petrography.

Field identification of rocks for engineering purposes should be based on the use of common, easily understood, simple, geological names. In many cases knowledge of the precise name is of little consequence in the assessment of site conditions. If required the "field name" can be qualified by reference to a petrographic report. Reference to local geological reports often provides information on the rock types which may be expected.

(b) Mineralogy

The rock description should include the identification of the prominent minerals. This identification is usually restricted to the more common minerals in medium and coarse grained rocks.

(c) Grain Size

Rock material descriptions should include general grouping of the size of the predominant mineral grains as defined in Table E2.2.1. The maximum size, or size range, of the larger mineral grains or rock fragments should be recorded.

TABLE E2.2.1. - GRAIN SIZE GROUPS

TERM	GRAIN SIZE (mm)
Very Coarse	>60
Coarse	2 – 60
Medium	0.06 – 2
Fine	0.002 - 0.06
Very Fine	<0.002
Glassy	

(d) Colour

The colour of the rock should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by "light" or "dark". Borderline colours may be described by a combination of two colours, eg: grey-blue.

(e) Fabric

The fabric of a rock includes all the features of texture and structure, though the term refers specifically to the arrangement of the constituent grains or crystals in a rock. The fabric can provide an indication of the mode of formation of the rock:

- in sedimentary rocks bedding indicates depositional conditions,
- in igneous rocks the texture indicates the rate of cooling, and
- in metamorphic rocks the foliation indicates the stress conditions

Descriptions of fabric should include structure orientation, either with reference to North and horizontal, or to a plane normal to the core axis.

Tables E2.2.2, E2.2.3 and E2.2.4 list common textural features of sedimentary, igneous and metamorphic rocks with the subdivision of stratification spacing in Table E2.2.5.

TABLE E2.2.2 - COMMON STRUCTURES IN IGNEOUS ROCKS

STRATIFICATION (Planar)	STRATIFICATION (Irregular)
Bedding	Washout
Cross Bedding	Slump Structure
Graded Bedding	Shale Breccia
Lamination	

TABLE E2.2.3 - COMMON STRUCTURES IN IGNEOUS ROCKS

	FINE GRAINED ROCKS	COARSE GRAINED ROCKS
Uniform Grain Size	Massive	Massive
	Flow Banded	Granitic
	Vesicular	Pegmatitic
Different Grain Size	Porphyritic	Porphyritic

TABLE E.2.2.4 - COMMON STRUCTURES IN METAMORPHIC ROCKS

FINE GRAINED ROCKS	COARSE GRAINED ROCKS
Slatey Cleavage	Granoblastic
Spotted	Porphyroblastic
Hornsfelsic	Lincated
Foliated	Gneissic
Mylonitic	Mylonitic

TABLE E2.2.5 - STRATIFICATION SPACING

TERM	SEPARATION (mm)
Very Thickly Bedded	>2000
Thickly Bedded	600 - 2000
Medium Bedded	200 - 600
Thinly Bedded	60 - 200
Very Thinly Bedded	20 - 60
Laminated	6 - 20
Thinly Laminated	<6

(f) Strength

Substance strength is one of the most important engineering features of a rock and every description should include at least an estimate of the rock strength class of the material. This estimate can be calibrated by test results, either by Point Loan Strength Index or by Unconfined Compressive Strength.

The rock strength class in As 1726-1981 is defined by Point Loan Strength Index I_s,(50). The relationship between Point Loan and Unconfined Strength is commonly assumed to be about 20, but can range from 4 (in some carbonate rocks) to 40 (in some igneous rocks). It is necessary to confirm the relationship for each rock type and project. classification should be based on material at field moisture content, as some rocks give a significantly higher strength when tested dry.

Table E2.2.6 defines the rock strength classes, with indicative field tests listed in Table E2.2.7 which assist in classification when testing equipment is not available.

TABLE E2.2.6 - CLASSIFICATION OF ROCK STRENGTH

SYMBOL	TERM	POINT LOAD STRENGTH (MPa)	APPROX Qu (MPa)
EL	Extremely low	<0.03	<1
VL	very low	0.03 - 0.1	1 - 3
L	Low	0.1 - 0.3	3 - 10
M	Medium	0.3 - 1	10 - 30
H	High	1 - 3	30 - 70
VH	very high	3 - 10	70 - 200
EH	Extremely high	>10	>200

TABLE E2.2.7 - FIELD TESTS FOR ROCK STRENGTH CLASSIFICATION

STRENGTH CLASS	FIELD TEST
Extremely Low	Indented by thumb nail with difficulty
Very Low	Scratched by thumb nail
Low	Easily broken by hand or pared with a knife
Medium	Broken by hand or scraped with a knife
High	Broken in hand by firm hammer blows
Very High	Broken against solid object with several hammer blow
Extremely High	Difficult to break against solid object with several hammer blows

(g) Weathering/Alteration

In addition to the description of rock substance as examined, an assessment is required of the extent to which the original rock material has been affected by subsequent events. The usual processes are:

- Weathering - Decomposition due to the effect of surface or near surface activities
- Alteration - Chemical modification by the action of materials originating from within the mantle below.

The classification of weathering/alteration presented in Table E2.2.8 is based on the extent/degree to which the original rock substance has been affected. This classification has little engineering significance, as the properties of the rock as examined may bear no relationship to the properties of the fresh rock.

TABLE E2.2.8 - CLASSIFICATION OR ROCK WEATHERING/ALTERATION

TERMS	DEFINITION
Fresh (Fr)	Rock substance unaffected.
Fresh Stained (FR St)	Rock substance unaffected. Staining of defect surfaces.
Slightly (SW)	Partial staining or discolouration of rock substance.
Moderately (MW)	Staining or discolouration extends throughout the whole rock substance.
Highly (HW)	Rock substance partly decomposed.
Completely (CW)	Rock substance entirely decomposed.

E2.3 Rock Mass

The engineering properties of rock mass reflect the effect which the presence of defects has on the properties of the rock substance. Description of the rock mass properties consists of supplementing the description covered by Section E2.2 with data on the defects which are present.

(a) Defect type

The different defect types are described in Table E2.3.1.

(b) Defect orientation

Descriptions of defects should include orientation, either of individual fractures or of groups of fractures. Orientation should be with reference to North and horizontal, or to a plane normal to the core axis.

TABLE E2.3.1 - ROCK DEFECT TYPES

TYPE	SYMBOL	DESCRIPTION
Parting	Pt	A defect parallel or subparallel to a layered arrangement of mineral grains or micro-fractures which has caused planar anistrophy in the rock substance.
Joint	Jt	A defect across which the rock substance has little tensile strength and is not related to textural or structural features with the rock substance.
Sheared Zone	SZ	A zone with roughly parallel planar boundaries or rock substance containing closely spaced, often slickensided, joints.
Crushed Zone	CZ	A zone with roughly parallel planar boundaries of rock substance composed of disoriented, usually angular, fragments of rock.
Seam	Sm	A zone with roughly parallel boundaries infilled by soil or decomposed rock.

(c) Defect features

The character of a defect is described by its continuity, planarity, surface roughness, width, and infilling.

Continuity In outcrop the extent of a joint, bedding plane or similar defect both along and across the strike can be measured. In core, continuity measurement is restricted to defects nearly parallel to the core axis.

Planarity Described as “Planar”, “Irregular”, “Curved” or “Undulose”.

Roughness Described as “Rough”, “Smooth”, “Polished” or “Slickensided”.

Width Measured in millimetres normal to the plane of the defect

Infilling Described as “Clean”, “Stained”, “Veneer” (<1 mm) or “Infill” (>1 mm). The coating or infilling material should be identified.

(d) Defect spacing

The spacing of defects, particularly where they occur in parallel groups or sets, provides an indication of the rock block sizes which:

- have to be supported in the face or roof of an excavation
- will be produced by the excavation operation.

It is preferable to provide measured data but discontinuity spacing is grouped as shown in Table E2.3.2.

TABLE E2.3.2 - DISCONTINUITY SPACING

DESCRIPTION	SPACING (mm)
Extremely Widely Spaced	>6000
Very Widely Spaced	2000 - 6000
Widely Spaced	600 - 2000
Medium Spaced	200 - 600
Closely Spaced	60 - 200
Very Closely Spaced	20 - 60
Extremely Closely Spaced	<20

E3. DESCRIPTION OF WELL CONSTRUCTION, PID AND GROUNDWATER SYMBOLS

TABLE E3.1 – BORE CONSTRUCTION DETAILS

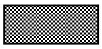
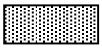
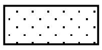
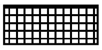
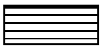
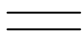
SHADING / SYMBOL	DESCRIPTION
	Cement-Based Grout
	Bentonite Seal
	Sand Filter
	Borehole Cuttings
	Class 18 PVC casing
	Class 18 PVC Slotted Screen
	End Caps
	Vapour Probe Tip
	Teflon Tubing

TABLE E3.2 – PID SYMBOLS

SYMBOL	MEANING
I	Insitu
A	Above Soil
H	Headspace

TABLE E3.3 – WATERTABLE SYMBOLS

SYMBOL	DESCRIPTION
	Standing Water Level
	Inflow
	Outflow

APPENDIX B – LABORATORY TEST RESULTS

CERTIFICATE OF ANALYSIS

Work Order	: **ES1815599**	Page	: 1 of 6
Client	: **SMEC TESTING SERVICES PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: SMEC TESTING ALL RESULTS	Contact	: Customer Services ES
Address	: P O BOX 6989 WETHERILL PARK NSW, AUSTRALIA 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 19161/9690C	Date Samples Received	: 30-May-2018 10:00
Order number	: E-2018-263	Date Analysis Commenced	: 30-May-2018
C-O-C number	: ----	Issue Date	: 04-Jun-2018 15:13
Sampler	: ----		
Site	: ----		
Quote number	: EN/222/17		
No. of samples received	: 19		
No. of samples analysed	: 19		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	4198	4187	4224	4192	4201
			Client sampling date / time	28-May-2018 00:00	28-May-2018 00:00	28-May-2018 00:00	28-May-2018 00:00	28-May-2018 00:00
Compound	CAS Number	LOR	Unit	ES1815599-001	ES1815599-002	ES1815599-003	ES1815599-004	ES1815599-005
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.0	5.4	5.7	5.0	5.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	12	18	34	79	69
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	5.2	6.7	6.3	10.2	16.4
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	4204	4247	4246	4222	4225
			Client sampling date / time	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00
Compound	CAS Number	LOR	Unit	ES1815599-006	ES1815599-007	ES1815599-008	ES1815599-009	ES1815599-010
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**5.5**	**4.8**	**4.9**	**5.0**	**5.2**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**32**	**20**	**26**	**30**	**16**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**5.4**	**9.1**	**9.8**	**18.6**	**14.8**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**10**	<10	<10	**30**	**10**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	4203	4202	4200/19161	711/19710	10530-S1
			Client sampling date / time	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00
Compound	CAS Number	LOR	Unit	ES1815599-011	ES1815599-012	ES1815599-013	ES1815599-014	ES1815599-015
				Result	Result	Result	Result	Result
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.9	5.1	5.9	5.2	6.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	83	53	73	177	92
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	25.0	9.4	4.0	14.9	18.3
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	110	40	70	140	60

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	10530-S2	10530-S3	21953-S1	21953-S2	----
			Client sampling date / time	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00	29-May-2018 00:00	----
Compound	CAS Number	LOR	Unit	ES1815599-016	ES1815599-017	ES1815599-018	ES1815599-019	--------
				Result	Result	Result	Result	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.4	4.9	5.4	4.9	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	20	46	16	160	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	19.4	16.8	16.1	14.4	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	40	60	60	320	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	----	----	70	<10	----