8 APRIL 2021

PROPOSED MULTISTOREY RESIDENTIAL BUILDING
67 PACIFIC PARADE, DEE WHY, NSW

GEOTECHNICAL INVESTIGATION REPORT

BL2093 Pty Ltd

SYD2020-0066AB Rev 1

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1 INTRODUCTION

CMW Geosciences Pty Ltd (CMW) was authorised by BL2093 Pty Ltd to carry out a geotechnical investigation of a site located at 67 Pacific Parade, Dee Why NSW by way of a signed authorisation (Reference SYD2020-0066AA Rev 0) dated 26 May 2020. The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter SYD2020-0066AA Rev 0 dated 21 May 2020.

This report has been revised (Rev 1) to reflect the updated design as detailed on the provided Architectural Drawings prepared by Benson McCormack Architecture (Ref. 2004A, Dwg Nos DA-0007, DA-0013, DA-0100 to 0102, DA-0200 to DA-0203 and DA-0300 to 0303, Rev 1) dated 25 November 2020.

2 SITE DESCRIPTION

The proposed development site comprises an area of approximately 695.6m² and is located on the south side of Pacific Parade, Dee Why, NSW as shown on the attached Figure 01: Site Location Plan.

The site has a north facing slope with existing ground levels ranging from RL41m AHD in the south east corner to RL29.5m AHD in the north west corner.

The site is bounded by Pacific Parade, The Crescent Reserve to the south and to the west and east by multistorey residential apartment buildings. The site was occupied with a single storey brick and sandstone residential dwelling at the time of the investigation. A near vertical unsupported 1 to 1.8m high rock wall was observed at the front of the site. Some boulder retaining walls were observed on site. By visual observation these retaining walls did not appear to be an engineered solution. Rock outcrop were observed near the front of the site. An unsupported sandstone rock wall was observed on the western side of the existing residence. The height of the wall was about 4.0m. The top 3.0m of the wall was leaning forward and generally covered with vegetation. An approximate 200mm thick clay seam was observed at about 0.9m from the toe of the wall. By visual observation, the strength of the sandstone rock appeared to be from high to very high with some bands of low strength rock. It was noticed that in the event of rainfall the water may be flowing on top of the sandstone rock wall which indicates a poor drainage system at the top of the wall.

A large crack was observed on the retaining wall at the rear boundary. A boulder retaining wall was present on top of the block wall. The current stability of the wall is unknown and should be investigated by a Structural Engineer if it is to remain.

Site views are shown in Appendix A.

3 PROPOSED DEVELOPMENT

The Architectural Drawings prepared by Benson McCormack Architecture (Ref. 2004A, Dwg Nos DA-0007, DA-0013, DA-0100 to 0102, DA-0200 to DA-0203 and DA-0300 to 0303, Rev 1) dated 25 November 2020 details that the proposed development comprises a 5-level residential building (including Ground Level) and 1 basement carpark. The finished floor level to the proposed basement is shown at RL 27.2m AHD, which would require an excavation to depths ranging from about 6.5m to 10m below existing surface levels.

4 FIELD INVESTIGATION

Following a dial before you dig search, and onsite service location, the field investigation was carried out on 10 June 2020. All fieldwork was carried out under the direction of CMW in general accordance with AS1726 (2017), Geotechnical Site Investigations. The scope of works completed were as follows:

- Undertake a walkover survey of the site to assess the general landform, site conditions and adjacent structures and infrastructure;

- One machine borehole, denoted BH01, was advanced using wash bore techniques to depths of up to 7m with rock coring to assess the ground conditions. An Engineering log of the borehole is provided in Appendix B;
- Two hand auger boreholes, denoted BH 02 and BH 03, were drilled using a 75mm diameter auger to target depths of up to 200mm below existing ground levels to visually observe the near surface soil profile. Engineering logs of the hand auger boreholes are presented in Appendix B;

The borehole locations are shown on the attached Site Investigation Plan in Drawing 01. Test locations were measured using handheld GPS. Elevations were inferred from the feature survey plan provided (Plan Reference 6213-DET).

5 LABORATORY TESTING

Two rock samples were sent to NATA registered Testing Laboratory – Macquarie Geotech to conduct the Point Load Strength Index.

The extent of testing carried out to provide the geotechnical parameters required for this study are presented in **Table 1**.

Table 1: Laboratory Test Schedule Summary		
Type of Test	**Test Method**	**Quantity and Depth**
Point Load Strength Index	AS 4133.4.1	2 Tests (5.50m – 5.60m) (6.20m – 6.29m)

6 GROUND MODEL

6.1 Geology

Based on review of 1:100 000 Geological Map, the site area is underlain by Rh: Medium to Coarse grained quartz sandstone, very minor shale and laminate lenses.

Figure 1: Geology of the site (Sydney 1:100 000 Geology Map)

6.2 Subsurface Conditions

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area and can be generalised according to the following subsurface sequence:

TOPSOIL: SAND	fine to medium grained, dark brown, moist, dense with rootlets and organic matter;
SAND (SP)	fine to medium grained, grey brown, moist, dense;
SANDSTONE	fine to medium grained, brown, very low strength, extremely weathered;
SANDSTONE	medium to coarse grained, brown, low strength, highly weathered;
SANDSTONE	grey, high strength, moderately weathered to slightly weathered;

6.3 Laboratory Test Results

Results of the Laboratory Test Certificates for Point Load Strength Index test in Appendix C are summarised in Table 2.

Table 2: Rock Strength Classification

Borehole No	Depth (m)		Point Load Strength Index, $I_{S(50)}$ (MPa)	Strength Grade
	Depth to Top	Depth to base		
BH 01	5.50	5.60	1.53	High Strength
BH 01	6.20	6.29	1.67	High Strength

7 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

7.1 Geotechnical Constraints

Based on the provided architectural drawings, it is understood that the site works include:

- Demolition of the existing building;
- Excavation of a single level basement (single level below Pacific Parade street level);
- Construction of a multi storey residential building;

The following constraints may be identified in relation to excavation of the proposed basement.

- Excavation near unsupported sandstone rock wall on the eastern side.
- Excavation to achieve the proposed design level and potential vibration effects from excavation machinery.

7.1.1 Rear Retaining Wall

The concrete block wall at the rear of the property was visibly cracked at the time of our field investigation. We recommend a suitably qualified (and insured) structural engineer assess the current stability of the wall prior to undertaking any of the proposed works on site, so that suitable stabilisation measures can be installed should they be required. We note the potential for vibrations associated with demolition and excavation to may further reduce the wall stability.

7.2 Dilapidation Surveys

Dilapidation surveys should be carried out on surrounding buildings, retaining walls and other nearby structures that may be affected as a result of the proposed excavation. The dilapidation survey should be undertaken both inside and outside of the surrounding building before the commencement of demolition of the existing structures on site. Dilapidation surveys should be used to set vibration limits for site works so as not to damage nearby structures. Dilapidation surveys can also to document any existing defects so that any claims for the damage due to construction related activities can be accurately measured.

7.3 Excavation Characteristics

The excavation recommendations provided below should be complemented by reference to the Safe Work Australia Code of Practice 'Excavation Work', dated January 2020. Additionally, we recommend the use of excavation contractors with appropriate experience and a competent supervisor who is aware of vibration damage risks, etc. The contractor should have all appropriate statutory and public liability insurances and should be provided with a full copy of this report.

The proposed excavation is expected to extend through the shallow soil and extremely weathered rock profile into sandstone bedrock, which we infer will be predominantly of at least medium strength.

Excavation of soil and extremely low strength rock should be achievable using buckets fitted to hydraulic excavators. Excavation of low and higher strength bedrock will present 'hard rock' excavation conditions and would most effectively be excavated using rock hammers. The rock hammers would also be required for detailed rock excavations such as for footings, trenches, lift pits etc. Grid sawing techniques in conjunction with ripping or hammering will help facilitate excavation. We recommend the sides of the main excavation be saw cut as this results in a face with less overbreak and instability and helps reduce transmission of vibration across the boundaries.**fds dfsa** Dust suppressions by spraying water should be carried out whenever rock saws are being used.

7.3.1 Vibrations

During demolition and excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations within acceptable limits to avoid any damage to the adjacent buildings and structures. Ground vibrations can be perceptible to humans at levels above 2mm/s component peak particle velocity (PPV). This is generally much lower than the vibration levels required to cause structural damage to buildings.

Allowable vibration limits should be determined by the Structural Engineer following review of the dilapidation reports. By referencing the German Standard DIN4150-3:1999-02, the vibrations should be limited to a peak particle velocity of 5mm/s (for frequencies up to 10Hz) for nearby residential buildings in good condition, however lower limits are expected to be required for the existing rear retaining wall in poor condition.

We recommend that quantitative vibration monitoring be carried out whenever hydraulic hammers are used during demolition or excavation on site. Vibration monitors should be connected to suitable alarm systems so that site staff become aware immediately if vibration thresholds are exceeded.

If monitoring confirms that vibration limits are being exceeded, alternative excavation techniques (such as grinding) may be required.

7.3.2 Groundwater Seepage

Groundwater was not noted during our field investigation, nevertheless, we recommend that all cut faces and retaining wall incorporate spoon drains of subsoil drains to intercept any potential seepage which could occur along the soil-bedrock interface or open defects within the bedrock profile (if present). If seepage occurs, it is expected to be of limited volume and readily controlled by sump and pump techniques or gravity grained systems.

The excavation should be monitored by the site foreman and geotechnical engineer as excavation progresses to confirm the drainage requirements.

7.4 Excavation Support

Excavations through the expected relatively shallow soil profile may be temporarily battered to slopes no steeper than 1 Vertical (V) in 2 Horizontal (H), provided surcharge loads are kept well clear of the crest of the temporary batters. Retaining walls can then be constructed along the toe of the temporary batters and subsequently backfilled.

The sandstone bedrock can be cut vertically, but must be progressively inspected by a geotechnical engineer at not more than 1.5m depth increments, to assess the need for localised temporary support (e.g rock bolts, dowels, shotcrete etc) of potentially unstable rock wedges or extremely weathered bands. Based on the results of our field investigation we expect that some stabilisation measures will be required, including 'dental' treatment for clay bands/seams, extremely weathered bands/seams etc. A provisions should be made in the budget and program for the above inspections and stabilisation measures.

7.4.1 Design Parameters

It is suggested that design of permanent retaining structures be based on an average bulk unit weight for the retained material of 20kN/m³ and on a triangular distribution. In order to maximise rigidity of these walls, 'at rest' (K_o) earth pressure conditions may be considered.

Earth pressure coefficients and geotechnical parameters for retaining wall design are presented in Table 3 and 4 below. Surcharge loads from the adjacent properties should be included in the wall design by multiplying vertical loads by the appropriate coefficient given in Table 4.

Table 3: Earth Pressure Coefficients (non-sloping crest surface)

Depth (m)	Material Description	Unit Weight (kN/m³)	Ø' (degrees)	Earth Pressure Coefficient		
				Ko (at rest)	Ka (Active)	Kp (Passive)
0 – 0.8	Sand	16	26	0.55	0.38	2.66
0.8 – 7.0	Sandstone	20	30	1.0	0.33	3.00

Table 4: Geotechnical Parameters for the Design of Retaining Wall

Material Description	C' (kPa)	E (MPa)
Sand	0	15
Sandstone (Class IV)	20	100

Note: C': Drained cohesion; Ø: Drained angle of friction; E: Young's modulus

The above design parameters are based on Classification of Sandstones and Shales in the Sydney Region: A forty year review, P.J.N. Pells1, G. Mostyn2, R. Bertuzzi2 and P. K. Wong3, Volume 54: No.2 June 2019.

Application of hydrostatic pressure should not be ignored to the lateral earth pressures unless permanent drainage system of the ground behind the walls is installed. We advise all wall drainage to comprise a

proper subsoil drainage system incorporating a slotted pipe surrounded by a free draining single sized crushed aggregate or alternatively, a proper drainage system designed by experienced groundwater engineer. The aggregate should be appropriately protected using non-woven materials, geotextile, or filter fabric.

7.5 Foundations

Based on the investigation and the proposed finished levels for the lower basement level, it is anticipated that at the base of the proposed excavation, sandstone bedrock (Class IV) would be exposed. Pad/strip footings founded in at least low strength sandstone bedrock below bulk excavation level may be designed for a maximum allowable bearing pressure of 1,000kPa, provided at least the initial footing excavations are inspected by a geotechnical engineer prior to pouring concrete, and following the inspection of the completed excavation by a geotechnical engineer.

Larger allowable bearing pressures may be possible, however this would need to be confirmed with additional boreholes completed after demolition or from spoon testing completed within footing excavations. Additional geotechnical advice should be sought if higher bearing pressures are preferred.

Footings found at, or near, the crest of a vertical cut face (that is within a distance equal to the depth of excavation) should be designed for a maximum allowable bearing pressure of 600kPa, provided the rock immediately below the base of the footing is inspected by a geotechnical engineer to identify possible adverse defects or weathered bands, which may impact stability of the footing above. It is possible that deeper footings or additional bolting may be required locally subject to the geotechnical inspection and design check

The settlement of foundations proportioned on the basis of the above allowable parameters would be expected not to exceed 1% of the footing width/diameter as per Classification of Sandstones and Shales in the Sydney Region: A forty year review, P.J.N. Pells1, G. Mostyn2, R. Bertuzzi2 and P. K. Wong3, Volume 54: No.2 June 2019.

7.6 Site Classification

Although not relevant to the proposed multi story building development proposed for this site, a site classification of Class P to AS2870 is recommended due to the abnormal moisture conditions created by the presence of trees and existing structures.

8 FURTHER ASSESSMENT

The current investigation is only for the lodgement of Development Application to the local council. Given the nature of the site conditions and proposed depth of excavation, we recommend that an additional borehole be drilled out at the rear of the site to a depth of about 10-12m including rock coring to confirm the recommendations provided and the subsurface profile across the whole site is consistent with the current investigation.

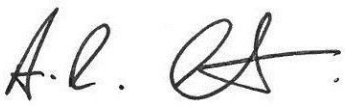
9 CLOSURE

The findings contained within this report are the result of limited discrete investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, can it be considered that these findings represent the actual state of the ground conditions away from our investigation locations.

If the ground conditions encountered during construction are significantly different from those described in this report and on which the conclusions and recommendations were based, then we must be notified immediately.

This report has been prepared for use by BL2093 Pty Ltd in relation to the Proposed 5 Storey Residential Building, 67 Pacific Parade, Dee Why NSW project in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. Use of this report by parties other than BL2093 Pty Ltd and their respective consultants and contractors is at their risk as it may not contain sufficient information for any other purposes.

For and on behalf of CMW Geosciences Pty Ltd

Prepared/Compiled by	Reviewed/Authorised by
	
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Distribution: 1 copy to BL2093 Pty Ltd (electronic)
Original held by CMW Geosciences Pty Ltd

10 REFERENCES

Australian Standards Geotechnical Site investigation AS1726-2016

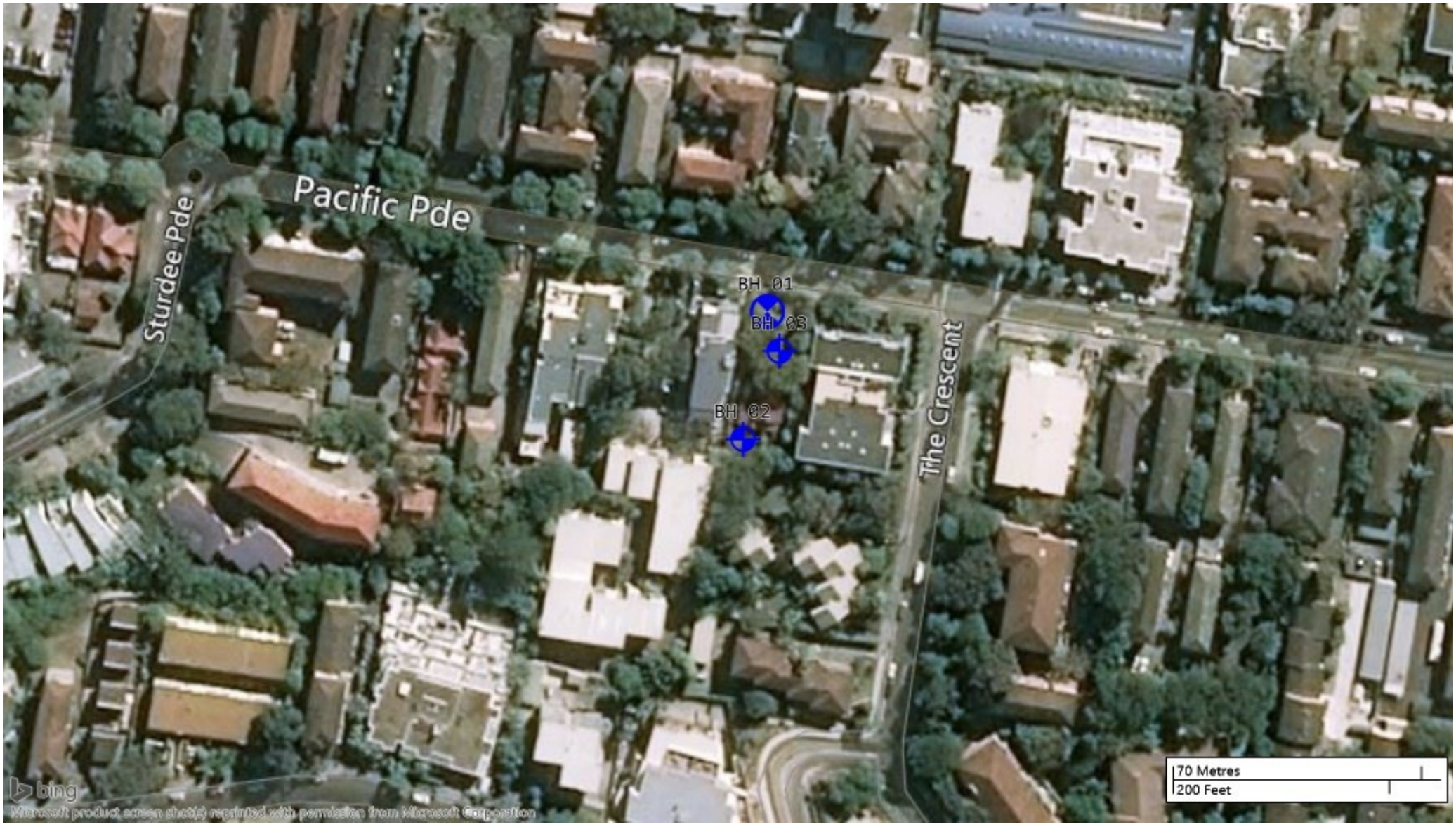
Australian Standards Residential Slabs and Footings AS2870-2011

Quarterly Journal of Engineering Geology by G. S. Pettifer & P. G. Fookes 1994

Classification of Sandstones and Shales in the Sydney Region: A forty year review, P.J.N. Pells1, G. Mostyn2, R. Bertuzzi2 and P. K. Wong3, Volume 54: No.2 June 2019.

Drawing

Site Investigation Plan



LEGEND:

- Locations By Type - HA
- Locations By Type - RC

CMW Geosciences

CLIENT:	Diversified Group Pty Ltd	DRAWN:	CS	PROJECT:	SYD2020-0066
PROJECT:	67, Pacific Parade, Dee Why, NSW	CHECKED:	RS	FIGURE:	1
		REVISION:	0	SCALE:	1:1500
TITLE:	Site Investigation Plan	DATE:	16/06/2020	SHEET:	A4 L

Appendix A

Site View

Figure 1: Existing single storey brick and sandstone residential dwelling

Figure 2: Unsupported rock wall at the front of the site

Figure 3: Crack on the Block wall at rear side

Figure 4: Boulder retaining walls

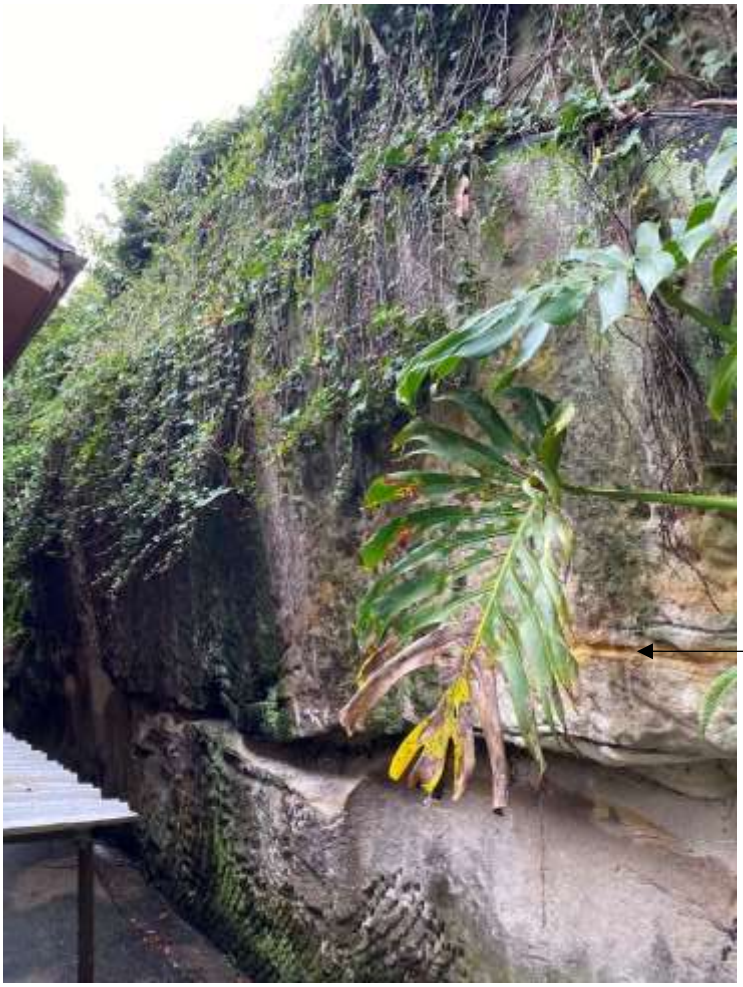


Figure 5: Unsupported sandstone rock at eastern side of the site

Figure 6: Rock on the surface

Appendix B

Explanatory notes and Borehole Logs

Explanatory Notes – Soil Description

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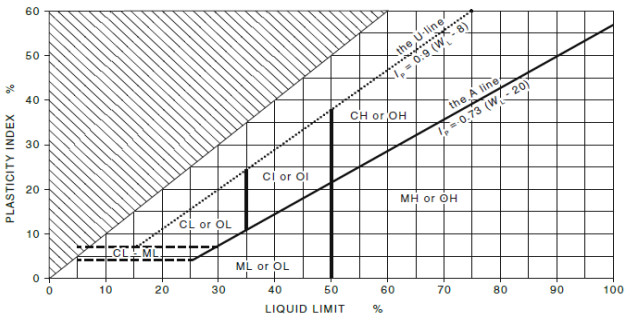
GRAVEL	Gravelly SAND	Sandy CLAY	FILL
SILTY GRAVEL	SILTY SAND	SILT	TOPSOIL
CLAYEY GRAVEL	CLAYEY SAND	Gravelly SILT	COBBLES & BOULDERS
Sandy GRAVEL	CLAY	Sandy SILT	CONCRETE
SAND	Gravelly CLAY	PEAT	NO CORE

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



WATER	
Groundwater Level	Groundwater Inflow

CLASSIFICATION AND INFERRED STRATIGRAPHY

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

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

MOISTURE CONDITION (Cohesionless Soils)

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

MOISTURE CONDITION (Cohesive Soils)

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

DENSITY (Cohesionless Soils)

Sym.	Term	Density Index (%)	SPT 'N'
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

STIFFNESS (Cohesive Soils)

Sym.	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa

SAMPLING AND LABORATORY / INSITU TESTING RESULTS

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

DRILLING/EXCAVATION METHOD

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

Explanatory Notes – Rock Description


MUDSTONE


SILTSTONE


SANDSTONE


LIMESTONE


CHALK


BRECCIA


CONGLOMERATE


IGNEOUS


METAMORPHIC


GYPSUM


SHALE


PYROCLASTIC

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

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

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

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

Explanatory Notes – Defect Description

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

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

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

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

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

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

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

ROCK CORE LOGGING

AS1726-2017

ROCK DESCRIPTION AND CLASSIFICATION	
A	**DESCRIPTION**
1	Rock name (BLOCK LETTERS)
2	Grain size and Type
3	Colour
4	Fabric and Texture
5	Inclusions or minor components
6	Moisture Content
B	**CLASSIFICATION**
1	Strength
2	Weathering and/or alteration
C	**DEFECTS**
1	Type
2	Orientation
3	Surface roughness
4	Surface shape
5	Coating
6	Aperture
D	**STRATAGRAPHIC UNIT**
E	**CORE DRILLING PARAMETERS**
1	Core recovery and rock quality
2	Fracture Index

A1-A2

TABLE 16

GUIDE TO THE NAMING OF IGNEOUS ROCKS

Grain size mm	Massive crystalline		
	Much quartz, pale (felsic)	⟺	Little quartz, dark (mafic)
Coarse (>2)	GRANITE	DIORITE	GABBRO
Medium (0.06–2)	MICROGRANITE	MICRODIORITE	DOLERITE
Fine (<0.06)	RHYOLITE	ANDESITE	BASALT

A1-A2

TABLE 15

GUIDE TO THE NAMING OF SEDIMENTARY ROCKS

Grain size mm	Deposited rock type		At least 90% of rock is carbonate(Note 3)		Ejected from a volcano
			Low porosity, indurated	Porous, core can be broken by hand	
>2	CONGLOMERATE (larger rounded grains in a finer matrix) BRECCIA (angular or irregular rock fragments in a finer matrix)		LIMESTONE or DOLOMITE(Note 4)	CALCIRUDITE	AGGLOMERATE (rounded grains in a finer matrix or VOLCANIC BRECCIA (angular fragments in a finer matrix)
0.06–2	SANDSTONE(Notes 1,2)			CALCARENITE	TUFF
0.002–0.06	MUDSTONE(Note 5) silt and clay	SILTSTONE(Note 5) mostly silt		CALCISILTITE	Fine grained TUFF
<0.002		CLAYSTONE(Note 6) mostly clay		CALCILUTITE	

A1-A2

TABLE 17

GUIDE TO THE NAMING OF METAMORPHIC ROCKS

Grain size mm	Foliated	Non-foliated
Coarse (>2)	GNEISS—well developed but often widely spaced foliation sometimes with schistose bands	MARBLE—crystalline calcium carbonate
Medium (0.06–2)	SCHIST—well developed foliation with much mica, some micas larger than 2 mm	QUARTZITE—fused quartz grains
Fine (<0.06)	PHYLLITE—slightly undulose foliation sometimes spotted. SLATE—well developed planar cleavage	SERPENTINITE—usually a grey and green rock formed by the alteration of mafic igneous rocks HORNFELS—usually a fine grained rock formed by thermal metamorphism

NOTE: Foliated metamorphic rocks normally form by regional metamorphism and non-foliated metamorphic rocks form by contact or thermal metamorphism.

A4: Texture and fabric

INDISTINCT: little effect on strength properties DISTINCT: easily breaks along the fabric	**Igneous**	Flow banding	Layering of partially solidified rock or orientated crystals
	Metamorphic	Foliation	Parallel arrangement of mineral
		Cleavage	Foliation in fine grained metamorphic rocks
	Sedimentary	Bedding	<20mm Changes in sedimentation defined by grainsize
		Lamination	>20mm Similar to bedding

A5: Features inclusions and minor components

- Thickness - Size - Orientation - Coverage %	**Igneous**	Vesicles (empty) Amygdules (mineralised)
		'Floater' boulder size rock in residual to extremely weathered matrix
	Sedimentary	Cross stratification
		Clast or matrix support
		Nodules, pyrite crystals, iron stones, carbonates
		Mineral veins

B1: ROCK MATERIAL STRENGTH

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

B2: WEATHERING CLASSIFICATION

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

C4

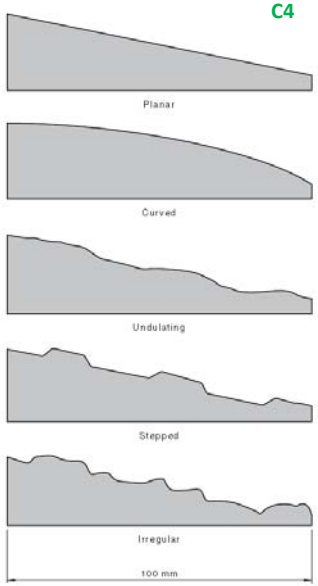
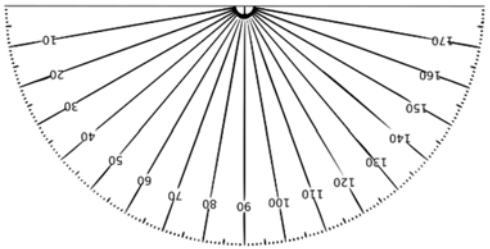


FIGURE 7 DEFECT SHAPES ILLUSTRATED AT MEDIUM SCALE

C1: Defect Type

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

C2



C6: Aperture

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

C2: Orientation

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

C3: Surface Roughness

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

C4: Surface Shape

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

C5: Coatings

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

E1: ROCK CORE RECOVERY		
Symbol	**Term**	**Definition**
TCR	Total Core Recovery (%)	The ratio of total length of core recovered to length of core run drilled, expressed as a percentage.
SCR	Solid Core Recovery (%)	The ratio of the total length of solid cylindrical pieces of core recovered to length of core run drilled, expressed as a percentage.
RQD	Rock Quality Designation (%)	The ratio of the total length of solid cylindrical pieces of core over 100mm in length recovered to length of core run drilled, expressed as a percentage.

E2: FRACTURE INDEX (FI): number of defects per meter of core	
Min / Max (mm)	0-20
	20-40
	40-100
	100-300
	300-1000
	>1000

$$RQD = \frac{250 + 190 + 200}{1200} \times 100\% = 53\%$$

CORE PRESENTATION	
Project name	High Definition
Project number	Drilling notes and depths
Date	Scale
Borehole name	Colour chart
Box number	Good lighting
Core depth	Wet core

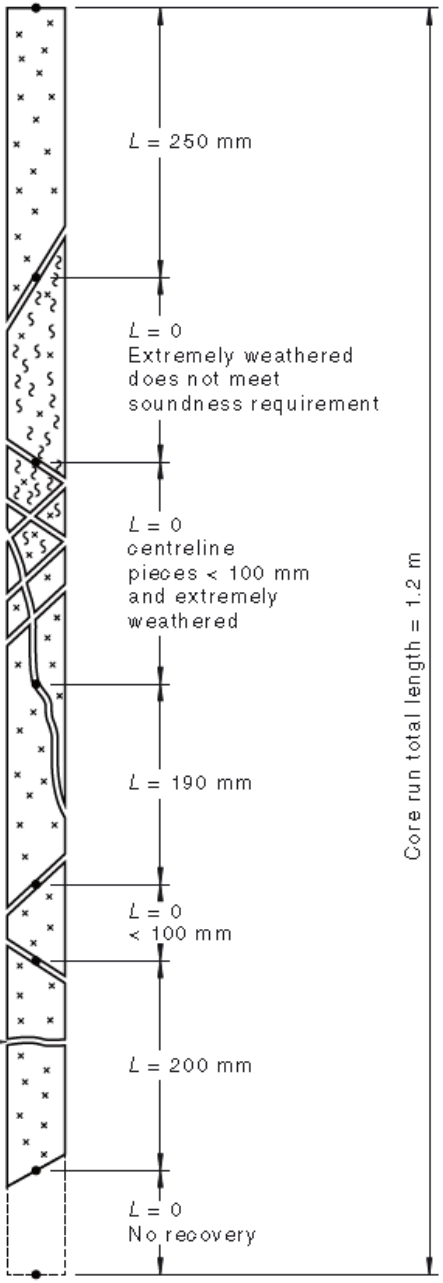


FIGURE 13 RQD MEASUREMENT PROCEDURE

BOREHOLE LOG - BH 01

Client: Diversified Group Pty Ltd
Project: 67, Pacific Parade, Dee Why, NSW
Location: 67, Pacific Parade, Dee Why, NSW
Project ID: SYD2020-0066
Date: 10/06/2020

CMW Geosciences

1:40 Sheet 1 of 1

Logged by: CS
Checked by: RS

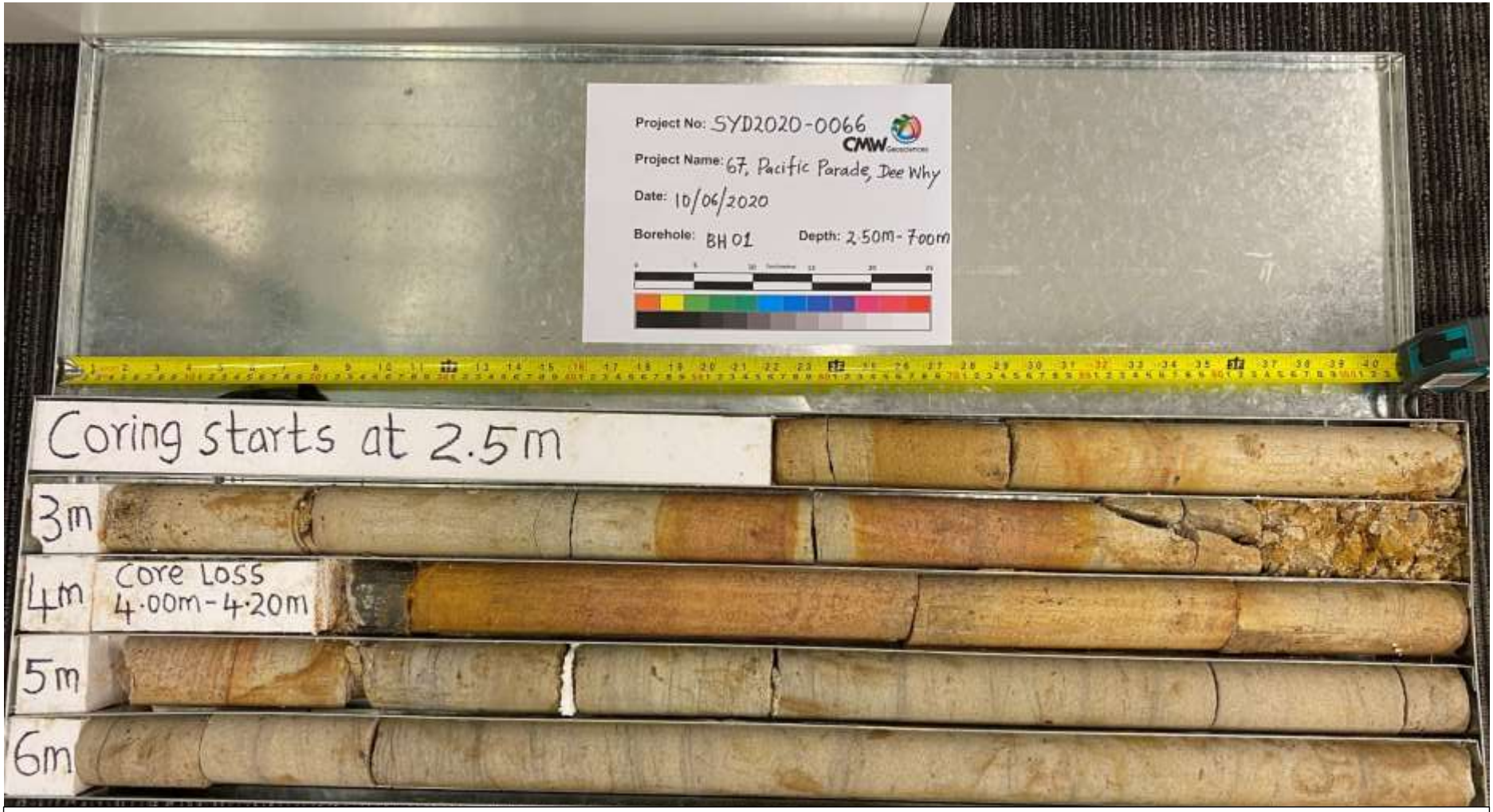
Position: E.341571m N.6263669m (MGA 51)
Elevation: 31 m (AHD)

Hole Diameter: 100mm
Angle from horizontal: 90°

Plant: Rig 17
Contractor: BG Drilling

Drilling Method	Well	Groundwater	Coring TCR	Coring SCR	Coring RQD	RL (m)	Depth (m)	Graphic Log	Rock/Soil Description	Consistency	Moisture Condition	Rock Strength (VL L M H VH EH; UCS (MPa); UCS (from Is50))	Cementation/ Weathering	Defect Spacing (mm)	Samples, test results and additional Data
HA						31.0			SP: TOPSOIL: SAND: fine to medium grained, dark brown with rootlets						
						30.9			SP: SAND: fine to medium grained, grey brown						
AD/V						30.6	1		SANDSTONE: fine to medium grained, brown				XW		
						29.0	2		SANDSTONE: medium to coarse grained, brown				XW-HW		
RC			92	87	82	28.5	3		SANDSTONE: pale orange brown to grey				MW		2.50-2.54m:JT, 10°, CU, rough 2.54-2.68m:JT, 0°, CU, rough 2.68-3.16m:JT, 0°, CU, rough 3.16-3.36m:IF, 0°, CU, rough 3.36-3.53m:JT, 3°, CU, rough 3.53-3.80m:JT, 2°, CU, rough
						27.2	4		SANDSTONE: fine to medium grained, pale orange brown to grey				XW		3.86-4.00m:SM, 10°, CU, rough
						27.0			CORE LOSS						
						26.8			grey *... from 4.20m to 5.20m, pale orange grey*				MW		4.20-4.23m:JT, 10°, CU, rough 4.23-4.60m:IF, 0°, CU, rough 4.60-4.80m:IF, 0°, CU, rough 4.80-5.20m:JT, 0°, CU, rough
			98	100	100		5						MW-SW		5.35-5.50m:JT, 0°, CU, rough 5.50-5.82m:IF, 0°, CU, rough 5.50-5.60m:C Is50=1.53MPa 5.82-5.95m:IF, 0°, CU, rough 5.95-6.09m:JT, 0°, CU, rough 6.09-6.21m:JT, 5°, CU, rough 6.20-6.29m:C Is50=1.67MPa
							6								
							7		Borehole terminated at 7.0 m						
							8								

Termination reason: Target Depth Reached
Remarks:



Borehole terminated at 7.0m

BOREHOLE CORE PHOTOGRAPH:

Logged by:	CS	Hole Diameter: 100mm	
Checked by:	RS	Angle from Horizontal: 90°	
Position:	E.341571m N.6263669m	Plant: Rig 17	
Elevation:	31 m (AHD)	Contractor: BG Drilling	

Client: BL2093 Pty Ltd
Project: Site investigation in Dee Why NSW
Location: 67 Pacific Parade, Dee Why, NSW
Project No: SYD2020-0066
Date: 10/06/2020

CMW Geosciences

BOREHOLE LOG - BH 02

Client: Diversified Group Pty Ltd
Project: 67, Pacific Parade, Dee Why, NSW
Location: 67, Pacific Parade, Dee Why, NSW
Project ID: SYD2020-0066
Date: 10/06/2020

CMW Geosciences

1:10 Sheet 1 of 1

Logged by: CS Position: E.341565m N.6263633m (MGA 51) Plant used: Hand Auger
Checked by: RS Elevation: 37.8 m (AHD) Contractor: N/A

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
				37.6			SP: TOPSOIL: SAND: fine to medium grained, dark brown with rootlets	M	D	
							Borehole terminated at 0.2 m			
					1					
					2					

Termination Reason: Refusal on Rock
Remarks:

BOREHOLE LOG - BH 03

Client: Diversified Group Pty Ltd
Project: 67, Pacific Parade, Dee Why, NSW
Location: 67, Pacific Parade, Dee Why, NSW
Project ID: SYD2020-0066
Date: 10/06/2020

1:10 Sheet 1 of 1

Logged by: CS Position: E.341575m N.6263658m (MGA 51) Plant used: Hand Auger
Checked by: RS Elevation: 35.9 m (AHD) Contractor: N/A

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Structure & other observations
				35.8			SP: TOPSOIL: SAND: fine to medium grained, dark brown with grass and rootlets	M	D	
							Borehole terminated at 0.1 m			
					1					
					2					

Termination Reason: Refusal on Rock
Remarks:

Appendix C

Laboratory Test Certificate

POINT LOAD STRENGTH INDEX REPORT

Client:	CMW Geosciences	**Moisture Content Condition:**	As received
Address:	Level 5, 35 Saunders Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	Dee Why (SYD2020-0066)	**Report No:**	S60781-PL
Job No:	S20266-1	**Date Tested:**	12/06/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client - results apply to the sample as received **Date Sampled:** 10/06/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S60781	BH 01 (5.50m - 5.60m)	Sandstone	Diametral	-	49.0	2.49	1.04	1.03	3
			Axial	51.7	37.0	3.74	1.54	1.53	1
S60782	BH 01 (6.20m - 6.29m)	Sandstone	Diametral	-	49.0	2.55	1.06	1.05	3
			Axial	51.6	35.0	3.91	1.70	1.67	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

NATA

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

15/06/2020

Date

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