GREEN
GEOTECHNICS

GEOTECHNICAL INVESTIGATION

FOR

VCROSS DEE WHY PTY LIMITED

12 THE STRAND, DEE WHY

REPORT GG11775.001A
30 APRIL 2025

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Geotechnical Investigation for a proposed mixed-use development at 12 The Strand, Dee Why

Prepared for

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30 April 2025

Document Authorisation

Our Ref: GG11775.001A

For and on behalf of Green Geotechnics

Matthew Green
Principal Engineer – Geotechnics

Document Control

Revision	Description	Format	Date	Author	Distributed to
A	Final	PDF	30/04/2025	MG	VCross Dee Why Pty Limited (Client)

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1. INTRODUCTION

This report presents the results of a geotechnical investigation undertaken by Green Geotechnics Pty Limited for a proposed mixed-use development at 12 The Strand, Dee Why, NSW. The investigation was commissioned by VCross Dee Why Pty Limited by return acceptance of Proposal PROP-2024-542, dated 15 October 2024.

We understand that the development comprises demolition of existing structures on the site prior to the construction of a four-level mixed use building comprising ground floor retail and three levels of residential unit accommodation overlying a two storey basement. The finished floor level of Basement 02 is set at Reduced Level (RL) 1.71 metres Australian Height Datum (AHD). Construction of the basement will require excavating to depths of between 7.0 and 8.6 metres below the existing ground surface, which includes a nominal 200mm allowance for the basement floor slab. Localised deeper excavations will also be required for lift overrun pits, sumps and foundations.

Structural loads have not been advised but we have assumed column loads in the moderate to high range will apply for this type of development.

The purpose of the investigation was to:

- assess the subsurface conditions over the site, including the determination of groundwater levels,
- provide a Site Classification to AS2870,
- provide a Subsoil Classification to AS1170.4,
- provide recommendations regarding the appropriate foundation system for the site including design parameters,
- comment on excavation conditions including recommendations for rock excavation and vibration control,
- provide parameters for the temporary and permanent support of the excavation,
- provide recommendations for basement construction, and
- provide an exposure classification to AS2159 & AS2870.

2. FIELDWORK DETAILS

The fieldwork was carried out on 11 November 2024 and comprised a detailed site walkover together with the drilling of two (2) boreholes numbered BH1 and BH2. The boreholes were drilled using rotary solid flight augers attached to a truck mounted Drillman GT30 drilling rig, supplied and operated by DB Services.

The site location is shown in the attached Figure A. The borehole locations, as shown on Figure B, were determined by taped measurements from existing surface features overlain on available survey drawings of the site. Photographs of the site indicating the borehole locations are shown on Figure C.

The strength of the soils encountered in the boreholes was assessed by undertaking Standard Penetration Tests (SPT's) at regular depth intervals. The consistency of cohesive soils encountered were augmented by carrying out pocket penetrometer readings on cohesive soil samples obtained from the SPT split spoon sampler.

Groundwater observations were made in all boreholes during drilling, on completion of drilling and a short time after completion of drilling. To assist with assessing long term groundwater levels, PVC Standpipe Piezometers were installed in both BH1 and BH2.

The fieldwork was completed in the full-time presence of our senior field geologist who set out the boreholes, nominated the sampling and testing, and prepared the borehole logs. The logs are attached to this report, together with a glossary of the terms and symbols used in the logs.

For further details of the investigation techniques adopted, reference should be made to the attached explanation notes.

Environmental and contamination testing of the soils was beyond the agreed scope of the works.

3. LABORATORY TESTING

To assess the soils for their aggressiveness and levels of salinity, representative soil samples were tested to determine the following:

- pH,
- Sulphate Content (SO4),
- Chloride Content (CL), and
- Electrical Conductivity (EC).

The detailed test reports are provided in Appendix B and are discussed in Section 5.9 of this report.

4. RESULTS OF INVESTIGATION

4.1 Site Description

The site is identified as Lot 13, Section 8 in DP 6953 and comprises a rectangular shaped parcel of land with an area of approximately 765m^2. At the time of the fieldwork the site was occupied by a two-storey brick building with flat roof which is located on the eastern half of the site. The western half of the site comprises a concrete car park and hard stand which is enclosed by timber and Colourbond fencing. The existing building has been constructed to the northern and southern boundaries, with awnings and a paved area at the front.

The ground surface on the site falls approximately 1.8 metres to the east from RL 9.8 metres AHD in the rear hardstand area to RL 8 metres AHD at the front courtyard. Site vegetation comprised a thin garden strip on the rear boundary.

To the east of the site is The Strand, and to the west is a three level residential unit building set back around 7 metres from the site boundary. To the south of the site is No.9 The Strand, a three (3) level brick mixed use building set back between 1.2 and 6.2 metres from the site boundary with a car parking area to the rear. To the north of the site is No.13 The Strand, a four (4) and five (5) level mixed use building with a ground floor loading dock which extends slightly below the ground surface and has been constructed to the boundary with the subject site.

4.2 Regional Geology & Subsurface Conditions

The 1:100,000 series geological map of Sydney (Geological Survey of NSW, Geological Series Sheet 9130) indicates that the site is underlain by Triassic Age bedrock belonging to the Hawkesbury Sandstone formation. Bedrock within this formation comprises fine to medium grained quartz sandstone. To the north of the site is a geological boundary with Quaternary Age alluvial deposits comprising sands, silts and clays.

For the development of a site-specific geotechnical model, the observed subsurface conditions from the boreholes have been grouped into four (4) geotechnical units which are summarised below in Table 4.1.

TABLE 4.1 – Summary of Subsurface Conditions

Unit	Material Type	Depth to top of Layer (m)	Depth to base of Layer (m)	Material Description
1	Concrete / Topsoil	Surface	0.1 to 0.3m	Concrete was encountered in both boreholes with thicknesses of 100mm to 120mm. The concrete in BH1 directly overlies aeolian sands, however a layer of silty sand fill materials were encountered below the concrete slab in BH2 to a depth of 0.3 metres.
2	Loose Becoming Medium Dense Sands and clayey silty sands	0.1 to 0.3m	1.7 to 2.0m	Sand, silty sand and clayey sand, generally loose to a depth 1.0 metre becoming loose to medium dense and medium dense with depth. Fine to medium grained with low plasticity fines, dry to moist.
3	Firm to stiff and interbedded stiff and very stiff clays with sand interbeds	1.7 to 2.0m	8.8 to >12.0m	Silty sandy clays with clayey sand interbeds, low plasticity with fine to medium grained sand, generally stiff and verry stiff with firm to stiff interbeds, ,moist becoming wet below depths of 3 to 4 metres.
4	Very stiff residual clays	6.5 to 15.0m	Unknown	Silty sandy clays, low to medium plasticity, stiff to very stiff and moist to wet

Groundwater observations made during auger drilling of the boreholes and in the piezometers are summarised below in Table 4.2.

TABLE 4.1 – Summary of Groundwater Observations

Borehole Id	Seepage Level – m (RL)	Standing Water Level After Drilling – m (RL)	Standing Water Level 24 hours after Drilling – m (RL)
1	2.8m (RL6.3m AHD)	2.0m (RL7.1m AHD)	2.3m (RL6.8m AHD)
2	3.4m (RL6.4m AHD)	2.9m (RL6.9m AHD)	3.0m (RL6.8m AHD)

5. GEOTECHNICAL RECOMMENDATIONS

5.1 Primary Geotechnical Considerations

Based on the results of the assessment, we consider the following to be the primary geotechnical considerations for the development:

- Basement excavation and retention to limit lateral deflections and ground loss as a result of excavations, resulting in damage to nearby structures,
- Constructing a basement below the water table and the need for construction stage dewatering, and
- Foundation design for structural loads.

5.2 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 there are existing structures present, abnormal moisture conditions (AMC) prevail at the site. (Refer to Section 1.3.3 of AS2870).

Because of the AMC and loose sands present, the site is classified a ***Problem Site (P).*** However, provided the recommendations given in Section 5.7 are adopted and footings are founded in at least stiff natural clays, the site may be reclassified ***Moderately Reactive (M).***

5.3 Excavation Conditions and Vibration Control

All excavation recommendations should be complemented with reference to the NSW Government Code of Practice for Excavation work, dated January 2020.

It would be appropriate before commencing excavation to undertake a dilapidation survey of any adjacent structures that may potentially be damaged. This will provide a reasonable basis for assessing any future claims of damage.

Based on the subsurface conditions observed in boreholes, the proposed basement excavation is expected to encounter concrete and topsoil overlying sandy soils and colluvial/alluvial interbedded sands and clays. We do not anticipate the excavations encountering he underling sandstone bedrock.

Excavation of the soils will be achievable using conventional excavation equipment, such as the buckets of hydraulic excavators. We do not anticipate the use of hydraulic rock hammers during the bulk excavation works.

Based on the observations made during drilling and in the piezometers, the basement is expected to encounter a groundwater table. Basement construction below the groundwater table has implications for both the construction and long-term phases of the project.

To control groundwater both during construction and in the long term, a relatively impermeable temporary support system/shoring wall will need to be installed, otherwise lowering the water table will cause ground settlement and possible damage to the roadways and buildings on adjacent properties. To limit boiling of groundwater below the base of the wall, it would need to be sufficiently embedded into a layer of stiff low permeability clayey soils.

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. Diaphragm walls and cutter soil mixed (CSM) walls are also effective in similar ground conditions.

Steel pile walls are often used to support excavations, however 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, a specialist piling contractor should be engaged to carry out the works. Localised dewatering within the confines of the basement shoring system will be required during the bulk excavation process. Dewatering can be achieved either using a spear point system or by excavating a pit in one corner of the site down to bulk excavation level and installing a submersible pump.

Prior to finalising the design of any temporary shoring or dewatering systems it will be necessary to carry out additional geotechnical investigations on the site, including a seepage analysis to determine inflow rates and additional electronic Cone Penetrometer Testing (CPT) testing to identify a suitable cut off depth for the wall.

Based on currently available groundwater data, and the proposed basement layout, we estimate that the total volume of water to be excavated from the confines of the basement to be in the order of 1.45ML. This calculation has been determined based on the following:

- Groundwater Level RL6.8 metres AHD
- Bulk Excavation Level RL1.51 metres AHD
- Basement footprint 665m^2
- Void ratio for interbedded sands and clays - 0.5

Water extracted from the site during the bulk excavation process is expected to be a one-off occurrence, provided an impermeable temporary shoring wall is installed.

Local and/or state approval may be required for the offsite disposal of groundwater during any dewatering.

5.4 Temporary Batter Slopes

As discussed above in Section 5.3, an impermeable temporary shoring system will be required to control groundwater inflow for the basement structure. However, for areas of the site outside the basement footprint, or in areas where excavation depths are limited, temporary batters may be considered.

Suggested temporary batter slope angles for dry cut slopes (i.e., above the groundwater table) not exceeding 2 metres in height are presented in Table 5.1 below. These recommendations are provided based on no surcharge loads, including construction loads and existing footing loads, being placed within H of the top of the batters, where H is the total batter height.

TABLE 5.1 – Recommended Temporary Dry Batter Slopes

Material	Temporary Batter Slope Ratio (H:V)
Unit 1 and 2 – Fill and Natural Sands	2:1
Unit 3 – Natural Clays	1:1

5.5 Retaining Wall Design

As per the recommendations given in Section 5.3, we recommend that the basement excavations be temporarily supported by an impermeable shoring wall.

When considering the design of the support system, it will be necessary to allow for the loading from structures in adjoining properties, any ground surface slope and the water table present.

For the design of temporary structures where some ground movement is acceptable, an active earth pressure coefficient (K_a) may be adopted. However, where adjoining structures are within the zone of influence of the excavation, or it is necessary to limit lateral deflections, it will be necessary to adopt at rest (K_o) conditions. K_o conditions should also be used to design the permanent support system.

A triangular lateral earth pressure distribution should be adopted for cantilevered walls, and a rectangular or trapezoidal lateral earth pressure distribution should be adopted for walls that are progressively propped at their top and base, and/or where two or more rows of anchors are used.

The lateral earth pressure for a cantilevered wall should be determined as a proportion of the vertical stress, as given in the following formula:

$\sigma z = K z \gamma$, where σz = Horizontal pressure at depth z (kPa)

K = Earth pressure coefficient

z = Depth (m)

γ = Unit weight of soil or rock (kN/m^3)

The design of propped/anchored or internally braced walls is more complex and therefore should be carried out using specialist software (i.e., Wallap, Plaxis etc.)

Retaining walls may be designed using the parameters provided below in Table 5.2.

TABLE 5.2 – Retaining Wall Design Parameters

Material Unit	Bulk Unit Weight (kN/m³) Dry	Bulk Unit Weight (kN/m³) Saturated	Effective Cohesion C' (kPa)	Effective Angle of Friction, ϕ (Deg)	Poisson's Ratio	Elastic Modulus E' (MPa)	Earth Pressure Co-efficients Active (K_a)	Earth Pressure Co-efficients At Rest (K_o)	Earth Pressure Co-efficients Passive (K_p)[2]
Loose Sand	18	8	0	25	0.3	8	0.4	0.6	-
Firm to Stiff Clay	18	8	0	26	0.3	10	0.4	0.6	2.5
Stiff / Very Stiff Clay	19	9	5	27	0.3	20	0.38	0.57	2.8

1. These values assume that some wall movement and relaxation of horizontal stress will occur due to the excavation. Actual in-situ K_0 values may be higher, particularly in the rock units.

2. Includes a reduction factor to the ultimate value of K_p to consider strain incompatibility between active and passive pressure conditions. Parameters assume horizontal backfill and no back of wall friction.

The embedment of retaining walls can be used to achieve passive support. A triangular passive earth pressure distribution (increasing linearly with depth) may be assumed, starting from 0.5 m below excavation toe/base level.

5.6 Drainage and Basement Floor Slab Construction

The basement structure extends below the groundwater table and therefore it will need to be constructed as a tanked structure. Tanked basement structures are subject to hydrostatic uplift when constructed below a permanent groundwater table. For preliminary design purposes we recommend adopting a static groundwater elevation of RL6.8 metres AHD.

Where stiff clayey soils are exposed over the excavation footprint, no special treatment is required other than the removal of loose and softened material. In some areas there may be some remaining loose wet sands which will likely need to be excavated. Areas, which have to be built-up to infill low points in the excavations should be filled with properly compacted sub-base material.

Slab-on-grade construction is considered appropriate for the basement floor slab provided that it is isolated from internal columns or footings.

5.7 Foundation Design

On completion of bulk excavation, stiff clayey soils are expected to be exposed in the base of any pad/strip footings (assuming a nominal footing depth of 0.5m). Any slab on ground sections of the ground floor which are outside the basement footprint are likely to encounter fill or loose sands at founding level.

To limit the potential for differential settlement we recommend that the proposed structures be uniformly supported on footings founded on the stiff natural clays.

Foundation design parameters for the various units are provided in Table 5.3 below.

TABLE 5.3 – Foundation Design Parameters

(Unit) Material	Maximum Allowable (Serviceability) Values (kPa)		
	End Bearing Pressure	Shaft Friction in compression#	Shaft Friction in tension*
(1) Topsoil /Fill	-	-	-
(2) Loose Sands	-	-	-
(3) Firm to Stiff Clays	100	20	10
(4) Stiff / Very Stiff Clays	250	20	10

Higher bearing pressures may be attributable to the stiff clayey layers subject to the outcomes of further geotechnical testing (i.e., the CPT testing),

However, should significantly higher bearing pressures be required then piles will need to be used to transfer the loads to the underlying sandstone bedrock which is likely to be present at depths exceeding 20 meters.

All shallow footings should be poured with minimal delay (i.e. preferably on the same day of excavation) or the base of the footing should be protected by a concrete blinding layer after cleaning of loose spoil and inspection.

Piles drilled for the temporary shoring system and any foundations will encounter groundwater and interbedded sandy/clayey soils, and therefore will need to be drilled using continuous flight auger (CFA) injected methods. Drilling of rock sockets into the deeper underlying sandstone bedrock will require the use of large purpose-built piling rigs equipped with rock augers.

The initial stages of footing excavation/drilling, particularly if bored piles are adopted, should be inspected by a geotechnical engineer/engineering geologist to ascertain that the recommended foundation material has been reached and to check initial assumptions about foundation conditions and possible variations that may occur between borehole locations. The need for further inspections can be assessed following the initial visit.

5.8 Site Classification to AS1170.4 (Earthquake)

The site sub-soil classification has been determined using AS1170.4-2007. The classification is based on the results of the borehole drilling. The depth of soil recorded in the subsurface profile exceeds 3 metres, therefore the site is classified as a Shallow Soil Site (C_e). An earthquake hazard factor (Z) of 0.08 applies to sites within the Sydney region.

5.9 Exposure Classification to AS2870 & AS2159

The aggressiveness or erosion 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 regard to the electrical conductivity, the laboratory test results have been multiplied by the appropriate factor to convert the results to EC_e.

The soils on the site consist of low permeability clays below the groundwater table. Therefore, the soil conditions B are considered appropriate. The test results are summarised in Table 5.4 below.

Table 5.4 – Exposure Classification Summary Table

Sample ID	Location	Depth (m)	pH	EC_e (dS/m)	Sulfate (ppm)	Chloride (ppm)	Exposure Classification AS2159		Exposure Classification AS2870
							Steel Piles	Concrete Piles	
S1	BH1	1.2	9.9	0.5	20	<10	Non-Aggressive	Non-Aggressive	A1
S2	BH1	4.0	5.0	0.3	30	20	Non-Aggressive	Mild	A2
S3	BH2	2.6	5.2	0.2	20	40	Non-Aggressive	Non-Aggressive	A1
S4	BH3	5.6	5.0	0.1	30	30	Non-Aggressive	Non-Aggressive	A1

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that EC_e values of 0.1 dS/m to 0.5 dS/m are consistent with the presence of non-saline soils.

6. FURTHER GEOTECHNICAL INPUT

The following summarises the scope of further geotechnical work recommended within this report. For specific details reference should be made to the relevant sections of this report.

- CPT testing to assess for the presence of continuous clay layers for the cut of wall and to determine the depth to the underlying sandstone bedrock,

- Undertake a detailed seepage analysis following additional geotechnical investigations,

- Complete dilapidation surveys of the adjoining buildings and structures.

- Inspection of shoring piles during installation to ensure there is adequate support for the excavations.

- Inspection of footing excavations to ascertain that the recommended foundation has been reached and to check initial assumptions regarding foundation conditions and possible variations that may occur.

- We also recommend that Green Geotechnics view the proposed earthworks and structural drawings in order to confirm they are within the guidelines of this report.

Nevertheless, it will be essential during excavation and construction works that progressive geotechnical inspections be commissioned to check initial assumptions about excavation and foundation conditions and possible variations that may occur between inspected and tested locations and to provide further relevant geotechnical advice.

7. GENERAL RECOMMENDATIONS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Green Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of Green Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

REPORT INFORMATION

Introduction

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

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

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation.

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

Groundwater

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

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

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

Reports

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

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

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

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

Site Anomalies

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

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FIGURES

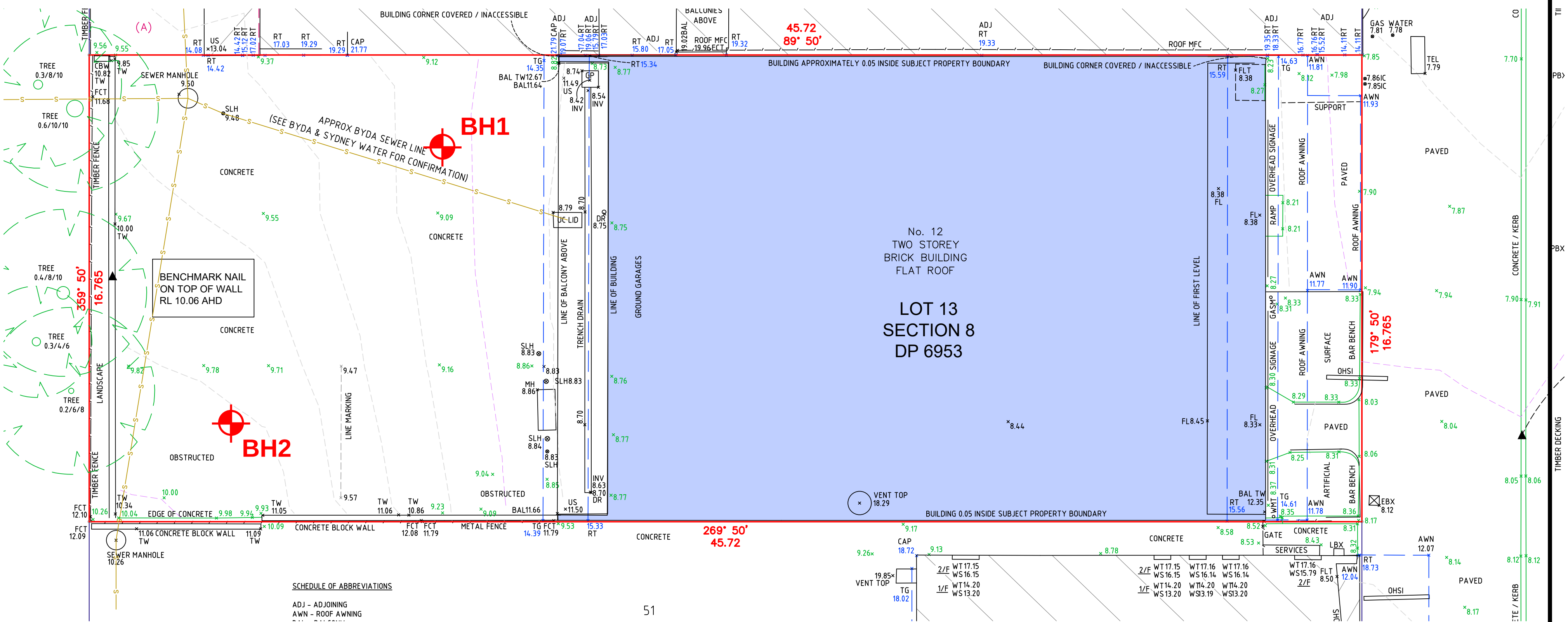
GREEN GEOTECHNICS	Project No: GG11775.001	Geotechnical Investigation 12 The Strand, Dee Why **SITE LOCATION PLAN**	Figure No: GG11775.001A
	Client: VCross Dee Why PTY LTD		Drawn By: MG
	Date: 30 April 2025		Scale: Unknown

Legend:

= Borehole

= DCP

= Test Pit



Project No: GG11775.001	Geotechnical Investigation 12 The Strand, Dee Why **TEST LOCATION PLAN**
Client: VCross Dee Why PTY LTD	
Date: 30 April 2025	

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Figure No: GG11775.001B

Drawn By: MG

Scale: Unknown

Position of BH1

Position of BH2

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	Client: VCross Dee Why PTY LTD		
	Date: 30 April 2025	**SITE PHOTOGRAPHS**	

APPENDIX A – BOREHOLE LOGS

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Engineering Log - Borehole

Project No.: GG11775.001

Client:	VCross Dee Why PTY LTD	Commenced:	11/11/2024
Project Name:	Geotechnical Investigation: 12 The Strand, Dee Why	Completed:	11/11/2024
Hole Location:	12 The Strand, Dee Why	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Drillman GT30 Truck	Inclination:	-90°	RL Surface:	9.10 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	DB

Drilling Information

Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)
AD/T				1.00m SPT 4,5,10 N=15 (S1 at 1.20m) 1.45m		8.1	1
			11/11/2024, Measured after drilling (≈2.8m)			7.1	2
				2.50m SPT 5,9,10 N=19 2.95m		6.1	3
				4.00m SPT 9,4,3 N=7 (S2 at 4.0m) 4.45m		5.1	4
				5.50m SPT 10,12,10 N=22 5.95m		4.1	5

Soil Description

Depth	Group Symbol	Material Description (Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional)	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
0.10m		CONCRETE: 100mm thick.			
0.25m	SM	Silty SAND: fine to medium grained, dark brown.	M / D	L	AEOLIAN SOIL
0.60m	SP	SAND: fine to medium grained, pale grey.	M / D	L	
0.80m	SM	Clayey Silty SAND: fine to medium grained, dark brown and orange brown. (coffee rock).	M / D	L	
2.00m	SM	Clayey Silty SAND: fine to medium grained, pale grey with dark grey.	M	L to MD	ALLUVIAL SOIL
	CL /SM	Silty Sandy CLAY: low plasticity, pale grey, sand is fine to medium grained. with some sand interbeds.	M; M / W; W	St to VSt; F to St; St to VSt	ALLUVIAL SOIL or COLLUVIAL SOIL

Method
AS - Auger Screwing
ADV Auger V Bit
ADT Auger Tungsten Carbide Bit
RR - Rock Roller
WB- Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
PP - Pocket Penetrometer

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet
w - Moisture Content
PL - Plastic Limit
LL - Liquid Limit

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
Fr - Friable
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

GREEN GEOTECHNICS

Borehole No.
BH1

Engineering Log - Borehole

Project No.: GG11775.001

Client:	VCross Dee Why PTY LTD	Commenced:	11/11/2024
Project Name:	Geotechnical Investigation: 12 The Strand, Dee Why	Completed:	11/11/2024
Hole Location:	12 The Strand, Dee Why	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Drillman GT30 Truck	Inclination:	-90°	RL Surface:	9.10 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	DB

Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description (Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional)	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T									CL /SM	Silty Sandy CLAY: low plasticity, pale grey, sand is fine to medium grained. with some sand interbeds. *(continued)*	W	St to VSt	ALLUVIAL SOIL or COLLUVIAL SOIL
				7.00m SPT 3,4,5 N=9 7.45m		2.1	7					F to St	
						1.1	8					St to VSt	
				8.50m SPT 7,9,12 N=21 8.95m		0.1	9						
						-0.9	10						
						-1.9	11						

Method
AS - Auger Screwing
ADV - Auger V Bit
ADT - Auger Tungsten Carbide Bit
RR - Rock Roller
WB - Washbore

Support
C - Casing

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Samples and Tests
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Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T						-3.9	13		CL /SM	Silty Sandy CLAY: low plasticity, pale grey, sand is fine to medium grained. with some sand interbeds. *(continued)*	W		ALLUVIAL SOIL or COLLUVIAL SOIL
						-4.9	14						
						-5.9	15		CL /SM	15.00m Silty Sandy CLAY: low plasticity, pale grey, sand is fine to medium grained. (interbedded sand/ clay).	M / W		Possibly RESIDUAL SOIL
						-6.9	16						
						-7.9	17			18.00m Hole Terminated at 18.00 m Discontinued			

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Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Drillman GT30 Truck	Inclination:	-90°	RL Surface:	9.80 m		
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	DB

Drilling Information | **Soil Description** | **Observations**

Method: AD/T

Groundwater: 11/11/2024, Measured after drilling (approx. 2.95 m inflow; level at approx. 3.4 m)

Samples & Field Tests	RL (m)	Depth (m)
1.00m SPT 5,6,12 N=18 1.45m	8.8	1
	7.8	2
2.50m SPT 3,4,7 N=11 (S3 at 2.60m) 2.95m	6.8	3
4.00m SPT 15,15,15 N=30 4.45m	5.8	4
	4.8	5
5.50m SPT 5,6,9 N=15 (S4 at 5.60m) 5.95m		

Depth	Group Symbol	Material Description (Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional)	Moisture Condition	Consistency / Relative Density	Structure and Additional Observations
0.12m		CONCRETE.			
0.30m	SM	TOPSOIL Silty SAND: fine to medium grained, dark grey and brown.	D	L	TOPSOIL
1.40m	SP	SAND: fine to medium grained, pale grey.	D / M	L; L to MD	AEOLIAN SOIL
1.70m	SM	Clayey Silty SAND: fine to medium grained, dark grey and brown.	M	MD	
	CL	Silty Sandy CLAY: low plasticity, pale grey, sand is fine to medium grained. with some sand interbeds.	M; M / W; W	St; St to VSt; St to VSt	ALLUVIAL SOIL or COLLUVIAL SOIL

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Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:	DB

Drilling Information | **Soil Description** | **Observations**

Method	Support	Penetration	Groundwater Levels	Samples & Field Tests	Recovery	RL (m)	Depth (m)	Graphic Log	Group Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	Structure and Additional Observations
AD/T									CL	Silty Sandy CLAY: low plasticity, pale grey, sand is fine to medium grained. with some sand interbeds. *(continued)*	W	St to VSt	ALLUVIAL SOIL or COLLUVIAL SOIL
							6.50m		CL /CI	Silty Sandy CLAY: low to medium plasticity, pale grey with dark grey.	M / W	St to VSt	Possibly RESIDUAL SOIL
				7.00m SPT 4,8,10 N=18 7.45m		2.8	7						7.00: P.P= 450kPa
						1.8	8						
				8.50m SPT 3,7,10 N=17 8.95m									8.50: P.P= 450kPa
						0.8	9 (9.00m)			Hole Terminated at 9.00 m Discontinued in silty sandy clay			
						-0.2	10						
						-1.2	11						

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SAMPLING & IN-SITU TESTING

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock. Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure. Undisturbed samples are taken by pushing a thin walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility.

Test Pits

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

Large Diameter Augers

Boreholes can be drilled using a large diameter auger, typically up to 300 mm or larger in diameter mounted on a standard drilling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration.

Diamond Core Rock Drilling

A continuous core sample of can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter (NMLC). The borehole is advanced using a water or mud flush to lubricate the bit and removed cuttings.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable, and the test is discontinued.

The test results are reported in the following form.

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

  4,6,7
  N=13

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

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.

- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

SOIL DESCRIPTIONS

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

Type	Particle Size (mm)
Coarse Gravel	20 – 63
Medium Gravel	6 – 20
Fine Sand	2.36 – 6
Coarse Sand	0.6 – 2.36
Medium Sand	0.2 – 0.6
Fine Sand	0.075 – 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion
And	Specify
Adjective	20 - 35%
Slightly	12 - 20%
With some	5 - 12%
With a trace of	0 - 5%

Definitions of grading terms used are:

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

Cohesive Soils

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

Description	Abbreviation	Undrained Shear Strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	ST	50 - 100
Very stiff	VST	100 - 200
Hard	H	200

Cohesionless Soils

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

Relative Density	Abbreviation	SPT N Value	CPT qc value (MPa)
Very loose	VL	<4	<2
Loose	L	4 - 10	2 -5
Medium Dense	MD	10-30	5-15
Dense	D	30-50	15-25
Very Dense	VD	>50	>25

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Fill - moved by man.

Transported soils may be further subdivided into:

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

ROCK DESCRIPTIONS

GREEN GEOTECHNICS

Rock Strength

The Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Soil developed on extremely weathered rock, the mass structure and substance fabric are no longer evident.
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable.
Distinctly Weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured usually by iron staining.
Moderately weathered	MW	Staining and discolouration of rock substance has taken place.
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.

Degree of Fracturing

The following classification applies to the spacing of natural fractures in core samples (bedding plane partings, joints and other defects, excluding drilling breaks

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured Core	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Unbroken Core lengths mostly > 1000 mm

Stratification Spacing

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

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

Rock Quality Designation

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

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

'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling/handling, then the broken pieces are fitted back together and are not included in the calculation of RQD.

ABBREVIATIONS

Introduction

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

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
ADT	Auger Drill TC Bit
ADV	Auger Drill V Brit
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

Z	Water seep
V	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
S	Chemical sample
U50	Undisturbed tube sample (50mm)
W	Water sample
PP	Pocket Penetrometer (kPa)
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

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

Defect Type

C	Crushed Seam
DB	Drilling Break
DL	Drilling Lift
EW	Extremely Weathered Seam
HB	Handling Break
IS	Infilled Seam
J	Joint
MB	Mechanical Break
P	Parting
S	Sheared Surface
SS	Sheared Seam
SZ	Sheared Zone

Orientation

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

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

Coating or Infilling Term

cn	clean
ct	coating
sn	stained
vn	veneer

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pr	planar
st	stepped
un	undulating

Roughness

po	polished
rf	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

SYMBOLS

Graphic Symbols for Soil and Rock

General

- Asphalt
- Road base
- Concrete
- Filling

Soils

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

Sedimentary Rocks

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

Metamorphic Rocks

- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks

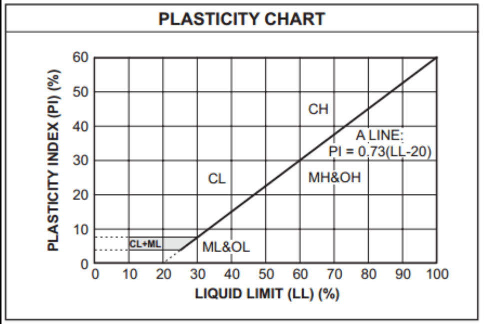
- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry

UNIFIED SOIL CLASSIFICATION TABLE

GREEN GEOTECHNICS

Field Identification Procedures (Excluding particles larger than 75um and basing fractions on estimated weights)				Group Symbols	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils More than half of the material is large that 75um sieve size[b] (The 75um sieve size is about the particle visible to the naked eye)	Gravels More than half of the coarse fraction is larger than a 4mm sieve	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name: indicative approximate percentages of sand and gravel; maximum size; angularity; surface condition, and hardness of the coarse grains; local of geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty Sand*, gravelly; about 20% hard, angular gravel particles 12mm maximum size; rounded and subangular sand grains, coarse to fine, about 15% non-plastic fines low dry strength; well compacted and moist in place; alluvial sand; *(SM)*	Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75um sieve size) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP; More than 12% GM, GC, SM, SC; 5 to 12% Borderline cases requiring use of dual symbol	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, grave-sand mixtures, little or no fines			Not meeting all graduation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures			Atterberg limits below "A" line or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are borderline cases of requiring use of dual symbols
			Plastic fines (for identification procedures see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures			Atterberg limits above "A" line with *PI* greater than 7
	Sands More than half of the coarse fraction is smaller than a 4mm sieve	Clean sands (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines			$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines			Not meeting all graduation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures			Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are borderline cases of requiring use of dual symbols
			Plastic fines (for identification procedures see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures			Atterberg limits above "A" line with *PI* greater than 7

Identification Procedures of Fractions Smaller than 380 um Sieve Size		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Find-grained soils More than half of the material is smaller than 75um sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slit plasticity	Give typical name: indicative degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey Silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; *(ML)*
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity Chart
For laboratory classification of fine-grained soils

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines

2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity

APPENDIX B – LABORATORY TEST RESULTS

CERTIFICATE OF ANALYSIS

Work Order	: **ES2436695**	Page	: 1 of 2
Client	: **GREEN GEOTECHNICS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR MATTHEW GREEN	Contact	: Customer Services ES
Address	: PO BOX 3244 ROUSE HILL 2155	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: GG11775	Date Samples Received	: 12-Nov-2024 08:00
Order number	: ----	Date Analysis Commenced	: 12-Nov-2024
C-O-C number	: ----	Issue Date	: 18-Nov-2024 15:53
Sampler	: JK		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

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, unless the sampling was conducted by ALS. 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	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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 Contract 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.

- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	GG11775/S1	GG11775/S2	GG11775/S3	GG11775/S4	----
			Sampling date / time	11-Nov-2024 00:00	11-Nov-2024 00:00	11-Nov-2024 00:00	11-Nov-2024 00:00	----
Compound	CAS Number	LOR	Unit	ES2436695-001	ES2436695-002	ES2436695-003	ES2436695-004	--------
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	9.9	5.0	5.2	5.0	----
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	37	30	18	13	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	3.2	15.3	13.5	15.2	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	30	20	30	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	20	40	30	----