GREEN

GEOTECHNICS

GEOTECHNICAL INVESTIGATION

FOR

D.J THOMPSON PTY LIMITED

23-25 BASSETT STREET, MONA VALE

REPORT GG11415.001

12 MARCH 2024

Regulated Design Record				
Project Address: 23-35 Bassett Street, Mona Vale				
Project Title: Proposed Aged Care Facility				
Consent No:		Body Corporate Reg No: N/A		
Drawing Title: Geotechnical Investigation Report, 23-35 Bassett Street, Mona Vale		Drawing No: Report Ref: GG11415.001A		
Rev	**Date**	**Description**	**DP Full Name**	**Reg No**
-		Geotechnical Report		

Geotechnical Investigation for proposed alterations and additions to an aged care facility at 23-25 Bassett Street, Mona Vale

Prepared for

D.J Thompson Pty Limited
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Prepared by

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12 March 2024

Document Authorisation

Our Ref: GG11415.001A

For and on behalf of Green Geotechnics

Matthew Green
Principal Engineer – Geotechnics

Document Control

Revision	Description	Format	Date	Author	Distributed to
	Final	PDF	12/03/2024	MG	D.J Thompson Pty Limited (Client)

Table of Contents

1. INTRODUCTION

This report presents the results of a geotechnical investigation undertaken by Green Geotechnics Pty Limited for proposed alterations and additions to an existing residential aged care facility at 23 & 25 Bassett Street, Mona Vale, NSW. The investigation was commissioned by Northside Constructions on behalf of D.J Thompson Pty Limited by return acceptance of Proposal PROP-2024-072, dated 21 February 2024.

We understand that the development comprises partial demolition of existing structures on the site prior to the construction of a two-level aged care facility with a single level of basement car parking and flood flow zone. The finished floor level of the basement is set at Reduced Level (RL) 1.2 metres Australian Height Datum (AHD). Construction of the basement will require excavating to depths of between 2.5 and 3.5 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 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 bedrock and 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, and
- provide parameters for the temporary and permanent support of the excavation.

2. PREVIOUS GEOTECHNICAL INVESTIGATION

A previous geotechnical investigation was undertaken in March 2020 by White Geotechnical Group (Reference J2485, dated 17 March January 2020). The previous investigations included the drilling of two (2) hand augered boreholes and six (6) Dynamic Cone Penetrometer (DCP) tests.

The subsurface conditions were reported as a layer of topsoil and fill overlying natural sandy soils to the maximum depth of drilling, 2.0 meters. Bedrock was not encountered to a depth of at least 4.2 metres based on the Dynamic Cone Penetrometer (DCP) test results, however the DCP rods were noted as being wet on extraction, indicating the likely presence of groundwater.

3. FIELDWORK DETAILS

The fieldwork was carried out on 4 and 5 March 2024 and comprised a detailed site walkover together with the drilling of six (6) boreholes numbered BH1 to BH6. BH1 and BH2 were drilled using rotary solid flight augers attached to a track mounted Christie Engineering drilling rig, supplied and operated by BG Drilling. BH3, BH4 and BH5 were drilled using a utility mounted Christie Engineering drilling rig supplied and operated by Green Geotechnics. Due to the presence of buried services BH6 was drilled using a hand auger.

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 DCP tests adjacent BH3, BH4 and BH5 and Standard Penetration Tests (SPT's) in BH1 and BH2. The consistency of cohesive soils encountered in BH1 and BH2 were augmented by carrying out pocket penetrometer readings on cohesive soil samples obtained from the SPT split spoon sampler. The strength of the weathered bedrock in BH1 and BH2 was assessed by observation of the auger penetration resistance when using a tungsten carbide drilling bit, together with examination of the recovered rock cuttings.

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 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.

4. RESULTS OF INVESTIGATION

4.1 Site Description

The site is located on the southern side of Bassett Street and is legally described as Lot 38 in Deposited Plan (DP) 7236 and Lot 2 in DP 748426. The site is rectangular in shape with a combined area of approximately 6,503m^2. At the time of the fieldwork No.23 (Lot 38) was occupied by a single storey clad residential cottage with tile roof and separate clad garage with metal roof in the rear garden area. At the time of the fieldwork No.25 (Lot 2) comprised single storey brick cottage with tile roof at its eastern end with a frontage of around 15 metres, to the west of which is a one and two storey brick aged car facility with tile roof.

The aged care facility includes a suspended tennis court with garage parking below, areas of concrete hard stand and parking, together with garden areas and a concrete driveway which extends down the western side of the building. There are existing concrete block retaining walls on the site.

The ground surface on the site falls approximately 1.2 metres to the south from RL 4.5 metres AHD to RL3.3 metres AHD. Site vegetation comprised grassed lawns, garden beds, shrubs and trees.

To the north of the site is Bassett Street and to the south of the site are residential dwellings and units fronting Heath Street. To the east of the site is No. 21 Bassett Street, a single storey brick cottage with metal roof set back around 0.9 metres from the site boundary. To the west of the site is a multi dwelling residential complex identified as No.37, 37A and 37B Bassett Street. Structures on the site to the west are set back around 3 metres from the boundary.

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.

Reference to available digital mapping on MinView indicates that the site is underlain by Holocene age deposits comprising clay, silt and fluvial/marine sand, with a geological boundary with the Hawkesbury Sandstone formation located some 35 metres north of the site.

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	Fill	Surface	0.5 to 2.0m	Concrete was encountered in BH1 and BH5 with thicknesses of 150mm to 210mm. Gravelly clayey sand, silty sandy clay and clayey silty sand fill was encountered across the site, being deepest in BH1. The fill is dark grey brown to orange, fine to medium grained, moist and appears variably compacted.
2	Loose Becoming Medium Dense Sands and clayey silty sands	0.5 to 2.0m	3.4 to 3.6m	Sand, silty sand and clayey sand, generally loose to a depth of 2.5 to 3.0 metres becoming loose to medium dense with depth. Fine to medium grained with low plasticity fines, moist becoming wet with depth.
3	Stiff and Very stiff Clays	3.4 to 3.6m	8.8 to >12.0m	Sandy silty clays and silty clays with ironstone gravel, generally medium to high plasticity and moist
4	Class 5 Sandstone Bedrock	8.8 to >12.0m	Unknown	Highly weathered very low strength sandstone bedrock with low strength bands and ironstone and claystone lenses. Dry to moist

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	2.0m (RL1.6m AHD)	2.0m (RL1.6m AHD)	2.0m (RL1.6m AHD)
2	2.0m (RL2.4m AHD)	Not Recorded	2.6m (RL1.8m AHD)
3	2.0m (RL1.6m AHD)	2.1m (RL1.5m AHD)	-
4	2.0m (RL1.8 AHD)	2.0m (RL1.8 AHD)	-
5	2.0m (RL1.7m AHD)	2.1m (RL1.6m AHD)	-
6	Not Encountered	Not Encountered	Not Encountered

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 fill overlying primarily sandy soils and a limited volume of clayey soils. The clayey soils are likely to be encountered close to bulk excavation level and during detailed excavation of footings and pits. 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. The groundwater appears to be perched in the sandy soils above the underlying silty clay layer, which we would expect to be relatively impermeable. Construction of the basement 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, the temporary support system selected must be impermeable, otherwise lowering the water table will cause ground settlement and possible damage to the roadways and buildings on adjacent properties. The support system can be embedded into the underling clayey materials or sandstone bedrock to both generate passive resistance in the shoring system, and to control seepage around the base of the support system (i.e., cutting off the groundwater).

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

Steel pile walls are often used to support excavations, 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. The equipment used should also be capable of penetrating the underlying bedrock if required to by the structural design.

Localised dewatering within the confines of the basement shoring system will be required during the bulk excavation process. Dewatering can be achieved by excavating a pit in one corner of the site down to bulk excavation level and installing a submersible pump.

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 1ML. This calculation has been determined based on the following:

- Groundwater Level RL 1.8 metres AHD
- Bulk Excavation Level RL1.0 metres AHD
- Basement footprint 2,200m^2
- Void ratio for a loose sand 0.6

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 5.2 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 5.2 – Recommended Temporary 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 temporary 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 5.3.

TABLE 5.3 – Retaining Wall Design Parameters

Material Unit	Bulk Unit Weight (kN/m^3)		Effective Cohesion C' (kPa)	Effective Angle of Friction, ϕ (Deg)	Poisson's Ratio	Elastic Modulus E' (MPa)	Earth Pressure Co-efficients		
	Dry	Saturated					Active (K_a)	At Rest (K_o)	Passive (k_p)^2
1	18	8	0	24	0.3	8	0.4	0.6	-
2	18	8	0	27	0.3	15	0.4	0.6	2.5
3	19	N/A	5	27	0.3	30	0.38	0.57	2.8
4	22	N/A	50	30	0.25	100	-	-	3.5

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. We understand that the site is located within a flood zone and therefore we recommend adopting an uplift pressure equal to the maximum predicted flood level.

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 in either the stiff natural clays, or the underlying sandstone bedrock.

Foundation design parameters for the various units are provided in Table 5.4 below.

TABLE 5.4 – Foundation Design Parameters

(Unit) Material	Maximum Allowable (Serviceability) Values (kPa)			Ultimate Strength Limit State Values (kPa)		
	End Bearing Pressure	Shaft Friction in compression#	Shaft Friction in tension*	End Bearing Pressure	Shaft Friction in compression#	Shaft Friction in tension*
(1) Topsoil	-	-	-	-	-	-
(2) Loose Sands	100	-	-	-	-	-
(3A) Stiff Clays	150	20	10	450	40	20
(3B) Very Stiff Clays	300	10	10	750	40	20
(4) Class 5 Sandstone	700	70	35	2,100	210	105

* Uplift capacity of piles in tension loading should also be checked for inverted cone pull out mechanism.

clean socket of roughness category R2 or better is assumed

In accordance with AS2159-2009 “Piling–Design and Installation”, for limit state design, the ultimate geotechnical pile capacity shall be multiplied by a geotechnical reduction factor (Φ_g). This factor is derived from an Average Risk Rating (ARR) which considers geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing (if any). Where testing is undertaken, or more comprehensive ground investigation is carried out, it may be possible to adopt a larger Φ_g value that results in a more economical pile design. Further geotechnical advice will be required in consultation with the pile designer and piling contractor, to develop an appropriate Φ_g value.

Settlements for pad footings in stiff clays are anticipated to be up to about 15mm where loading does not exceed the maximum allowable values presented in Table 5.4. Settlements for piled foundations in sandstone bedrock are anticipated to be about 1% of the pile diameter, based on serviceability parameters as per Table 5.4.

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 will encounter groundwater and sandy soils, and therefore will need to be drilled using continuous flight auger (CFA) injected methods. Piles drilled below bulk excavation level from inside the confines of the basement (i.e., foundation piles drilled from bulk level after installation of the cut-off wall) may be feasible using conventional open hole bored cast in-situ drilling methods, however some limited groundwater inflow should be anticipated. Drilling of rock sockets into the underlying sandstone bedrock will require the use of large purpose-built piling rigs equipped with rock augers.

Bored pile footings drilled using open hole methods should be drilled, cleaned, inspected and poured with minimal delay, on the same day. Water should be prevented from ponding in the base of footings as this will tend to soften the foundation material, resulting in further excavation and cleaning being required.

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.

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.

- 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.

Copyright

FIGURES

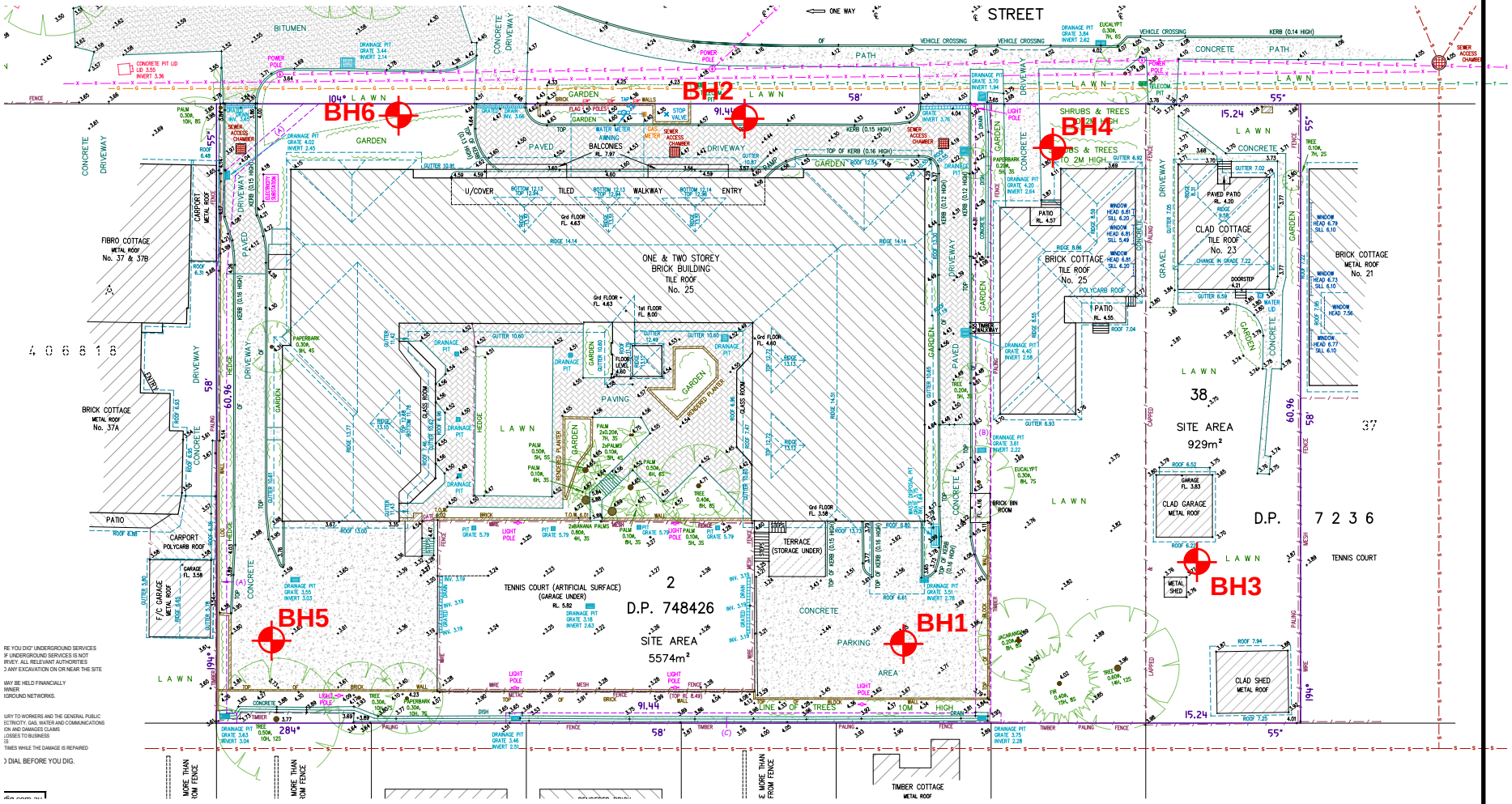
GREEN GEOTECHNICS	Project No: GG11415.001	Geotechnical Investigation 23-25 Bassett Street, Mona Vale	Figure No: GG11415.001A
	Client: DJ Thompson Family Trust		Drawn By: MG
	Date: 12 March 2024	**SITE LOCATION PLAN**	Scale: Unknown

Legend:

= Borehole

= DCP

= Test Pit



GREEN GEOTECHNICS	Project No: GG11415.001	Geotechnical Investigation 23-25 Bassett Street, Mona Vale	Figure No: GG11415.001B
	Client: DJ Thompson Family Trust		Drawn By: MG
	Date: 12 March 2024	**TEST LOCATION PLAN**	Scale: Unknown

Position of BH1

Position of BH2

GREEN GEOTECHNICS	Project No: GG11415.001	Geotechnical Investigation 23-25 Bassett Street, Mona Vale	Page: 1 of 3
	Client: DJ Thompson Family Trust		
	Date: 12 March 2024	**SITE PHOTOGRAPHS**	

Position of BH3

Position of BH4

GREEN GEOTECHNICS	Project No: GG11415.001	Geotechnical Investigation 23-25 Bassett Street, Mona Vale	Page: 2 of 3
	Client: DJ Thompson Family Trust		
	Date: 12 March 2024	**SITE PHOTOGRAPHS**	

Position of BH5

Position of BH6

GREEN GEOTECHNICS	Project No: GG11415.001	Geotechnical Investigation 23-25 Bassett Street, Mona Vale	Page: 3 of 3
	Client: DJ Thompson Family Trust		
	Date: 12 March 2024	**SITE PHOTOGRAPHS**	

APPENDIX A – BOREHOLE LOGS

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Borehole No.
BH1
Page 1 of 3

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	3.60 m	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:

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			5/3/2024, Measured after drilling	0.50m SPT 9,9,7 N=16 0.95m		2.6	1			CONCRETE: 210mm thick. 0.21m			
									SC	FILL Gravelly Clayey SAND: fine to medium grained, orange brown with pale grey, with sandstone gravel.	M		FILL
				1.50m SPT 2,1,1 N=2 1.95m		1.6	2			2.00m	M / W		
									SM	Silty SAND: fine to medium grained, pale brown and grey.	W	L	ALLUVIAL SOIL
				3.00m SPT 6,8,7 N=15 3.45m		0.6	3		SM	3.00m Clayey Silty SAND: fine to medium grained, dark grey with pale grey. 3.40m	W	MD	
						-0.4	4		CI /CH	Silty Sandy CLAY: medium to high plasticity, dark grey with pale grey, sand is fine grained; with sandy interbeds.	M	St	4.50: P.P = 200kPa
				4.50m SPT 4,7,22 N=29 4.95m		-1.4	5			5.50m			
				6.00m					CH	Silty CLAY: high plasticity, pale grey.	M	VSt	

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

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

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

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

Support
C - Casing

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

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	3.60 m	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:

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				SPT 5,6,10 N=16 6.45m		-3.4	7		CH	Silty CLAY: high plasticity, pale grey *(continued)*			ALLUVIAL SOIL 6.00: P.P = 350kPa 7.00: P.P = 350kPa
				SPT 7,9,10 N=19 7.95m		-4.4	8						8.00: P.P = 450kPa
				SPT 10,12,16 N=28 9.45m		-5.4	9				M	VSt	9.00: P.P = 450kPa
						-6.4	10						
						-7.4	11						
				12.00m									

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

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

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

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

Support
C - Casing

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

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	3.60 m	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:

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				SPT 22 N=22+ 12.15m					CH	Silty CLAY: high plasticity, pale grey *(continued)*	M	VSt	
										Red brown and orange brown with ironstone gravel			
										12.30m Red brown and orange brown with ironstone gravel *(continued)*			ROCK
										SANDSTONE: fine to medium grained, red brown with orange brown and pale grey. estimate very low strength (Class 5).	M / D		
						-9.4	13			13.00m			
										Hole Terminated at 13.00 m Discontinued on weathered sandstone			
						-10.4	14						
						-11.4	15						
						-12.4	16						
						-13.4	17						

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.
BH2
Page 1 of 2

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	4.40 m	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:

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			5/3/2024, Measured after drilling	1.00m SPT 3,3,4 N=7		3.4	1		CL	FILL Silty Sandy CLAY: low plasticity, dark brown, sand is fine grained.	M		FILL
				1.45m 1.50m SPT 2,2,3 N=5					SC	0.50m Clayey SAND: fine to medium grained, orange brown.	M	L	COLLUVIAL SOIL
				1.95m		2.4	2		SP	1.50m SAND: fine to medium grained, pale brown and orange brown.	M / W	L	ALLUVIAL SOIL
				3.00m SPT 2,4,4 N=8		1.4	3		SM	2.80m Silty SAND: fine to medium grained, dark grey with pale grey.	W	MD to MD	
				3.45m					CI /CH	3.50m Silty CLAY: high plasticity, pale grey.		St	
				4.50m SPT 4,9,13 N=22		0.4	4				M		
				4.95m		-0.6	5					VSt	5.00: P.P = 450kPa
				6.00m									

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

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

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

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

Support
C - Casing

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

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

GREEN GEOTECHNICS

Borehole No.
BH2
Page 2 of 2

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie CE180	Inclination:	-90°	RL Surface:	4.40 m	
Hole Diameter:	110 mm	Bearing:		Datum:	AHD	Operator:

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				SPT 16,19,19 N=38 6.45m		-2.6	7		CI /CH	Silty CLAY: high plasticity, pale grey *(continued)* Trace of ironstone gravel	M	VSt	6.00: P.P = 450kPa
				7.50m SPT 16,23 N=29+ 7.85m		-3.6	8		CI /CH	7.30m Silty Sandy CLAY: medium to high plasticity, red brown with orange brown and pale grey, sand is fine to medium grained; (completely weathered sandstone).	M	VSt to H	RESIDUAL SOIL 8.00: P.P = 450kPa
				9.00m SPT 25 N=25+ 9.15m		-4.6	9			8.80m SANDSTONE: fine to medium grained, orange brown with pale grey and red brown, with clay seams. estimate very low strength (Class 5). 9.15m	M / D		ROCK
						-5.6	10			Hole Terminated at 9.15 m Discontinued on weathered sandstone			
						-6.6	11						

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

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

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

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

Support
C - Casing

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

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

GREEN GEOTECHNICS

Borehole No.
BH3
Page 1 of 2

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	3.70 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

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			4/3/2024, Measured after drilling			2.7	1		SM	FILL / TOPSOIL Clayey Silty SAND: fine to medium grained, dark brown.	M		FILL / TOPSOIL
										0.50m			
									SC	Clayey SAND: fine to medium grained, orange brown, trace of sandstone gravel.	M	L	COLLUVIAL SOIL
						1.7	2			1.80m			
									SP	SAND: fine to medium grained, pale brown and grey.	M / W	L	ALLUVIAL SOIL
										2.60m			
						0.7	3		SM	Silty SAND: fine to medium grained, dark grey with pale grey.	W	L / MD	
										3.50m			
						-0.3	4		CL	Silty Sandy CLAY: low plasticity, pale grey, sand is fine grained.	W	St	
										4.60m			
						-1.3	5		CH	Silty CLAY: high plasticity, pale grey.	M	VSt	

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

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

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

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

Support
C - Casing

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

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	4/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	4/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	3.70 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

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						-3.3	7		CH	Silty CLAY: high plasticity, pale grey *(continued)*	M	VSt	ALLUVIAL SOIL
						-4.3	8			8.00m			
									CI /CH	Silty Sandy CLAY: medium to high plasticity, pale grey with occasional red brown, sand is fine grained.			
						-5.3	9						
						-6.3	10				M	VSt	
						-7.3	11						
										12.00m			

Hole Terminated at 12.00m
Discontinued in silty sandy clay

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

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

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

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

Support
C - Casing

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

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

GREEN GEOTECHNICS

Borehole No.
BH4
Page 1 of 2

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	5/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	5/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	3.80 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

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			5/3/2024, Measured after drilling			2.8	1		CL	FILL Silty Sandy CLAY: low plasticity, dark brown, sand is fine grained; (with some plastic). 0.50m	M		FILL
									SC	Clayey SAND: fine to medium grained, orange brown. 1.40m	M	L	ALLUVIAL SOIL
						1.8	2		SP	SAND: fine to medium grained, pale brown. 2.40m	M / W	L	
						0.8	3		SM	Silty SAND: fine to medium grained, dark grey. 3.40m	W	L to MD	
						-0.2	4		CI /CH	Silty CLAY: medium to high plasticity, dark grey with pale grey. 4.00m	M	St	
						-1.2	5		CH	Silty CLAY: high plasticity, pale grey with occasional red brown, trace of ironstone gravel.	M	VSt	

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

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	5/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	5/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	3.80 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

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						-3.2	7		CH	Silty CLAY: high plasticity, pale grey with occasional red brown, trace of ironstone gravel.*(continued)*	M	VSt	ALLUVIAL SOIL
										6.50m			
									CI /CH	Silty CLAY: medium to high plasticity, pale grey with red brown, trace of fine grained sand; trace of ironstone gravel.	M	VSt	
						-4.2	8			8.00m			
										Hole Terminated at 8.00 m Discontinued in silty clay			
						-5.2	9						
						-6.2	10						
						-7.2	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
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.
BH5
Page 1 of 2

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	5/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	5/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	3.70 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

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			5/3/2024, Measured after drilling			2.7	1			0.15m CONCRETE: 150mm thick.			
									CL	FILL Silty CLAY: low plasticity, orange brown with dark brown and dark grey, trace of fine grained sand. 0.70m	M		FILL
									SC	Clayey SAND: fine to medium grained, orange brown. 1.80m	M	L	COLLUVIAL SOIL
						1.7	2		SP	SAND: fine to medium grained, pale brown and grey. 2.60m	M / W	L	ALLUVIAL SOIL
						0.7	3		SM	Silty SAND: fine to medium grained, dark grey. 3.60m	W	L to MD	
						-0.3	4		CH	Silty CLAY: high plasticity, pale grey.	M	St	
						-1.3	5			Occasional sandy interbedds		VSt	

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

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	5/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	5/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Christie Utility	Inclination:	-90°	RL Surface:	3.70 m		
Hole Diameter:	105 mm	Bearing:		Datum:	AHD	Operator:	JK

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						-3.3	7		CH	Silty CLAY: high plasticity, pale grey *(continued)*	M	VSt	ALLUVIAL SOIL
						-4.3	8			8.00m Hole Terminated at 8.00 m Discontinued in silty clay			
						-5.3	9						
						-6.3	10						
						-7.3	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
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.
BH6
Page 1 of 1

Engineering Log - Borehole

Project No.: GG11415.001

Client:	DJ Thompson Family Trust	Commenced:	5/3/2024
Project Name:	Geotechnical Investigation: 23-25 Bassett Street, Mona Vale	Completed:	5/3/2024
Hole Location:	23-25 Bassett Street, Mona Vale	Logged By:	JK
Hole Position:	See Plan	Checked By:	MG

Drill Model and Mounting:	Hand Auger	Inclination:	-90°	RL Surface:	4.30 m		
Hole Diameter:	65 mm	Bearing:		Datum:	AHD	Operator:	JK

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
HA									CL	FILL Silty Sandy CLAY: low plasticity, dark brown, sand is fine grained; trace of cobbles/ gravel.			FILL
										0.50m Hole Terminated at 0.50 m Refusal in fill			
						3.3	1						
						2.3	2						
						1.3	3						
						0.3	4						
						-0.7	5						

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
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H - Hard
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VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Dynamic Cone Penetrometer Test Report

Project Number: GG11415

Site Address: 23-25 Bassett Street, Mona Vale

Test Date: 04/03/2024

Test Method: **AS 1289.6.3.2**

Technician: JK

Test No	BH3	BH4	Test No	BH3	BH4	Test No	BH3
Starting Level	Surface Level	Surface Level	Starting Level	3.00m	3.00m	Starting Level	6.00m
Depth (m)	Penetration Resistance (blows / 150mm)			Depth (m)	Penetration Resistance (blows / 150mm)		
0.00 - 0.15	1	1	3.00 - 3.15	4	10	6.00 - 6.15	15
0.15 - 0.30	2	2	3.15 - 3.30	4	11	6.15 - 6.30	16
0.30 - 0.45	2	4	3.30 - 3.45	6	12	6.30 - 6.45	17
0.45 - 0.60	4	4	3.45 - 3.60	5	10	6.45 - 6.60	22
0.60 - 0.75	5	2	3.60 - 3.75	6	8	6.60 - 6.75	Refusal
0.75 - 0.90	6	3	3.75 - 3.90	8	4	6.75 - 6.90	
0.90 - 1.05	4	2	3.90 - 4.05	12	7	6.90 - 7.05	
1.05 - 1.20	3	3	4.05 - 4.20	12	9	7.05 - 7.20	
1.20 - 1.35	3	3	4.20 - 4.35	8	16	7.20 - 7.35	
1.35 - 1.50	3	2	4.35 - 4.50	8	18	7.35 - 7.50	
1.50 - 1.65	4	4	4.50 - 4.65	9	22	7.50 - 7.65	
1.65 - 1.80	4	3	4.65 - 4.80	9	Refusal	7.65 - 7.80	
1.80 - 1.95	6	3	4.80 - 4.95	10		7.80 - 7.95	
1.95 - 2.10	7	3	4.95 - 5.10	10		7.95 - 8.10	
2.10 - 2.25	4	3	5.10 - 5.25	11		8.10 - 8.25	
2.25 - 2.40	2	4	5.25 - 5.40	11		8.25 - 8.40	
2.40 - 2.55	2	3	5.40 - 5.55	12		8.40 - 8.55	
2.55 - 2.70	2	4	5.55 - 5.70	13		8.55 - 8.70	
2.70 - 2.85	3	7	5.70 - 5.85	14		8.70 - 8.85	
2.85 - 3.00	6	8	5.85 - 6.00	15		8.85 - 9.00	

Remarks: * Pre drilled prior to testing

Dynamic Cone Penetrometer Test Report

Project Number: GG11415

Site Address: 23-25 Bassett Street, Mona Vale

Test Date: 04/03/2024

Test Method: **AS 1289.6.3.2**

Technician: JK

Test No	BH5		Test No	BH5		Test No	
Starting Level	Surface Level		Starting Level	3.00m		Starting Level	
Depth (m)	Penetration Resistance (blows / 150mm)			Depth (m)	Penetration Resistance (blows / 150mm)		
0.00 - 0.15	*		3.00 - 3.15	3		6.00 - 6.15	
0.15 - 0.30	*		3.15 - 3.30	4		6.15 - 6.30	
0.30 - 0.45	2		3.30 - 3.45	4		6.30 - 6.45	
0.45 - 0.60	4		3.45 - 3.60	5		6.45 - 6.60	
0.60 - 0.75	3		3.60 - 3.75	5		6.60 - 6.75	
0.75 - 0.90	3		3.75 - 3.90	6		6.75 - 6.90	
0.90 - 1.05	3		3.90 - 4.05	7		6.90 - 7.05	
1.05 - 1.20	2		4.05 - 4.20	8		7.05 - 7.20	
1.20 - 1.35	2		4.20 - 4.35	10		7.20 - 7.35	
1.35 - 1.50	2		4.35 - 4.50	10		7.35 - 7.50	
1.50 - 1.65	3		4.50 - 4.65	10		7.50 - 7.65	
1.65 - 1.80	4		4.65 - 4.80	11		7.65 - 7.80	
1.80 - 1.95	3		4.80 - 4.95	12		7.80 - 7.95	
1.95 - 2.10	3		4.95 - 5.10	13		7.95 - 8.10	
2.10 - 2.25	2		5.10 - 5.25	14		8.10 - 8.25	
2.25 - 2.40	2		5.25 - 5.40	14		8.25 - 8.40	
2.40 - 2.55	3		5.40 - 5.55	17		8.40 - 8.55	
2.55 - 2.70	3		5.55 - 5.70	22		8.55 - 8.70	
2.70 - 2.85	3		5.70 - 5.85	Refusal		8.70 - 8.85	
2.85 - 3.00	4		5.85 - 6.00			8.85 - 9.00	

Remarks: * Pre drilled prior to testing

SAMPLING & IN-SITU TESTING

GREEN GEOTECHNICS

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

GREEN GEOTECHNICS

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:

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

'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

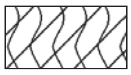

Asphalt


Road base

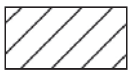

Concrete

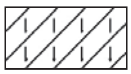

Filling

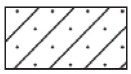
Soils


Topsoil

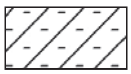

Peat


Clay

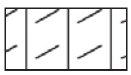

Silty clay

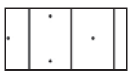

Sandy clay

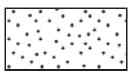

Gravelly clay

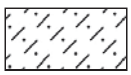

Shaly clay

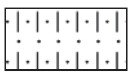

Silt


Clayey silt


Sandy silt

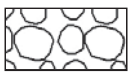

Sand

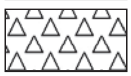

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

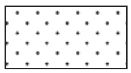

Talus

Sedimentary Rocks

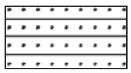

Boulder conglomerate

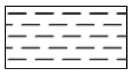

Conglomerate


Conglomeratic sandstone

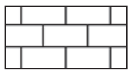

Sandstone


Siltstone

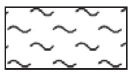

Laminite

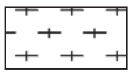

Mudstone, claystone, shale

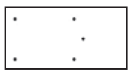

Coal


Limestone

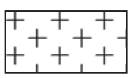
Metamorphic Rocks

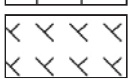

Slate, phyllite, schist

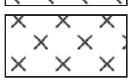

Gneiss

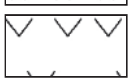

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote

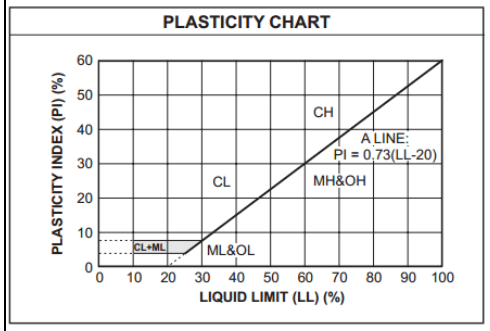

Tuff, breccia


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 Not meeting all graduation requirements for *GW* 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 Atterberg limits above "A" line with *PI* greater than 7
		Gravels with fines (appreciable amount of fines)	Predominantly one size or range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, grave-sand mixtures, little or no fines		
			Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	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 Not meeting all graduation requirements for *SW* 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 Atterberg limits above "A" line with *PI* greater than 7
			Predominantly one size or range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		
Find-grained soils More than half of the material is smaller than 75um sieve size	Identification Procedures of Fractions Smaller than 380 um Sieve Size						
	Silts and clays liquid limit less than 50	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)			
		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