TO: PINNACLE STREET PTY LTD

RE: GEOTECHNICAL INVESTIGATION

FOR: RESIDENTIAL UNIT DEVELOPMENT
10-14, 46-50 PINNACLE STREET

AT: MIRANDA

REPORT No. 15099/GK/1 Rev 0

AUGUST 2015

KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

GREG D KEIGHRAN P/L (Inc NSW) trading as
KEIGHRAN GEOTECHNICS • A.B.N. 84 073 692 387
5/25 Isabella Street North Parramatta NSW 2151
PO Box 2325 North Parramatta NSW 1750
Telephone (02) 9890 7873 • Facsimile (02) 9890 7874
E-mail gregk@gdkgeo.com

KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

Greg D. Keighran Pty Ltd (Inc NSW)

A.B.N. 84 073 692 387
P.O. Box 2325
North Parramatta NSW 1750

5/25 Isabella Street,
North Parramatta NSW 2151

Telephone: (02) 9890 7873
Facsimile : (02) 9890 7874
Email: mail@gdkgeo.com

Principal
G.D. Keighran BE P.Eng

Date 24th August 2015 Your Ref: Our Ref: 15099/GK/1

REPORT

TO : PINNACLE STREET PTY LTD
RE : GEOTECHNICAL INVESTIGATION
FOR : RESIDENTIAL UNIT DEVELOPMENT
10 -14, 46-50 PINNACLE STREET
AT : MIRANDA

SUMMARY

At the request of Pinnacle Street Pty Ltd, Keighran Geotechnics in conjunction with Sydney Geotechnics has carried out a subsurface investigation for a proposed multi-level residential unit development with basement car parking on 10-14, 46-50 Pinnacle Street at Miranda.

This report details the method of investigation and the subsurface profiles encountered. On the basis of this data, the subject properties have been assessed and design recommendations presented for the proposed residential unit development

Yours faithfully,
KEIGHRAN GEOTECHNICS
per:

G.D. KEIGHRAN
Director - Principal Engineer

TABLE OF CONTENTS

DRAWINGS

APPENDICES

1. INTRODUCTION

At the request of Pinnacle Street Pty Ltd, Keighran Geotechnics in conjunction with Sydney Geotechnics has carried out a subsurface investigation for a proposed multi-level residential unit development with basement car parking on 10-14, 46-50 Pinnacle Street at Miranda.

- to assess subsurface conditions
- provide recommendations on appropriate foundation design parameters for the proposed development
- provide recommendations on appropriate excavation , excavation support and retaining wall parameters
- check the effects of the development on the Cronulla – Sutherland Rail Line
- assess any difficulties which could be encountered during construction

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The subject property is situated on the eastern end of Pinnacle Street which loops back to the eastern side of Sylvania Road on the northern side of the railway underpass.

The properties are currently developed with six (6) residential dwellings which are to be demolished for the proposed development. The property is located at the crest of the local terrain and is close to level with no significant fall.

The adjoining properties on the western sides are similar residential dwellings to those of the subject properties and are located within about 1 to 2 metres from the common boundary. The property has frontages on three sides to Pinnacle Street and is located across the road from the Cronulla to Sutherland Railway lines to the south.

The proposed residential unit development comprises two (2) residential towers of 6 and 8 stories in height above two (2) basement car parking levels with driveway ramp centrally located on the southern side frontage. The basement is located about between 4 and 6.5 metres of the Pinnacle Street frontages and 6 metres from the common boundary with the residential properties to the west.

The basement excavation from our review of the architectural drawings by Dickson Rothschild Architects appear to be excavated to a basement floor level RL 44.7 m which ranges between 5.5 and 9.1 metres below the existing surface RL (50.2 to 53.8 m).

3. METHOD OF INVESTIGATION

The fieldwork for this investigation was carried out by Sydney Geotechnics on the 19th September 2013 and comprised:

a) Detailed site inspection and geotechnical assessment.
b) Excavation of five (5) boreholes drilled to Refusal in the weathered shale / laminite bedrock
c) Logging of the subsurface conditions by a senior technical officer from Sydney Geotechnics

The locations of the five (5) boreholes and other site features are indicated on the Drawing No. 15099/1A presented in this Report. Spiral flight augers were used to drill the bores. Classification and description of the substrata was assisted by samples obtained from the auger cuttings.

The subsurface conditions as described by Sydney Geotechnics and reviewed by our principal geotechnical engineer are detailed in the borehole logs, presented in Appendix A. The method of soil classification adopted is explained in Appendix B and an engineering classification of sedimentary rocks in the Sydney Basin in Appendix C.

4. SITE GEOLOGY AND SUBSURFACE CONDITIONS

The subject property is indicated on the Wollongong 1:100,000 Geological Sheet as being underlain by Rhs – Claystone, siltstone and laminate overlying Rh – Sandstone both from the Hawkesbury Group from the Triassic Geological Period.

The specific subsurface conditions encountered in the borehole locations on the subject properties can be summarised as follows:-

FILL:	bricks on the surface , loose to a depth of 0.2 metres in BH 3 only.
TOPSOIL:	clayey silt, dark grey, moist and loose to firm . Encountered all boreholes to a depth of 0.2 to 0.3 metres. In BH 3, FILL materials were encountered on the surface of the TOPSOIL profile to 0.4 metres.
RESIDUAL (1):	silty clay and Silty sandy clay, medium plasticity, trace ironstone, red brown, moist and stiff. Encountered below the TOPSOIL to depths ranging from 0.9 to 1.5 metres.
RESIDUAL (2):	silty sandy clay and shaley clay, light grey and some red and orange, moist and stiff to very stiff. Encountered below RESIDUAL (1) to depths of 1.7 to 2.7 metres.
BEDROCK:	shale and siltstone, extremely to highly weathered, Class V / IV, weak , low strength, grey and brown, yellow and brown, moist to dry with depth and very stiff to hard. Commencing at depths ranging from 1.7 to 2.7 metres. TC refusal was encountered at 1.7 to 2.8 metres below the existing surface.

Groundwater was not encountered in any of the boreholes.

The depths at which the above profiles were encountered in the boreholes are summarised below in Table No. 4.1.

Table No. 4.1 - Subsurface Condition Summary

Borehole	Topsoil / Fill *	Residual Silty Sandy Clays	Bedrock (Class V/IV)	TC-Bit Refusal (1000 kPa)
BH 1	0.0 – 0.2 m	0.2 – 2.5 m	2.5 – 2.6 m	2.6 m
BH 2	0.0 – 0.3 m	0.3 – 2.7 m	2.7 – 2.8 m	2.8 m
BH 3	0.0 – 0.4 m *	0.4 – 2.4 m	2.4 – 2.5 m	2.5 m
BH 4	0.0 – 0.2 m	0.2 – 1.7 m	1.7 – 1.8 m	1.8 m
BH 5	0.0 – 0.2 m	0.2 – 1.6 m	1.6 – 1.7 m	1.7 m

5. PRINCIPAL GEOTECHNICAL CONSTRAINTS

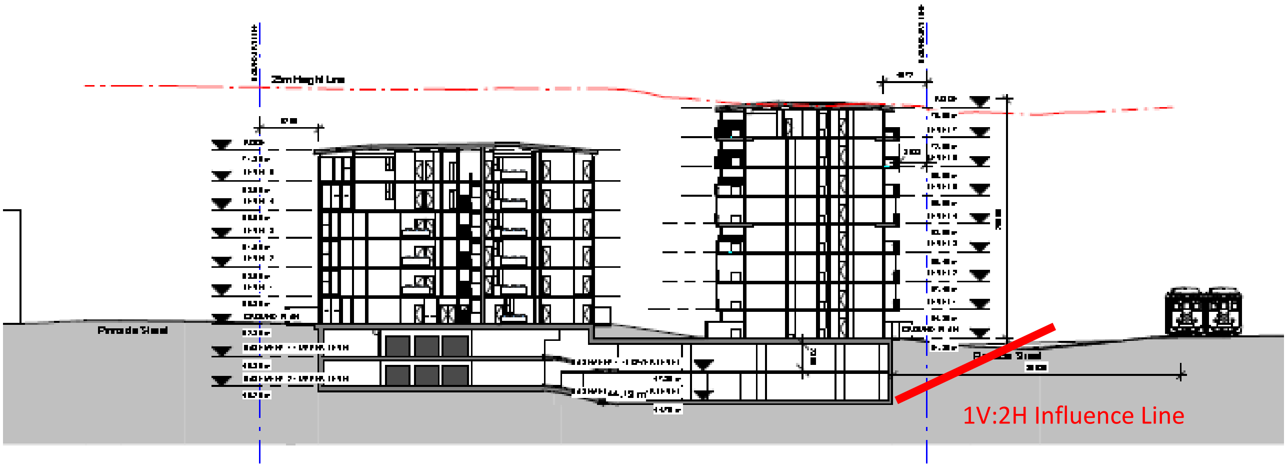
The principal geotechnical factors, which will influence the development of the property, are summarised as follows:

- Installation of support or appropriate battered slopes to the property boundaries prior to bulk excavation to limit potential distress to the adjoining structures and Rail services.
- Residual red brown silty clays grading to light grey and orange shaley clays below the surface are present to depths 1.7 to 2.8 metres below the existing surface.
- Shale / siltstone bedrock (Class V to IV) commences within 1.7 to 2.7 metres below the surface. The shale bedrock is predominantly low strength Class V/ IV to TC refusal. The strength of the shale siltstone will increase with depth and the hard sandstone strata is likely to be encountered in the excavation down to RL 44.7 metres.
- No Groundwater was not encountered in any of the boreholes.

6. RAIL CORRIDOR STABILITY AND EFFECT OF PROPOSED RESIDENTIAL UNIT DEVELOPMENT

We understand that the proposed residential Unit development will construct two (2) basement levels (RL 44.7 m – Lowest) to a depth of about 5.5 to 9.1 metres below the existing surface RL (50.2 to 53.8 m) to commencing about 3.0 to 6.4 metres from the Pinnacle Street frontages and 6 metres from the existing property boundary along the western side.

The rail corridor land commences on the opposite southern side of Pinnacle Street about 12 metres from the subject properties southern boundary and the closest rail line within the Rail Corridor is 30.689 m from the proposed basement wall as detailed in the extract from Drawing DA-304 below.



With the closest rail line located about 30.8 metres from the basement wall, the basement excavations on the southern boundary side are between 5.5 and 7.0 metres in depth will be well outside the typical 1V:2H (14 metres minimum) influence line from the closest rail line and sleepers.

Open cut / unsupported excavations may be permitted, however, the stability of Pinnacle Street which is inside within the zone of influence will require temporary / permanent support is provided to the excavation unless suitable battering of the excavation can be undertaken within the subject property boundaries. .

The residual soils overlying weathered shale bedrock which commence along the southern boundary at 1.6 to 1.7 metres below the existing surface and are typically able to be excavated to steeper than 1V:1H provided the exposed face is protected from the weather by plastic sheeting pinned to the wall and draped, lapped and pinned down to the base of the basement excavation.

The open cut method of excavation within the property boundaries will require a minimum of width of 4.02 metres of battered slope down to the base of the excavation. This can be undertaken almost wholly within the subject property boundary except for southern corner which has only 3.0 metres to the property boundary. Support will be required around the south eastern corner to remain inside the property boundaries.

We conclude that the proposed construction two (2) basement levels may be undertaken by a combination of either open cutting methods using suitable stable batter slopes or be fully supported by soldier piles with shotcrete infills. The final construction of the basement walls and the structure will permanently support the excavation and backfilled to the existing ground levels.

The proposed excavation and building construction will have **no short or long term influence on the stability of the existing rail lines** located on the opposite and on the southern side of Pinnacle Street.

7. SITE PREPARATION

We understand that the development of the subject property requires excavation up to 9.1 metres in depth to obtain the design floor level. Details for Bulk Excavation are provided in Section 8.

The buildings on the adjoining properties to the west are considered to be within the zone of influence of the bulk excavation along the western boundary which is detailed as the proposed basement floor Level of RL 44.7 m continues to 6.0 metres the common boundary.

The existing footings of the adjoining residential building are not known at this time and we recommend that the footing details for the adjoining residential buildings on the western sides are researched, otherwise, some form of excavation support will be required along this boundary prior to excavation.

8. EXCAVATION SUPPORT / RETAINING WALLS

The residual soils that will be encountered during excavation are generally fairly shallow (between 1.6 to 2.8 metres thick) in a moist and firm to stiff condition to the commencement of weathered shale / siltstone laminite bedrock. About three quarters of the bulk excavation to the design levels will be undertaken in the highly weathered shale or better bedrock.

The shale / laminite bedrock is considered to be Class V and Class IV to a depth between 1.7 to 2.8 metres and as such are readily excavated using medium to large excavator equipped with tiger teeth or a ripper tooth, medium size dozers fitted with rippers. However, we consider that hydraulic hammers will be required for the lower sections of the excavation and for in close trimming work for foundation excavations where harder shale / sandstone will be encountered. Care should be taken by assessing the effect of any vibrations on adjoining structures before hydraulic hammers are used.

Temporary excavations (where not supporting existing structures) (for construction purposes only) may be sloped back at 1H:1V (soil and extremely to highly weathered bedrock) and 0.25H:1V (moderately weathered or better quality rock).

Unsupported permanent excavations (where not supporting existing structures or services) in the in situ material and/or fill batters should be sloped back at gradients not steeper than 2H:1V (soil and extremely to highly weathered rock) and 0.5H:1V (moderately weathered rock). Steeper batters may be allowable if more competent (less weathered) bedrock is exposed and subject to inspection of the strata exposed in the excavation faces by a geotechnical engineer.

For the design of excavation support, if the proposed excavation is within the influence of structures on the adjoining property and retaining walls permanently supporting the excavated faces may be designed adopting the following earth pressure parameters.

The following soil/rock parameters are considered appropriate using a triangular stress distribution for assessing the design loads on shoring / retaining walls:-

Soil Type	Earth Pressure Coefficients			
	Active (Ka)		Passive (Kp)	Bulk Density
	Temporary	Permanent	Temporary	
Silty clay and shaley clay soils	0.4	0.5	2.5	21 kN/m^3
EW to HW, low strength Class IV shale	0.15	0.25	6.7	22 kN/m^3
MW, medium, to high strength Class III shale	0	0	200 kPa *	23 kN/m^3

* Rectangular Stress Distribution

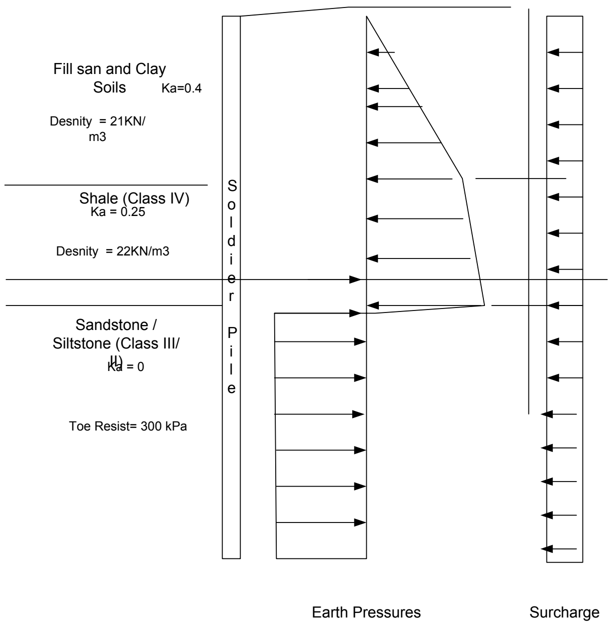


Figure No. 8.1 - Recommended Earth Pressure Stress Distribution

The retaining wall designs should also allow for any additional surcharge loads, which should be calculated separately. Appropriate drainage systems and free draining backfill should be provided to prevent the build-up of hydrostatic pressures behind all retaining walls except in the case of the shoring piles if required, which should be designed for a full hydrostatic pressure.

Appropriate drainage systems and free draining backfill should be provided to prevent the build-up of hydrostatic pressures behind all retaining walls. Backfill behind walls should be compacted to 98 % Standard Compaction with a field moisture content at +/- 2 % of the optimum moisture content where the backfill is required to support floor slabs, perimeter paths etc.

The design of anchors is to be undertaken in accordance with AS 4678 – 2002 and incorporate anchor bond lengths within the Class III shale bedrock based on a working bond strength of 500 kPa. The design should allow for effective bonding to be developed behind the active zone determined by drawing a 45 degree line from the base of the piles to intersect the ground surface behind the excavation face. The above bond strength is assumes a minimum length of 3 metres and each anchor is proof loaded to 1.3 times (temporary anchors) and 1.5 times (permanent anchors) its working load prior to locking off. Anchors and bond length are to be checked for a cone pull-out mechanism. Retaining walls are to be designed for hydrostatic pressures unless effective drainage is provided and surcharge loads should be added to the lateral earth pressures

Since the property is flanked by adjoining structures on the western side, driven and or anchor supported piles may not be a viable option depending on the support of the neighbouring owners. Excavation below the foundations of adjoining structures will require support not only to the soils but possibly to the adjoining structure. We would recommend that a dilapidation report undertaken by your structural engineer is obtained of all adjoining structures prior to the commencement of excavation works.

The above suggest values are ultimate values and incorporation of a factor of safety is necessary in the design.

9. BULK EXCAVATION

The proposed unit development is to comprise the construction of the multi storey residential unit building with two (2) levels of basement car parking being provided at about 5.5 to 9.1 metres below existing surface level.

About one quarter of the bulk excavation will be undertaken in silty or silty sandy clays soils and extremely weathered shale bedrock to the base of the excavation with the remainder in Class IV shale or better..

These silty clay and silty sandy clay soils and EW to HW shale will be readily excavated using 12 – 30 tonne excavators with a standard bucket attachments, however, the shale / sandstone bedrock in the lower three quarters of the excavation may require the use of large ripper attachments and possibly limited hydraulic hammer work where Class III shale / sandstone or better is encountered in the excavation.

The use excavating equipment close to existing structures on adjoining properties may have significant damaging effect. The extend of the effect is dependent on the frequency and amplitude of the excavation equipment, the stiffness of the underlying soil or bedrock and the distance from the structure. Other factors which need to be considered are the structures foundations and homogeneity of the founding strata. As the distance from the source increases the chance of the presence of discontinuity's in the stiffness of the strata may create a damping effect potentially reducing the vibrations felt.

Excavations of the bedrock within 6 metres of existing structures adjoining the property are to be undertaken with care and should the use of hydraulic hammers be required the Contractor is to ensure that vibrations resulting from such work are minimised and limited to a maximum peak particle velocity of about 5 mm / second at any adjoining structure.

We recommend the operation of hydraulic hammers should include:

- Excavation of loose or rippable rock blocks by bucket or single ripper attachments prior to the commencement of rock hammering;
- Saw cutting along the excavation perimeter and where ever considered necessary to minimise vibrations
- Progressive breakage from open excavated faces;
- Selective breakage along open joints where these are present;
- Use of rock hammers in short bursts to prevent generation of resonant frequencies;
- Orientation of the rock hammer pick away from property boundaries and into existing open excavation;
- The movement of large blocks away from the structures prior to breaking up for transport from the property.

However, we would recommend that the method and size of proposed excavation equipment are advised and inspected prior to excavation being undertaken to assess their possible impact.

We recommend that a dilapidation report is prepared on all adjoining structures which includes photos of the external and internal walls identifying any existing distress.

For the purposes of disposal, the existing soils and weathered bedrock have not been assessed for contamination as part of our Brief and as such a suitable qualified Environmental consultant should engaged to assess the soil and rock for disposal and their recommendations are to be followed for the disposal of the silty clay soils and weathered shale / laminite / sandstone bedrock to be excavated from the property.

10. BUILDING FOUNDATIONS

In assessing the possible foundations for the proposed building, we consider that strip / pad footings founded below the lower basement level would be suitable. We understand that the basement will be cut into the shale / sandstone bedrock and the excavated materials will be removed from the property. We consider that weathered shales / sandstone of at least Class III strength will be exposed in the lower portions of the excavation and that the proposed unit structure will be founded on the Class III or better shale / sandstone bedrock.

10.1 High Level Footing

The proposed structure may be founded on pad / strip footings. Based on the above principal geotechnical constraints, we would recommend the following allowable bearing pressure:

- 150 kPa for pad footings founded in the residual clay soils.
- 1500 kPa for pad footings founded in the Class IV / III shale / sandstone bedrock at the depth of TC-Bit refusal.
- 3500 kPa for pad footings founded in the Class III shale / sandstone bedrock below TC Refusal

Settlements and differential settlements in the order of 0 to 10 mm can be expected.

10.2 Bored Pier Foundations

We recommend that bored piers used around the perimeter of the excavation be taken to weathered shale or sandstone bedrock at the base of the basement through the natural soils and weathered rock with socket lengths at least 1.0 metres below excavation level. Based on the above principal geotechnical constraints, we would recommend the following allowable bearing pressures:

Bedrock Type and Class	Allowable Bearing Capacity	Allowable Shaft Adhesion
Class IV / III Shale (Confirmed by Inspection)	1500 kPa	150 kPa
Class III Shale / sandstone (Confirmed by inspection)	3500 kPa	300 kPa

11. CONSTRUCTION METHODOLOGY AND SEQUENCING

The following construction methodology and sequencing is anticipated and recommended during piling, bulk earthworks for the basement construction:-

- Demolition of existing structures , services and removal of vegetation with the building area
- Installation of perimeter piling where open cutting and stable batters are unsuitable to the nominated depth detailed by the structural engineering drawings
- Commencement of excavation within the basement perimeter piles / property boundaries using medium to large excavators.

- Excavation along the sections of the western side of the structure which can be open cut, is to be battered down to the basement level at the temporary slope of 1V:to 1H in the soils / Highly weathered rock and 1V to 0.25H in the Class III rock or better.

- Inspection of the excavation by an experienced geotechnical engineer when shale bedrock is encountered (between 1.7 to 2.8 metres) to assess rock strength and stability of excavation.

- Installation of vibration meters if nominated by the geotechnical engineer, (if bedrock is considered to be hard and requiring use of hydraulic hammers to excavate by above geotechnical inspection).

- Saw cutting of hard shale bedrock between perimeter wall and materials being excavated (if required by above geotechnical inspection)

- Inspection of excavation on completion of excavation to confirm bearing pressures for footing excavations

- Sign off that excavation and basement walls have been constructed to the design detailed in the structural drawings and as constructed will support adjoining properties including Rail Corridor.

12. GENERAL

Finally, it is to be noted that the recommendations in this report are based upon the information determined by the geotechnical investigation and analysis of this information by our experienced geotechnical engineers and our experience with this type of multi-level residential unit development within the Sutherland Shire.

Should the property conditions differ markedly from those predicted in this Report, of the scope of the development works vary significantly from those presently advised, further geotechnical advice should be obtained.

BH BOREHOLE LOCATION

GEOTECHNCIAL INVESTIGATION

GDK
KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

Ph : (02) 9890 7873
Fax: (02) 9890 7874

P.O. Box 2325, North Parramatta NSW 1750
5 / 25 Isabella Street, North Parramatta NSW 2151

Scale
Plan
Section
Drawn
Checked

PINNACLE STREET PTY LTD

RESIDENTIAL UNIT DEVELOPMENT
10-14 , 46-50 PINNACLE STREET
MIRANDA

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED TO CLIENT IN REPORT	AUG 2015	

Drawing No.
15099/1A

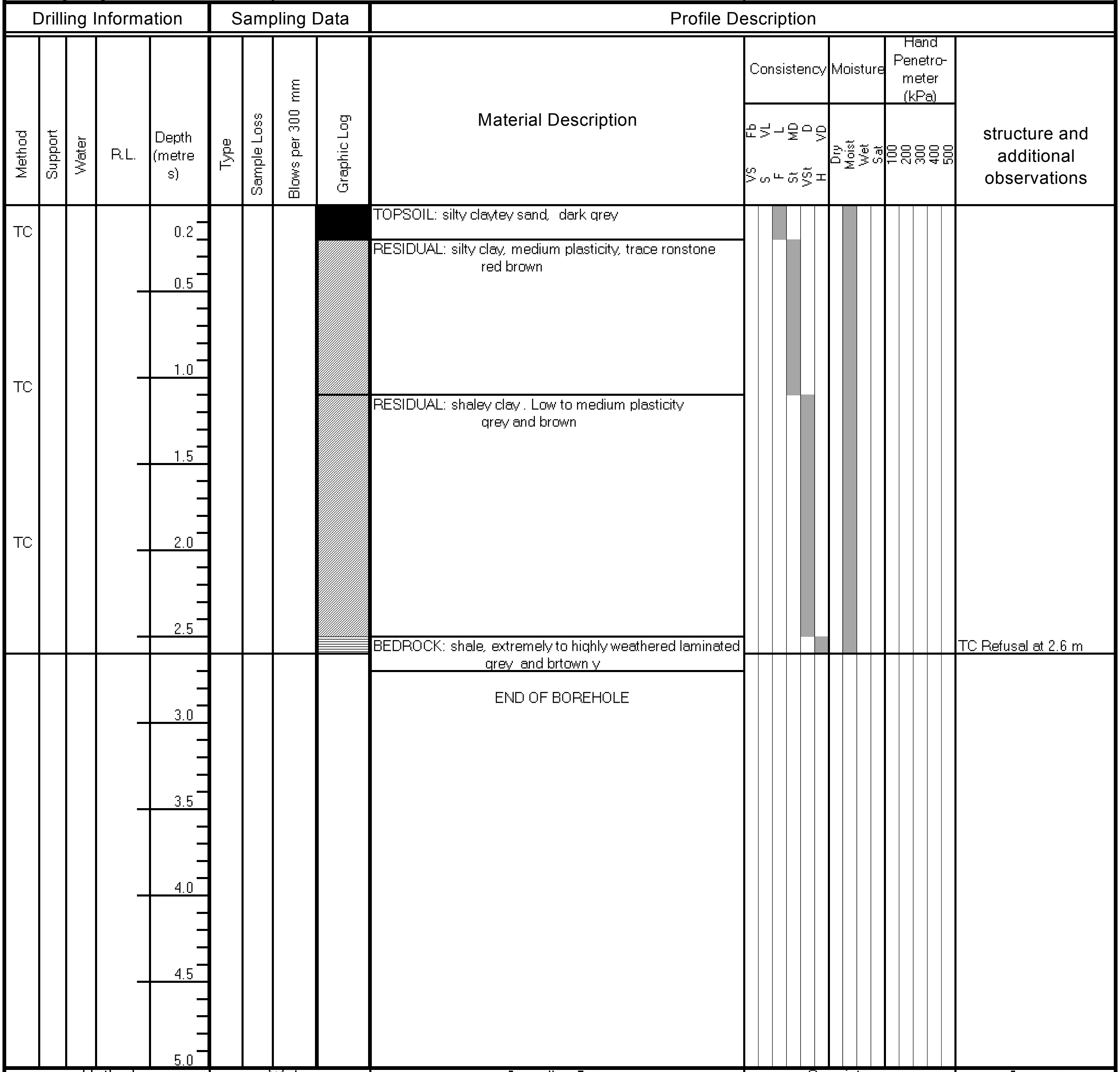
GDK
KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

BOREHOLE - ENGINEERING LOG

Ph: (02) 9890 7873
Fax: (02) 9890 7874
A.B.N. 84 073 692 3

BH 1
Sheet 1 of 1

Client:	Pinnacle Street Pty Ltd	Appendix:	**A**
Project:	Residential Unit Development - 10 - 14 & 46 -50 Pinnacle Street - Miranda	Your Reference:	
Bore Location:	Refer to Drawing No.15099/1A	Our Reference:	15099
Date Drilled:	19th September 2013	File Name:	15099bhlog.xls
Hole Commenced:		Supervised by:	SW
Hole Completed:		Checked by:	GA
Slope Deg:	Surface RL:	Drill Model:	Digga Ute Mounted
Bearing Deg:	Datum:	Hole Diameter:	100 mm



TOPSOIL: silty claytey sand, dark grey

RESIDUAL: silty clay, medium plasticity, trace ronstone
red brown

RESIDUAL: shaley clay . Low to medium plasticity
grey and brown

BEDROCK: shale, extremely to highly weathered laminated
grey and brtown y

TC Refusal at 2.6 m

END OF BOREHOLE

Method		Water	Sampling Data		Consistency				Support	
					Cohesive		Non Cohesive			
CC	Concrete Core	__/__/__ Date of Water Level	UD 50	Undisturbed Sample 50 mm diameter	VS	Very Soft	Fb	Friable	C	Casing
V	Auger with V-Bit				S	Soft	VL	Very Loose	M	Mud
TC	Auger with TC-Bit				F	Firm	L	Loose		
R	Roller / Tricone	▼ Static Water Table	D	Disturbed Sample	St	Stiff	MD	Medium Dense		
W	Washbore	▶ Water Inflow	SPT	Standard Penetration Test	VSt	Very Stiff	D	Dense		
M	Mud Drilling	◁ Partial Water Loss	Nc	Cone Penetrometer	H	Hard	VD	Very Dense		
A	Air Reverse Circulation	◀ Drilling Water Loss								
HFA	Hollow Flight Auger									

KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

BOREHOLE - ENGINEERING LOG

Ph: (02) 9890 7873
Fax: (02) 9890 7874
A.B.N. 84 073 692 3

BH 2
Sheet 1 of 1

Client:	Pinnacle Street Pty Ltd	Appendix:	**A**
Project:	Residential Unit Development - 10 - 14 & 46 -50 Pinnacle Street - Miranda	Your Reference:	
Bore Location:	Refer to Drawing No.15099/1A	Our Reference:	15099
Date Drilled:	19th September 2013	File Name:	15099bhlog.xls
Hole Commenced:		Supervised by:	SW
Hole Completed:		Checked by:	GA
Slope Deg:	Surface RL:	Drill Model:	Digga Ute Mounted
Bearing Deg:	Datum:	Hole Diameter:	100 mm

Drilling Information					Sampling Data				Profile Description				
Method	Support	Water	R.L.	Depth (metres)	Type	Sample Loss	Blows per 300 mm	Graphic Log	Material Description	Consistency VS S F St VSt H Fb VL L MD D VD	Moisture Dry Moist Wet Sat	Hand Penetrometer (kPa) 100 200 300 400 500	structure and additional observations
TC				0.6				■	TOPSOIL: silty claytey sand, dark grey	F	Moist		
				0.5 0.6				▨	RESIDUAL: silty clay, medium plasticity, trace ronstone red brown	St	Moist		
TC				1.0 1.5				▨	RESIDUAL: silty sandy clay . medium plasticity red brown and grey	St	Moist		
TC				2.0 2.5 2.7				▨	RESIDUAL: shaley clay . Low to medium plasticity grey and brown	VSt	Moist		
								☰	BEDROCK: shale, extremely to highly weathered laminated grey and brtown y	H	Moist		TC Refusal at 2.8 m
				3.0 3.5 4.0 4.5 5.0					END OF BOREHOLE				

Method		Water	Sampling Data		Consistency				Support	
CC	Concrete Core	__/__/__ Date of Water Level	UD 50	Undisturbed Sample 50 mm diameter	Cohesive		Non Cohesive		C	Casing
V	Auger with V-Bit				VS	Very Soft	Fb	Friable	M	Mud
TC	Auger with TC-Bit				S	Soft	VL	Very Loose		
R	Roller / Tricone	▼ Static Water Table	D	Disturbed Sample	F	Firm	L	Loose		
W	Washbore	▶ Water Inflow	SPT	Standard Penetration Test	St	Stiff	MD	Medium Dense		
M	Mud Drilling	◁ Partial Water Loss	Nc	Cone Penetrometer	VSt	Very Stiff	D	Dense		
A	Air Reverse Circulation	◀ Drilling Water Loss			H	Hard	VD	Very Dense		
HFA	Hollow Flight Auger									

GDK
KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

BOREHOLE - ENGINEERING LOG

Ph: (02) 9890 7873
Fax: (02) 9890 7874
A.B.N. 84 073 692 3

BH 3
Sheet 1 of 1

Client:	Pinnacle Street Pty Ltd	Appendix:	**A**
Project:	Residential Unit Development - 10 - 14 & 46 -50 Pinnacle Street - Miranda	Your Reference:	
Bore Location:	Refer to Drawing No.15099/1A	Our Reference:	15099
Date Drilled:	19th September 2013	File Name:	15099bhlog.xls
Hole Commenced:		Supervised by:	SW
Hole Completed:		Checked by:	GA
Slope Deg:	Surface RL:	Drill Model:	Digga Ute Mounted
Bearing Deg:	Datum:	Hole Diameter:	100 mm

Drilling Information					Sampling Data				Profile Description				
Method	Support	Water	R.L.	Depth (metres)	Type	Sample Loss	Blows per 300 mm	Graphic Log	Material Description	Consistency (VS Fb / S VL / F L / St MD / VSt D / H VD)	Moisture (Dry / Moist / Wet / Sat)	Hand Penetrometer (kPa) (100 / 200 / 300 / 400 / 500)	structure and additional observations
TC								■	FILL: loose bricks on surface TOPSOIL: silty claytey sand, dark grey	F L	Moist		
				0.4 0.5				▨	RESIDUAL: silty clay, medium plasticity, trace ronstone red brown	St MD	Moist		
TC				1.0						VSt D (from about 1.1)			
				1.4 1.5				▨	RESIDUAL: silty sandy clay . medium plasticity red brown and grey	VSt D	Moist		
TC				2.0									
				2.2				▨	RESIDUAL: shaley clay . Low to medium plasticity grey and brown	VSt D	Moist		
				2.5				▤	BEDROCK: shale, extremely to highly weathered laminated grey and brtown	H VD	Moist		TC Refusal at 2.5 m
									END OF BOREHOLE				
				3.0									
				3.5									
				4.0									
				4.5									
				5.0									

Method		Water	Sampling Data		Consistency				Support	
CC	Concrete Core	_/_/_ Date of Water Level	UD 50	Undisturbed Sample 50 mm diameter	Cohesive		Non Cohesive		C	Casing
V	Auger with V-Bit				VS	Very Soft	Fb	Friable	M	Mud
TC	Auger with TC-Bit				S	Soft	VL	Very Loose		
R	Roller / Tricone	▼ Static Water Table	D	Disturbed Sample	F	Firm	L	Loose		
W	Washbore	▶ Water Inflow	SPT	Standard Penetration Test	St	Stiff	MD	Medium Dense		
M	Mud Drilling	◁ Partial Water Loss	Nc	Cone Penetrometer	VSt	Very Stiff	D	Dense		
A	Air Reverse Circulation	◀ Drilling Water Loss			H	Hard	VD	Very Dense		
HFA	Hollow Flight Auger									

KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

BOREHOLE - ENGINEERING LOG

Ph: (02) 9890 7873
Fax: (02) 9890 7874
A.B.N. 84 073 692 3

BH 4
Sheet 1 of 1

Client:	Pinnacle Street Pty Ltd	Appendix:	**A**
Project:	Residential Unit Development - 10 - 14 & 46 -50 Pinnacle Street - Miranda	Your Reference:	
Bore Location:	Refer to Drawing No.15099/1A	Our Reference:	15099
Date Drilled:	19th September 2013	File Name:	15099bhlog.xls
Hole Commenced:		Supervised by:	SW
Hole Completed:		Checked by:	GA
Slope Deg:	Surface RL:	Drill Model:	Digga Ute Mounted
Bearing Deg:	Datum:	Hole Diameter:	100 mm

Drilling Information					Sampling Data				Profile Description	Consistency						Moisture				Hand Penetrometer (kPa)					
Method	Support	Water	R.L.	Depth (metres)	Type	Sample Loss	Blows per 300 mm	Graphic Log	Material Description	VS Fb	S VL	F L	St MD	VSt D	H VD	Dry	Moist	Wet	Sat	100	200	300	400	500	structure and additional observations
TC				0.2				■	TOPSOIL: silty claytey sand, dark grey			▨					▨								
				0.5				▨	RESIDUAL: silty clay, medium plasticity, trace ronstone red brown becoming grey with depth				▨				▨								
TC				1.0				▨					▨				▨								
				1.5				▨					▨				▨								
TC				1.7				▨	RESIDUAL: shaley clay . Low to medium plasticity red brown and grey					▨			▨								
				1.8				▤	BEDROCK: siltstone , highly weathered laminated pale yellow brown						▨		▨								TC Refusal at 1.8 m
				2.0					END OF BOREHOLE																
				2.5																					
				3.0																					
				3.5																					
				4.0																					
				4.5																					
				5.0																					

Method		Water	Sampling Data		Consistency				Support	
					Cohesive		Non Cohesive			
CC	Concrete Core	__/__/__ Date of Water Level	UD 50	Undisturbed Sample 50 mm diameter	VS	Very Soft	Fb	Friable	C	Casing
V	Auger with V-Bit				S	Soft	VL	Very Loose	M	Mud
TC	Auger with TC-Bit	▼ Static Water Table			F	Firm	L	Loose		
R	Roller / Tricone	▶ Water Inflow	D	Disturbed Sample	St	Stiff	MD	Medium Dense		
W	Washbore	◁ Partial Water Loss	SPT	Standard Penetration Test	VSt	Very Stiff	D	Dense		
M	Mud Drilling	◀ Drilling Water Loss	Nc	Cone Penetrometer	H	Hard	VD	Very Dense		
A	Air Reverse Circulation									
HFA	Hollow Flight Auger									

KEIGHRAN GEOTECHNICS
Geotechnical • Pavements • Materials • Consulting Engineers

BOREHOLE - ENGINEERING LOG

Ph: (02) 9890 7873
Fax: (02) 9890 7874
A.B.N. 84 073 692 3

BH 5
Sheet 1 of 1

Client:	Pinnacle Street Pty Ltd	Appendix:	**A**
Project:	Residential Unit Development - 10 - 14 & 46 -50 Pinnacle Street - Miranda	Your Reference:	
Bore Location:	Refer to Drawing No.15099/1A	Our Reference:	15099
Date Drilled:	19th September 2013	File Name:	15099bhlog.xls
Hole Commenced:		Supervised by:	SW
Hole Completed:		Checked by:	GA
Slope Deg:	Surface RL:	Drill Model:	Digga Ute Mounted
Bearing Deg:	Datum:	Hole Diameter:	100 mm

Drilling Information					Sampling Data				Profile Description				
Method	Support	Water	R.L.	Depth (metres)	Type	Sample Loss	Blows per 300 mm	Graphic Log	Material Description	Consistency (VS Fb / S VL / F L / St MD / VSt D / H VD)	Moisture (Dry / Moist / Wet / Sat)	Hand Penetrometer (kPa) (100 / 200 / 300 / 400 / 500)	structure and additional observations
TC				0.2				■	TOPSOIL: silty claytey sand, dark grey	F	Moist		
				0.5 0.9				▨	RESIDUAL: silty clay, medium plasticity, trace ronstone red brown becoming grey with depth	St	Moist		
TC				1.0 1.5				▨	RESIDUAL: silty sandy clay . medium plasticity red brown and grey	St	Moist		
TC				1.7				☰	RESIDUAL: shaley clay . Low to medium plasticity red brown and grey	VSt H	Moist		TC Refusal at 1.7 m
								☰	BEDROCK: siltstone , highly weathered laminated pale yellow brown				
				2.0 2.5 3.0 3.5 4.0 4.5 5.0					END OF BOREHOLE				

Method		Water	Sampling Data		Consistency				Support	
					Cohesive		Non Cohesive			
CC	Concrete Core	_ / _ / _ Date of Water Level	UD 50	Undisturbed Sample 50 mm diameter	VS	Very Soft	Fb	Friable	C	Casing
V	Auger with V-Bit				S	Soft	VL	Very Loose	M	Mud
TC	Auger with TC-Bit	▼ Static Water Table	D	Disturbed Sample	F	Firm	L	Loose		
R	Roller / Tricone	▶ Water Inflow	SPT	Standard Penetration Test	St	Stiff	MD	Medium Dense		
W	Washbore	◁ Partial Water Loss	Nc	Cone Penetrometer	VSt	Very Stiff	D	Dense		
M	Mud Drilling	◀ Drilling Water Loss			H	Hard	VD	Very Dense		
A	Air Reverse Circulation									
HFA	Hollow Flight Auger									

The method of soil classification adopted is based on that presented in AS1726. Unless specific detailed testing has been undertaken, the soil descriptions in this report are based on visual assessment and are hence subjective interpretations.

1. PRIMARY CLASSIFICATION (based on the predominant particle size within the soil mass)

A. **Coarse Grained Soils**. ie. more than half the soil has particles larger than 0.075mm.

GRAVELS : more than half the coarse fraction is larger than 2.36mm. Gravels are further subdivided into fine (2.36 to 6mm), medium (6 to 20mm) and coarse (20 to 63mm). Particles larger than 63mm minimum dimension are called COBBLES and larger than 200mm are called BOULDERS.

SANDS : more than half of the coarse fraction is smaller than 2.36mm. Sands are further subdivided into fine (0.075 to 0.2mm), medium (0.2mm to 0.6mm) and coarse (0.6 to 2.36mm).

B. **Fine Grained Soils**. ie. more than half the soil has particles smaller than 0.075mm.

SILTS : particles range from 0.075mm to 0.002mm particles can be felt but not seen.

CLAYS : particles smaller than 0.002mm, which can be neither felt nor seen.

2. SECONDARY CLASSIFICATION

A. **Coarse Grained Soils** are described as either **Well Graded** (having good representation of all particles sizes), **Poorly Graded** (one or more intermediate sizes poorly represented or absent) or **Uniform** (particles all of one size).

In addition gravels and sands may have a proportion of their composition comprising clays and/or silts. When this occurs, the "trace" denotes less than 5 per cent of the total soil, "with clay/silt" denotes 5 to 12 percent of the total soil and the use of the prefix "silty" or "clayey" (as applicable) denotes greater than 12 per cent of the soil mass.

B. **Fine Grained Soils**: The plasticity of fine grained soils is denoted and defined as follows:-

low plasticity	liquid limit less than 35 percent
intermediate or medium plasticity	liquid limit from 35 to 50 percent
high plasticity	liquid limit greater than 50 percent

In addition, clays and silts may have proportion of sands or gravels in their composition. "Trace" denotes less than 15 percent coarse fraction and "with sand / gravel" denotes 15 to 30 percent coarse fraction. When the coarse fraction exceeds 30 percent, "sandy" or "gravelly" are used as a prefix.

3. CONDITION OF SOIL : the condition of the soil may be described in the following terms:-

Moisture condition : is described by the appearance and feel of the soil using one of the following terms:

'Dry' - looks and feels dry; cohesive soils usually hard, powdery or friable, granular soils run freely through the hands.

'Moist' - soil feels cool, darker in colour, granular soils tend to cohere, cohesive soils usually weakened by remoulding

'Wet' - as for moist but free water form on hands when handling.

Consistency of cohesive soils

Term	Undrained Shear Strength	General Guide To Consistency
Very soft	less than 12 kPa	Exudes between the fingers when squeezed in hand
Soft	12 to 25 kPa	Can be moulded by light finger pressure
Firm	25 to 50 kPa	Can be moulded by strong finger pressure
Stiff	50 to 100 kPa	Cannot be moulded by fingers and indented by thumb
Very Stiff	100 to 200 kPa	Can be indented by thumb nail
Hard	greater than 200 kPa	Can be indented with difficulty by thumb nail

Relative Density of cohesionless soils: The consistency of an essentially cohesionless soil is described in terms of the density index, as defined in AS 1289.A1 which requires some form of test on an undisturbed or in situ sample. Normally a penetration test (SPT, Scala or Dutch Cone) is used in conjunction with published correlation tables.

Term	Density Index	Field Guide To Consistency
Very loose	less than 15%	Ravels
Loose	15 to 35%	Shovels easily
Moderately Dense	36 to 65%	Shovelling difficult
Dense	66 to 85%	Pick required
Very dense	greater than 85%	Picking difficult

4. STRUCTURE OF SOIL : the following aspects of structure may be noted:-

a) Zoning : A soil may consist of separate zones of different properties. A 'Layer' is a continuous zone across an exposure. A 'Lens' is a discontinuous layer of different material, with lenticular shape. A 'Pocket' is an irregular inclusion of different material. The boundaries of the zones are described as 'sharp regular', 'sharp irregular' or 'gradual'.

b) Defects: Such as fissures or surfaces along which the soil breaks easily, root holes etc.

c) Cementing : Coarse grained soils or defects within soils may be cemented together by various agencies. If the cementing agent allows the particle aggregation to be easily fractured by hand when the soil is saturated it is described as 'weakly cemented'. If the cementing agent prevents fracturing by hand of the particle aggregations when saturated, the soil has assumed rock properties which are described according to the system adopted for classification of rocks.

5. ORIGIN

An attempt is made, where possible, to assess origin (fill, alluvial, residual, colluvial etc.) since this assists in the judgement of probable engineering behaviour. This assessment is generally restricted to field logging activities. An interpretation of landform is a useful guide to the origin of transported soils (eg. talus, slide debris, slope wash, alluvial, lacustrine, estuarine, aeolian and littoral deposits) while local geology and remnant fabric will assist identification of residual soils.

ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS IN THE SYDNEY AREA APPENDIX C

(from Australian Geomechanics Journal 1975)

This classification system provides a standardised terminology for the engineering description of the sandstone and shales in the Sydney Area, but the terms and definitions may be used elsewhere when applicable. Under this system rocks are classified by rock type, degree of weathering, strength, stratification spacing, and degree of fracturing. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc.) where these are relevant.

ROCK TYPE DEFINITIONS

Rock Type	Definition
Conglomerate	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments.
Sandstone	More than 50% of the rock consists of sand sized (.06 to 2mm) grains.
Siltstone	More than 50% of the rock consists of silt-sized (less than .06mm) granular particles and the rock is not laminated.
Claystone	More than 50% of the rock consists of clay or scricitic material and the rock is not laminated.
Shale	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated.

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

DEGREE OF WEATHERING

Term	Symbol	Definition
Extremely	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. Weathered it can be remoulded and can be classified according to the Unified Classification System but the texture of the original is still evident.
Highly	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects Weathered the whole of weathered substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole. Weathered of the rock weathered substance and the original colour of the fresh rock is no longer recognisable.
Slightly	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the Weathered rock substance usually by limonite has taken place. The colour and texture of the fresh recognisable.
Fresh	Fr	Rock substance unaffected by weathering.

DEGREE OF FRACTURING

The classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks.

Type	Description
Fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter.
Highly fractured	Core lengths are generally less than 20mm - 40mm with occasional fragments.
Fractured	Core lengths are mainly 30mm - 100mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300mm - 1000mm with occasional longer sections and occasional sections 100mm - 300mm.
Unbroken	The core does not contain any fracture.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics (1972).

Term	IS(50) MPa
Extremely weak	
	0.03
Very Weak	
	0.1
Weak	
	0.3
Medium Strong	
	1.0
Strong	
	3.0
Very Strong	
	10.0
Extremely strong	

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

Geotechnical engineering is based extensively on judgement and opinion. It is far less exact than other design disciplines.
Geotechnical engineering reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client or his representative. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. No individual other than the client should apply this report for its intended purpose without seeking additional geotechnical advice. No person should apply this report for any purpose other than that originally contemplated without first conferring with this firm.

1. This Geotechnical Report is based on project-specific factors

This geotechnical engineering report is based on a subsurface investigation which was designed for project-specification factors, including the nature of the structure, its size and configuration, the location of the structure on the site and its orientation, the location of access roads and parking areas. Unless further geotechnical advice is obtained this geotechnical engineering report should not be used:

* when the nature of the proposed structure is changed
* when the size or configuration of the proposed structure is modified
* for application to an adjacent site

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

2. The Limitations of Geotechnical Investigation

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points where samples are taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations, however this often does not result in any cost savings for the project. Unless otherwise specified in this report, the investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form a geological model and an engineering opinon is rendered about overall subsurface conditions and their likely behaviour with regard to proposed development. Despite thorough investigation the actual conditions at the site may differ from those inferred to exist, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs should not be regarded as definitive statements of subsurface conditions at a particular location. They are in fact the subjective interpretation of trained personnel and are limited by the method of investigation. For example, inspection of an excavation or test pit alllows greater area of the subsurface profile to be inspected than borehole investigation however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

3. Subsurface conditions are time dependent

Subsurface conditions may be modified by changing natural forces or man-made influences. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.

Construction operations at or adjacent to the site and natural events such as floods, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

4. Avoid misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

5. Boring logs should not be separated from the engineering report

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings.To minimise the likelihood of boring log misinterpretation, contractors should be given ready access to the complete geotechnical engineering report prepared or authorized for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by The Institution of Engineers Australia, National Headquarters, Canberra, 1987.

6. Geotechnical Involvement During Construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problem as if they arise.