REPORT

TO

BERACI PTY LTD

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED MIXED USE DEVELOPMENT

AT

171-189 PARRAMATTA ROAD, GRANVILLE, NSW

16 August 2004 Ref: 18756SPrpt

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

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1 INTRODUCTION

This report presents the results of a *geotechnical investigation* for a proposed mixed use development at 171-189 Parramatta Road, Granville, NSW. The investigation was commissioned by George Andary & Company Pty Ltd on behalf of Beraci Pty Ltd in a facsimile message dated 13 July 2004.

The final details of the proposed development are not yet known, however we understand it will comprise one or two levels of basement carparking with ground floor retail space and residential units to a maximum height of 10 levels above ground.

The purpose of the investigation was to obtain geotechnical information on the subsurface conditions, and to use this as a basis for our comments and recommendations on excavation, shoring, dewatering and footing design.

An environmental site screening was completed by Environmental Investigation Services (EIS), a division of Jeffery and Katauskas Pty Ltd, and the results will be provided in their report E18756F dated August 2004.

2 INVESTIGATION PROCEDURE

The fieldwork for the *investigation comprised the drilling* of twelve boreholes with a track mounted JK250 rig and a truck mounted JK550 drilling rig. Seven of these boreholes were drilled for environmental sampling to a depth of 1.5m. One Additional borehole was drilled to 0.6m depth with a hand auger, also for *environmental sampling*.

The remaining five boreholes (BH1, BH6, BH10, BH11 and BH13) were drilled primarily for geotechnical purposes and comprised spiral augering to nominal penetration into the better quality shale, then diamond coring of the shale bedrock with between 2.6m and 3.1m of core recovered from each location. Final depth for these geotechnical boreholes ranged from 11.5m to 13.1m below the existing site levels.

The fieldwork was completed in the full-time presence of a geotechnical engineer who nominated the sampling and testing locations and compiled the borehole logs. The borehole locations, as shown on the attached Figure 1, were set out by taped measurements from the apparent site boundaries. The borehole logs are also attached, together with a glossary of the terms and symbols used in the logs.

The soil strengths were assessed from the recorded SPT 'N' values and hand penetrometer tests completed on clayey samples recovered from the SPT sampler. In the environmental sampling boreholes, the soil strengths were assessed from examination of the samples.

The strength of the shale was initially assessed from the examination of the recovered rock cuttings and core. The strength of the shale was later confirmed by correlation from the results of moisture content tests completed on the cuttings and Point Load Strength Index tests completed on the core. These tests were completed in a NATA registered laboratory. The results of the moisture content and Point Load Strength Index tests are summarised in the attached Tables A and B. The core was also photographed in the laboratory and copies of the photos are provided with the borehole logs.

For further details of the investigation techniques adopted, reference should be made to the attached Report Explanation Notes.

3 RESULTS OF INVESTIGATION

3.1 Site Description

The site is located in a relatively flat region with surface slopes less than about 2°. The site contains two showrooms of one and two storeys, and these appear to be in good condition. There is an asphaltic concrete car park in good condition to the east of these buildings.

Residential buildings are located in the north-eastern portion of the site and there is a concrete car park in poor condition in the central north part of the site.

The remainder of the site comprises an open yard for the storage of scaffold equipment. There are stockpiles of rubble and timber on this portion of the site.

The site is bounded to the north and south by Victoria Street and Parramatta Road respectively. There is a two storey brick building to the east of the site which appears in good condition, and this extends to the common boundary.

Duke Street, which may be incorporated with the development, is located to the west of the site, and the Main Western Railway Line is on the far side of the road. The railway is located on an embankment about 3m to 4m above the site level, with the embankment comprising a 25° batter over a 2m concrete retaining wall; the retaining wall appears to be in good condition.

Adjacent to the south-west corner of the site is a fenced Sydney Water compound. It appears there is an in-ground pump station within that property.

3.2 Subsurface Conditions

The boreholes have disclosed a subsurface profile comprising a relatively thin fill layer over silty clays which in turn overlie shale bedrock. The more pertinent features of the materials encountered are described below. For details of the strata at each borehole, reference should be made to the borehole logs. A graphical summary of the strata encountered is presented in Figure 2.

Fill

Concrete pavements were encountered in BH6, BH10 and BH11 where they had thickness ranging from 100mm to 140mm. In BH11 there was a second slab with about 0.2m of sand fill between the slabs.

The fill was generally either silty clay or gravelly clay with varying proportions of ash, slag and concrete fragments. The fill extended to depths ranging from 0.2m to 0.7m.

Silty Clay

Natural silty clay was encountered below the fill in all boreholes. The silty clay ranged from stiff and very stiff strength (with moisture content above its plastic limit) to hard (with moisture content below its plastic limit). In general, the lower strength clays were toward the eastern end of the site. The silty clays were of medium and high plasticity.

Shale Bedrock

Shale bedrock was encountered at depths ranging from 6.8m to 9.2m below the existing surface levels. The shale was initially of extremely low strength, improving to medium strength at penetrations ranging from 0.4m to 1.6m into the shale. There were occasional bands of shale which were shown by the Point load Strength tests to be borderline medium and high strength.

Groundwater

Slight groundwater seepage was noted in the deeper boreholes, except BH6, at depths from 6.5m to 8.6m below the existing site levels. The boreholes were dry on the completion of augering, though the introduction of flush water from the coring precluded further useful measurements of groundwater levels. A PVC standpipe was installed in a borehole augered to 7.5m depth adjacent to BH6. The water level after about 24 hours was at a depth of 5.1m below the ground surface level.

Laboratory Test Results

The laboratory test results correlated reasonably well with the field logging assessments of rock strength.

4 COMMENTS AND RECOMMENDATIONS

At the time of preparation of this report, the final details of the development were not known. We have therefore provided generalised recommendations for commercial and residential buildings to ten levels with either one or two levels of basement car parking. Some further information may be required at a later dated when the firm details of the development are known.

4.1 Excavation and Retention

We understand that the proposed basement will extend to the site boundaries, and could range in depth from 3m for one basement to possibly 7m or so for 2 levels of basement. Such excavation will extend through the soils, and possibly into the upper shale for the deeper excavation.

The soil and shale of extremely low strength should be readily excavated using conventional hydraulic excavators, while shale to low strength should be rippable for

30 tonne excavators fitted with ripping tynes. Hydraulic rock breaker attachments will be required for shale of low to medium strength or better.

If the design changes so that the basement will not extend to the site boundaries, temporary batters may be formed at 1V in 1H provided their height does not exceed 4m, though excavation should not extend below a line drawn downward at 1V in 2H from the footings of adjacent structures. Higher batter should not exceed 1V in 1.5H.

Where this cannot be accommodated, it will be necessary to install a shoring system prior to the commencement of excavation. Where there are structures within a distance of twice the depth of excavation from the perimeter of the excavation, the shoring should be designed for a trapezoidal earth pressure distribution with a maximum magnitude of lateral earth pressure of 8H kPa, where H is the depth of excavation in metres. A magnitude of earth pressure of 6H kPa may be adopted where there are no settlement sensitive structures or services within the zone of influence of the excavation. The design should adopt these maximum earth pressures over the central 60% of the depth of excavation, tapering to zero at the crest and toe of the excavation. Appropriate surcharge loads and hydrostatic pressures are additional to the above.

We presume the temporary lateral restraint will be provided by either braces or anchors. If anchors are adopted, they will extend beyond the boundary and it will be necessary to obtain permission from the owners of the adjacent properties prior to installing the anchors. Anchors in shale of at least extremely low and medium strength may be designed for allowable bond values of 60kPa and 200kPa respectively. Anchors should have minimum free length and bond lengths of 4m and 3m respectively.

Where there will be only one basement level, the excavation will be above the groundwater level and so it would be feasible to use contiguous piles where there are adjoining structures or settlement sensitive services, with soldier piles and reinforced shotcrete infill panels elsewhere.

Where the basement will be two levels, this would extend below the water table (currently at a depth of about 5m but quite possibly higher following wet weather). This will result in difficulties during construction (seepage through pile walls, softened soils or heave in the basement etc) as well as long-term drainage issues. The current policy of the Department of Infrastructure, Planning and Natural Resources (DIPNR) is that permanent dewatering is not sustainable and not allowable. Our understanding is that developments below the water table are designated 'integrated developments' which have more complex planning approval processes.

If a two level basement is adopted, a secant pile wall should be adopted around the perimeter of the excavation. This secant pile wall should be socketed at least 1.0m into shale and may be used as part of the perimeter footing system. The secant pile wall will significantly reduce inflows during construction, though some dewatering using sumps and pumps is likely to be necessary.

In the long term, it will be necessary to either tank the basement which will result in potential uplift pressures from the groundwater, or incorporate long term drainage (drainage may be allowed when combined with a secant pile cutoff wall). If the basement is tanked, it will be important to have a pressure relief system to counter possible rises in groundwater level beyond a design threshold.

4.2 Footing Design

The clayey soils are of variable strength, ranging from stiff to hard, and so high level footings founded within the soils are not recommended for the support of the proposed development. All footings must therefore be founded on the shale bedrock.

Where there will be two basement levels, with excavation to possibly 7m below the existing ground levels, shale bedrock is likely to be close to the basement excavation level, and so pad and strip footings founded on the shale would be feasible over most of the site. There will however be some areas, such as near BH1 in the north-west part of the site, where the pad footings would need to be relatively deep. It would be possible to have a mixture of pad footings where the shale is shallow and piled footings elsewhere.

If there is only one basement level, it will be necessary to used piled footings.

Where piles or pad footings are founded with a nominal embedment of 0.3m into shale, they may be designed for an allowable bearing pressure of 700kPa, while the allowable bearing pressure could be increased to 1000kPa for nominal sockets into low strength shale.

The better quality, medium strength, dark grey shale would provide a much better foundation and footings founded on this may be designed for an allowable bearing pressure of 3500kPa. Sockets into the medium strength shale may be designed for an allowable shaft adhesion of 350kPa provided the sockets are clean and rough. For these load bearing sockets, it will be necessary to use a sidewall grooving tool following the initial drilling. The use of such equipment is not standard practice in Sydney and so the use of grooving tools should be nominated on the structural drawings should load bearing sockets be adopted.

installed around the perimeter of the basement, as well as on a grid or herringbone pattern through the basement area.

5 GENERAL COMMENTS

The construction of basements in soils below or near the water table can be quite complex and so we recommend that a meeting be held with the geotechnical engineers and the rest of the design team at an early stage of the preliminary design to discuss issues of shoring, dewatering and basement tanking. Only experienced contractors should be considered for construction.

The subsurface soil conditions between the completed boreholes 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.

The offsite disposal of soil may require classification in accordance with the EPA guidelines as inert, solid, industrial or hazardous waste. We can complete the necessary classification and testing if you wish to commission us. As testing requires about seven days to complete, allowance should be made for such testing in the construction programme unless testing is completed prior to construction. If contamination is found to be present then substantial further testing and delays should be expected.

If there is any change in the proposed development described in this report then all recommendations should be reviewed.

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. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. 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.

Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

P. Wright

P Wright
Associate

Reviewed by:

P. Wright
per

P Stubbs
Principal
For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD

Soil Test Services Pty Ltd
ABN 43 002 145 173
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SOIL TEST SERVICES

TABLE A
SUMMARY OF MOISTURE CONTENT TEST RESULTS

AS 1289 TEST METHOD 2.1.1

BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %
6	8.80-9.00	4.2
13	7.00-7.50	8.6

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SOIL TEST SERVICES

TABLE B
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
1	10.18-10.22	0.6	12
	10.87-10.91	0.7	14
	11.17-11.21	0.8	16
	11.80-11.84	0.6	12
	12.16-12.20	0.4	8
	12.74-12.77	0.5	10
	13.00-13.06	0.5	10
6	9.35-9.38	1.0	20
	9.86-9.90	0.6	12
	10.32-10.35	0.5	10
	10.78-10.81	0.7	14
	11.16-11.20	0.8	16
	11.75-11.79	0.5	10
	12.18-12.21	0.7	14
10	9.08-9.12	0.7	14
	9.75-9.78	0.7	14
	10.18-10.22	0.5	10
	10.77-10.81	0.7	14
	11.16-11.19	0.6	12
	11.77-11.81	0.4	8
11	8.88-8.91	0.5	10
	9.16-9.20	1.2	24
	9.89-9.91	0.6	12
	10.24-10.27	0.9	18
	10.86-10.89	0.9	18
	11.26-11.29	0.6	12

NOTES: **SEE PAGE 2**

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SOIL TEST SERVICES

TABLE B
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
13	9.24-9.27	0.7	14
	9.87-9.89	1.0	20
	10.25-10.28	0.6	12
	10.78-10.81	0.7	14
	11.16-11.19	0.6	12
	11.90-11.93	0.5	10

NOTES:

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RTA T223.
4. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :
   U.C.S. = 20 $I_{S(50)}$

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Borehole No. 1

1/3

BOREHOLE LOG

Client: BERACI PTY LTD

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP **Method:** SPIRAL AUGER JK550 **R.L. Surface:**

Date: 28-7-04 **Datum:**

Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES (ES / U50 / DB / DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	ES		0			FILL: Gravelly clay, medium plasticity, brown, with concrete, brick and fibro fragments, timber and fine to coarse grained sand.	MC>PL			
	ES, DS	N = 18 5,8,10			CL	SILTY CLAY: medium plasticity, grey mottled orange brown and red brown.	MC<PL	H	- >600 >600	
	DS	N = 14 6,6,8	1 – 2			SILTY CLAY: low to medium plasticity, grey mottled orange brown and red brown.	MC>PL	VSt	250 420 300	
ON COMPLETION OF CORING	DS	N = 13 4,6,7	2 – 3		CH	SILTY CLAY: high plasticity, grey mottled red brown and orange brown.			360 250 360	
	DS	N = 18 5,8,10	4 – 5		CL	SILTY CLAY: medium plasticity, grey mottled red brown and orange brown.			320 310 250	
								St-VSt		
	DS	N = 6 2,3,3	6						100 120 250	
			7			as above, but with fine to coarse grained ironstone gravel bands.				

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Borehole No. 1

BOREHOLE LOG

Client: BERACI PTY LTD

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP

Method: SPIRAL AUGER JK550

R.L. Surface:

Date: 28-7-04

Datum:

Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■	N = 22 8,10,12	8			SILTY CLAY: medium plasticity, grey mottled red brown and orange brown, with fine to coarse grained ironstone gravel bands.	MC>PL	St-VSt		
						9		-	SHALE: grey mottled orange brown.	XW	EL	-	
									SHALE: grey brown.	DW	L-M		LOW 'TC' BIT RESISTANCE
						10			SHALE: dark grey.	SW	M		LOW TO MODERATE RESISTANCE
						11 12 13 14			REFER TO CORED BOREHOLE LOG				

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CORED BOREHOLE LOG

Borehole No. 1

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP | **Core Size:** NMLC | **R.L. Surface:**
Date: 28-7-04 | **Inclination:** VERTICAL | **Datum:**
Drill Type: JK550 | **Bearing:** - | **Logged/Checked by:** A.H./PW

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT SPACING (mm)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		9		START CORING AT 10.0m						
FULL RET-URN		10–13		SHALE: dark grey, with thin light grey bands, bedded at 0°.	SW	M	X X X X X X X		- Be, 0°, Un, R - Be, 0°, Un, R - J, 20°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Cr, 0°, 3mm.t - Cr, 0°, 5mm.t - J, 20°, Un, R - J, 80°, Un, R	
		14, 15		END OF BOREHOLE AT 13.10m						

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Borehole No.
2
1/1

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP **Method:** HAND AUGER **R.L. Surface:**
Date: 28-7-04 **Datum:**
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Sandy gravelly clay, low to medium plasticity, grey brown, with timber, fine to medium grained igneous gravel, slag and charcoal.	MC>PL			
	■							CL-CH	SILTY CLAY: medium to high plasticity, grey mottled orange brown and red brown.	MC<PL	(H)	-	
						1			END OF BOREHOLE AT 0.6m				
						2							
						3							
						4							
						5							
						6							
						7							

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Borehole No. **3**
1/1

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 28-7-04
Method: SPIRAL AUGER JK550
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, medium plasticity, brown, with fine to medium grained igneous gravel and rootlets.	MC<PL			GRASS COVER
								CL-CH	SILTY CLAY: medium to high plasticity, orange brown mottled grey.	MC>PL	(H)	-	
						1			as above, but grey mottled orange brown and red brown.				
									END OF BOREHOLE AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

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Borehole No. **4**
1/1

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 28-7-04
Method: SPIRAL AUGER JK550
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Silty clay, medium plasticity, grey brown mottled orange brown, with fine to coarse grained igneous and quartz gravel.	MC<PL			
								CL-CH	SILTY CLAY: *medium to high* plasticity, mottled orange brown and grey.	MC<PL	(H)	-	
						1		CH	SILTY CLAY: high plasticity, grey mottled orange brown.				
									END OF BOREHOLE AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No. **5**
1/1

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 26-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			FILL: Silty clay, low plasticity, grey brown, with fine to coarse grained shale and igneous gravel, timber and a trace of charcoal.	MC>PL			
					CH	SILTY CLAY: high plasticity, grey mottled orange brown.	MC>PL	St-VSt	180 200 190	HP TESTING CARRIED OUT ON RECOVERED AUGER SAMPLES
			1							
						END OF BOREHOLE AT 1.5m				
			2							
			3							
			4							
			5							
			6							
			7							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
6

Client: BERACI PTY LTD

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP

Date: 27-7-04

Method: SPIRAL AUGER JK250

R.L. Surface:

Datum:

Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			CONCRETE: 100mm.t				NO APPARENT REINFORCEMENT
	ES				-	FILL: Gravelly clay, medium plasticity, dark grey, fine to coarse grained igneous gravel, with slag and concrete fragments.	MC>PL	-	-	
	ES, DS	N = 7 3,3,4			CH	SILTY CLAY: high plasticity, grey mottled red brown and orange brown.	MC>PL	St	150 160 170	
			1					VSt		
	DS	N = 12 5,6,6							250 300 200	
			2					St		
ON COMPLETION OF CORING	DS	N = 10 3,5,5	3							
			4							
	DS	N = 14 4,5,9						VSt	150 200 210	
			5			as above, but with fine to coarse grained ironstone gravel bands.				
	DS	N > 18 11,18/ 150mm REFUSAL	6					H	450 450	
					-	SHALE: grey mottled orange brown.	XW	EL		
							DW	L		VERY LOW 'TC' BIT
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

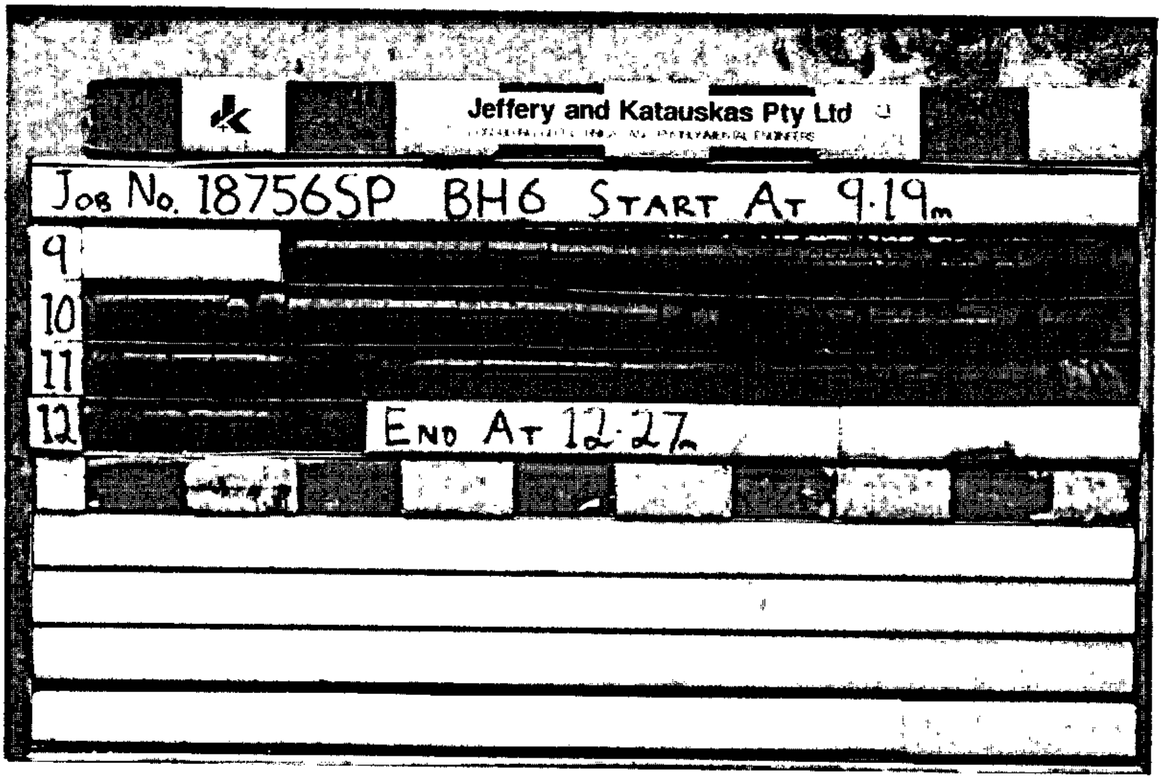
Borehole No. **6**

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Method: SPIRAL AUGER JK250
R.L. Surface:
Date: 27-7-04
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									SHALE: grey mottled orange brown.	DW	L		RESISTANCE
											M		LOW RESISTANCE
						8							
				■							M-H		MODERATE RESISTANCE
						9							
									REFER TO CORED BOREHOLE LOG				
						10							
						11							
						12							
						13							
						14							


Jeffery and Katauskas Pty Ltd
Job No. 18756SP BH6 Start At 9.19m
9
10
11
12
End At 12.27m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. 6

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP	**Core Size:** NMLC	**R.L. Surface:**
Date: 27-7-04	**Inclination:** VERTICAL	**Datum:**
Drill Type: JK550	**Bearing:** -	**Logged/Checked by:** A.H./PW

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		8								
		9		START CORING AT 9.19m						
FULL RET-URN		10 11 12		*SHALE: dark grey, with thin light grey bands, bedded at 0°.*	SW	M			- Cr, 0°, 3mm.t - J, 30°, Un, R - J, 60°, Un, R - Cr, 0°, 3mm.t - Cr, 0°, 5mm.t - Be, 0°, Un, R - J, 20°, Un, R - Cr, 60mm.t - Be, 0°, Un, R - Be, 0°, Un, R	
		13 14		END OF BOREHOLE AT 12.27m						

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 7
1/1

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 26-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			FILL: Silty clay, medium plasticity, brown, with fine to coarse grained sandstone gravel, brick and concrete fragments and rootlets.	MC<PL			WEED COVER
					CL	SILTY CLAY: medium plasticity, orange brown.	MC<PL	(H)	-	
			1		CL-CH	SILTY CLAY: medium to high plasticity, grey mottled red brown.				
						END OF BOREHOLE AT 1.5m				
			2							
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **8** 1/1

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 26-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION						0			FILL: Sandy clay, low plasticity, dark grey, with fibro, glass, fine to coarse grained gravel and charcoal fragments and rootlets.	MC<PL			WEED COVER
								CL	SILTY CLAY: medium plasticity, orange brown and grey.	MC<PL	(H)	-	
						1		CL-CH	SILTY CLAY: medium to high plasticity, grey mottled red brown and orange brown.				
									END OF BOREHOLE AT 1.5m				
						2							
						3							
						4							
						5							
						6							
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
9
1/1

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 28-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES U50 DB DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			FILL: Silty clay, medium plasticity, brown, with rootlets, and with a trace of fine to coarse grained igneous gravel.	MC<PL			
					CL-CH	SILTY CLAY: medium to high plasticity, orange brown mottled grey.	MC<PL	(H)	-	
			1			as above, but grey mottled red brown and orange brown.				
						END OF BOREHOLE AT 1.5m				
			2							
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 10

1/3

Client: BERACI PTY LTD

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP **Method:** SPIRAL AUGER JK250 **R.L. Surface:**

Date: 27-7-04 **Datum:**

Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			CONCRETE: 140mm.t				7mm DIAMTER REINFORCEMENT AT 100mm TOP COVER
	■							-	FILL: Silty clay, high plasticity, brown, with fine to coarse grained igneous gravel and concrete fragments.	MC>PL	-	-	
								CH	SILTY CLAY: high plasticity, grey mottled orange brown and red brown.	MC>PL	St	-	
	■			■	N = 5 1,2,3							150 160 140	
						1					VSt		
				■	N = 15 5,6,9							300 350 350	
						2							
▼ ON COMPLETION OF CORING													
				■	N = 19 6,8,11	3						200 200 320	
						4							
				■	N = 18 5,7,11							350 380 300	
						5							
				■	N = 13 4,6,7	6						350 300 250	
						7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

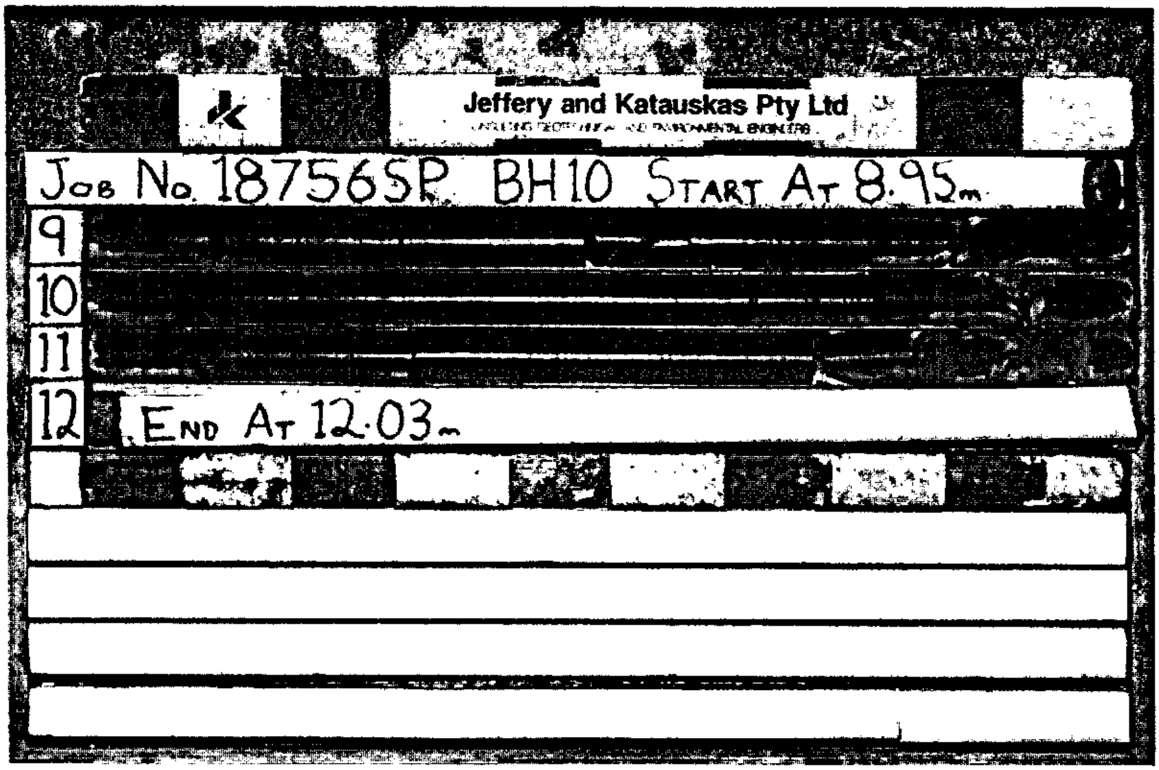
BOREHOLE LOG

Borehole No. **10**

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 27-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
					CH	SILTY CLAY: high plasticity, grey mottled orange brown and red brown.	MC>PL	VSt		
▶	DS	N > 18 8,18/ 150mm REFUSAL			-	SHALE: grey mottled orange brown.	XW	EL	-	
			8			SHALE: grey brown.	DW	VL-L L-M		VERY LOW 'TC' BIT RESISTANCE
						SHALE: dark grey, with high strength iron indurated bands.	SW			MODERATE RESISTANCE WITH HIGH BANDS
			9			REFER TO CORED BOREHOLE LOG				
			10							
			11							
			12							
			13							
			14							


Jeffery and Katauskas Pty Ltd
JOB NO. 18756SP. BH10 START AT 8.95m
9
10
11
12
END AT 12.03m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 10

CORED BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP | **Core Size:** NMLC | **R.L. Surface:**
Date: 27-7-04 | **Inclination:** VERTICAL | **Datum:**
Drill Type: JK550 | **Bearing:** - | **Logged/Checked by:** A.H./PW

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		8		START CORING AT 8.95m						
FULL RETURN		9–12		SHALE: dark grey, with thin light grey bands, bedded at 0°.	SW	M	× × × × × ×		- J, 60°, Un, R - J, 50°, Un, R - Cr, 0°, 1mm.t - J, 40°, Un, R - J, 45°, Un, R - J, 50°, Un, R - Cr, 40mm.t	
		12		END OF BOREHOLE AT 12.03m						
		13								
		14								

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **11**
1/3

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 26-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0		CONCRETE: 100mm.t				7mm DIAMETER REINFORCEMENT AT 100mm TOP COVER
	ES			-	FILL: Sand, fine to medium grained, orange brown.	M	-	-	
	ES			-	FILL: Sand, fine to medium grained, orange brown, with fine to coarse grained gravel and concrete fragments.	-	-	-	
				-	CONCRETE: 150mm.t	MC>PL			
	ES		1	CH	FILL: Silty clay, medium to high plasticity, grey brown, with fine to coarse grained gravel.	MC>PL	St	-	
	ES, DS	N = 10 1,2,8			SILTY CLAY: high plasticity, grey mottled red brown.		VSt	100 350 450	
ON COMPLETION OF CORING			2						
	DS	N = 10 3,4,6	3					220 250 260	
			4						
	DS	N = 24 3,10,14	5					280 300 250	
			6						
				-	SHALE: grey brown, with low strength bands, iron indurated bands and clay bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
			7						

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 11

BOREHOLE LOG

Client: BERACI PTY LTD

Project: PROPOSED RESIDENTIAL DEVELOPMENT

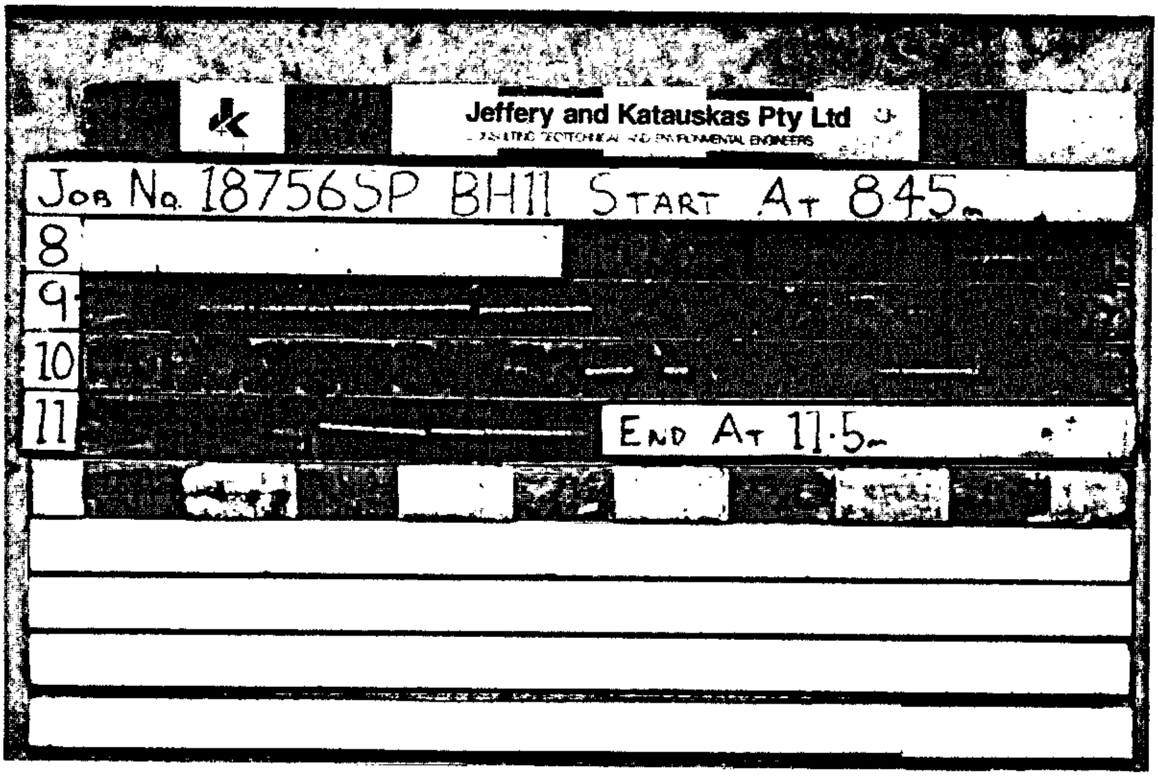
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Method: SPIRAL AUGER JK250
R.L. Surface:

Date: 26-7-04
Datum:

Logged/Checked by: A.H./PW

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									SHALE: grey brown, with low strength bands, iron indurated bands and clay bands.	XW	EL		
▶										DW	L-M		
						8			SHALE: dark grey.		M		MODERATE RESISTANCE
						9			REFER TO CORED BOREHOLE LOG				
						10							
						11							
						12							
						13							
						14							



Jeffery and Katauskas Pty Ltd
JOB No. 18756SP BH11 START AT 8.45m
8
9
10
11
END AT 11.5m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No. 11
3/3

Client:	BERACI PTY LTD
Project:	PROPOSED RESIDENTIAL DEVELOPMENT
Location:	171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP	**Core Size:** NMLC	**R.L. Surface:**
Date: 26-7-04	**Inclination:** VERTICAL	**Datum:**
Drill Type: JK550	**Bearing:** -	**Logged/Checked by:** A.H./PW

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		8		START CORING AT 8.45m					
FULL RET-URN		9, 10, 11		SHALE: dark grey, with thin light grey bands, bedded at 0°.	SW	M	× × × × × ×		- Cr, 60mm.t - XWS, 0°, 3mm.t - J, 75°, Un, R - J, 45°, Un, R - J, 85°, Un, R
		12, 13, 14		END OF BOREHOLE AT 11.5m					

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 12
1/1

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 28-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			ASPHALTIC CONCRETE: 40mm.t				
						FILL: Gravelly sand, fine to medium grained, dark grey, fine to coarse grained igneous gravel with a trace of clay.	M MC>PL	-	-	ROADBASE APPEARS POORLY COMPACTED
		N = 4 2,2,2			CH	FILL: Silty clay, medium plasticity, grey, with a trace of fine to coarse grained sansdtone gravel.	MC>PL	(VSt)	-	
			1			SILTY CLAY: high plasticity, grey mottled orange brown.				
						END OF BOREHOLE AT 1.5m				
			2							
			3							
			4							
			5							
			6							
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
13

BOREHOLE LOG

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP
Date: 26-7-04
Method: SPIRAL AUGER JK250
R.L. Surface:
Datum:
Logged/Checked by: A.H./PW

Groundwater Record	Samples (ES / U50 / DB / DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
			0			ASPHALTIC CONCRETE: 40mm.t				
						FILL: Gravelly sand, fine to coarse grained, brown, fine to coarse grained igneous gravel.	M	-	-	ROADBASE
		N = 3 1,1,2			CH	FILL: Gravelly sand, fine to coarse grained, brown, fine to coarse grained igneous gravel, with brick fragments and clay.	MC>PL	St	100 110 110	
			1			SILTY CLAY: high plasticity, orange brown.				
		N = 15 3,6,9				SILTY CLAY: high plasticity, grey mottled red brown.		VSt	320 390 360	
			2							
ON COMPLETION OF CORING		N = 14 7,7,7	3						320 400 350	
			4			as above, but with fine to coarse grained ironstone gravel bands.	MC<PL	H		
		N = 30 8,10,20							410 >600	
			5							
		N > 22 12,22/ 150mm REFUSAL	6		-	SHALE: grey mottled red brown, with iron indurated bands.	XW	EL	>600 >600	
			7							

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **13**

2/3

Client: BERACI PTY LTD

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP

Date: 26-7-04

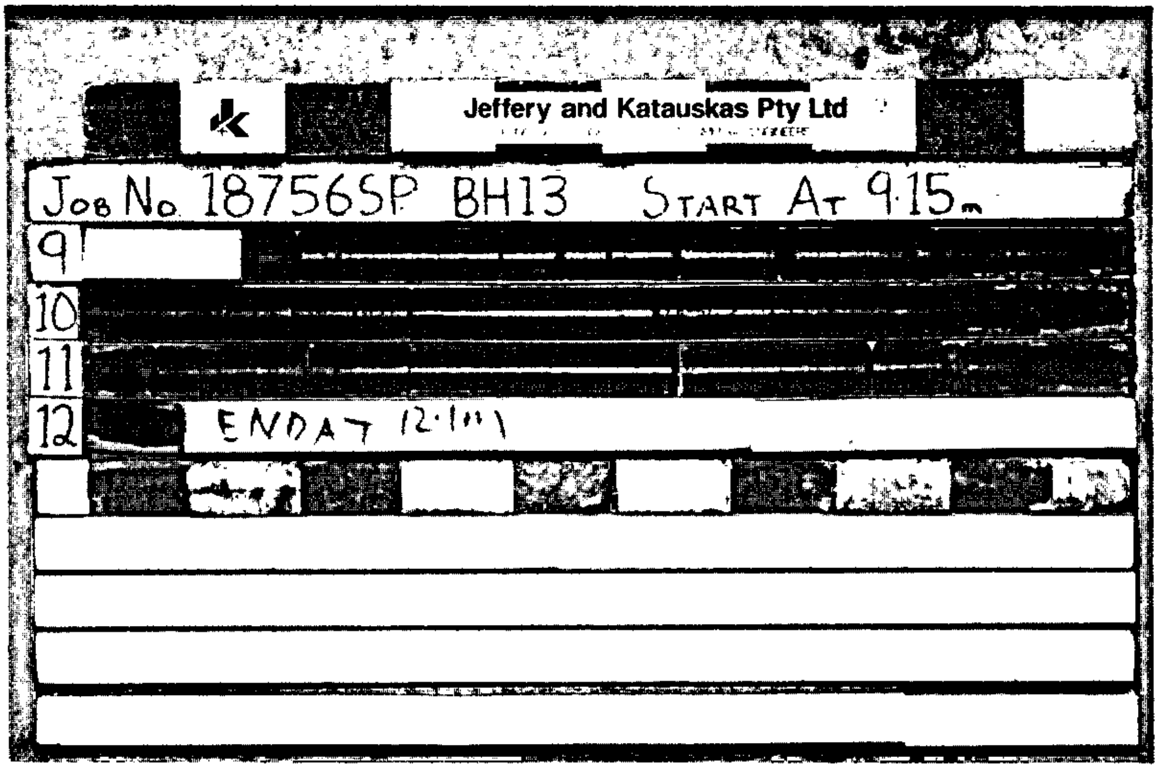
Method: SPIRAL AUGER JK250

Logged/Checked by: A.H./PW

R.L. Surface:

Datum:

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	DS					SHALE: grey brown.	DW	L		VERY LOW 'TC' BIT RESISTANCE
			8							
▶						SHALE; dark grey.	SW	M		LOW RESISTANCE WITH MODERATE BANDS
			9							HIGH RESISTANCE
						REFER TO CORED BOREHOLE LOG				
			10							
			11							
			12							
			13							
			14							


Jeffery and Katauskas Pty Ltd
JOB No. 18756SP BH13 START AT 9.15m
9
10
11
12
END AT 12.1m

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

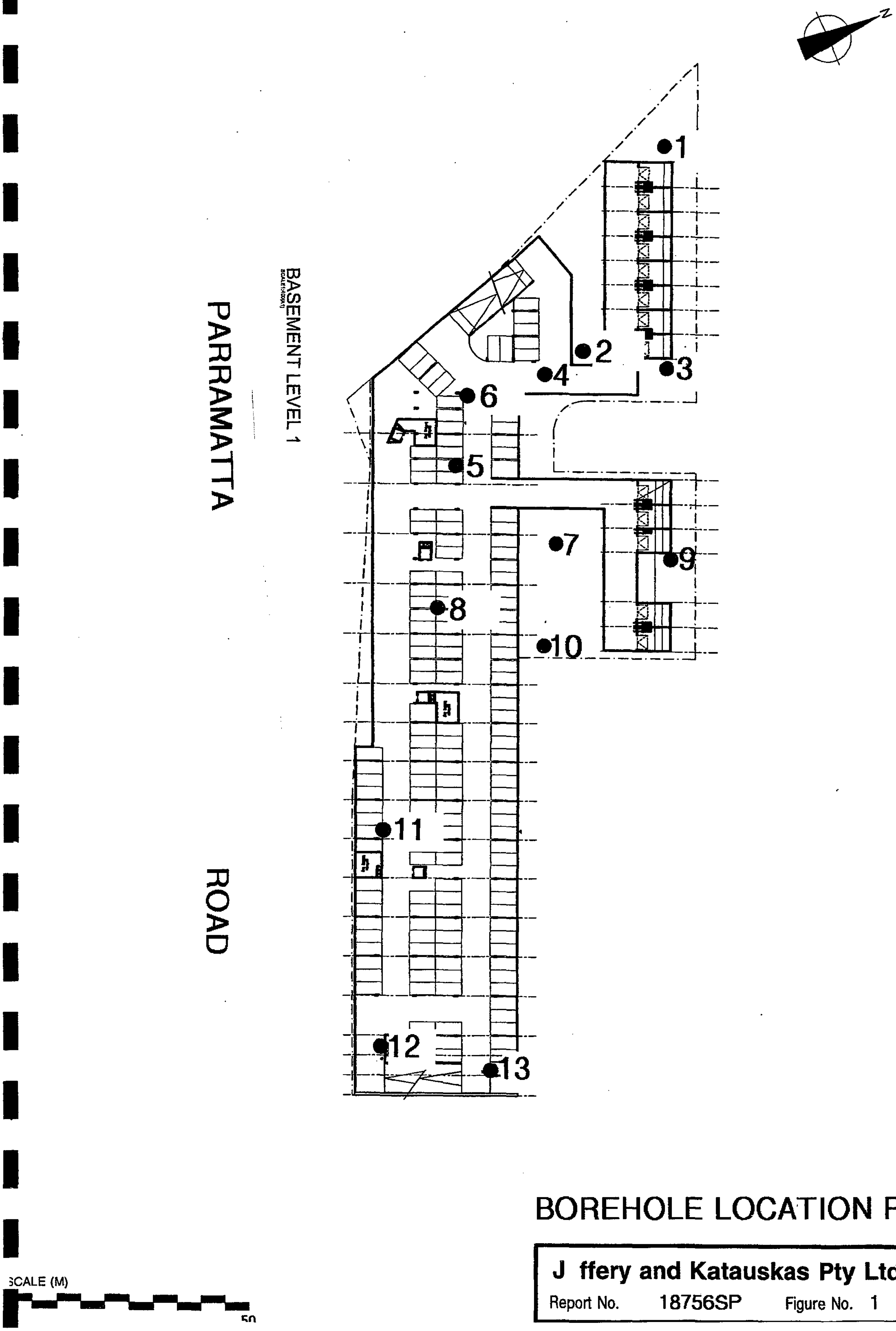
CORED BOREHOLE LOG

Borehole No. 13

Client: BERACI PTY LTD
Project: PROPOSED RESIDENTIAL DEVELOPMENT
Location: 171-189 PARRAMATTA ROAD, GRANVILLE, NSW

Job No. 18756SP **Core Size:** NMLC **R.L. Surface:**
Date: 28-7-04 **Inclination:** VERTICAL **Datum:**
Drill Type: JK550 **Bearing:** - **Logged/Checked by:** A.H./Pw

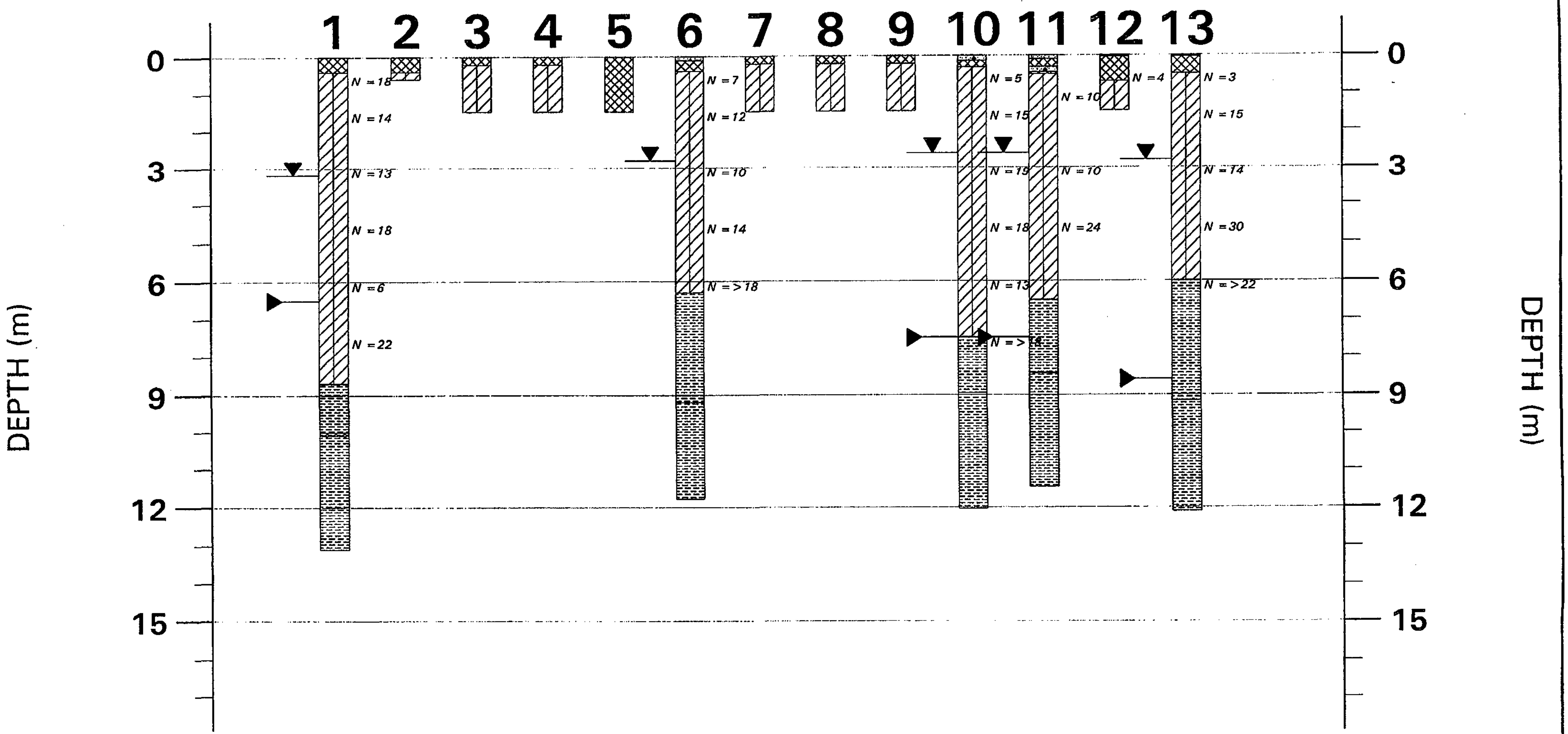
Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL VL L M H VH EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		8								
		9		START CORING AT 9.15m						
FULL RET-URN		10, 11, 12		SHALE: dark grey with thin light grey bands, bedded at 0°.	SW	M	× × × × × ×		- Be, 0°, Un, R - 2 x Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - 2 x Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Be, 0°, Un, R - Cr, 10mm.t	
		13, 14		END OF BOREHOLE AT 12.1m						



BOREHOLE LOCATION PLAN

J ffery and Katauskas Pty Ltd	
Report No. 18756SP	Figure No. 1

GRAPHICAL BOREHOLE SUMMARY



Fill
Silty Clay
Shale
Concrete
Asphaltic/ Bituminous Paving or Coal
Observed water level
Groundwater seepage level
N — SPT "N" VALUE
Nc — SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 150 (vert) ; NTS (horiz)

Jeffery and Katauskas Pty Ltd

Job No.: 18756SP

Figure No.: 2

Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
A.B.N. 17 003 550 801 A.C.N. 003 550 801

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached *Unified Soil Classification Table* qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, "Shale" is used to describe thinly bedded to laminated siltstone.

SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table. Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments.

Wash Boring: The borehole is usually advanced by a rotary bit, with water 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 "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term "mud" encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13

  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N>30

  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "N_c" on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The 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.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

The borehole or test pit logs presented herein are an engineering and/or geological interpretation of the sub-surface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible or justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or "reverted" chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed <u>or</u> where only a limited investigation has been completed <u>or</u> where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to
ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
iii) full time engineering presence on site.

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GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

DEFECTS AND INCLUSIONS

- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

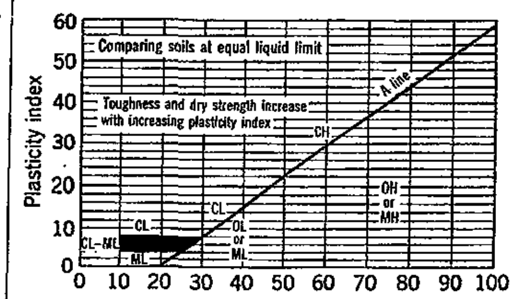
OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

UNIFIED SOIL CLASSIFICATION TABLE

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)				Group Symbols a	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils More than half of material is *larger* than 75 μm sieve sizeb (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	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; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or 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 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with 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 75 μm 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 symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures			Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures			Atterberg limits above "A" line, with *PI* greater than 7
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines			$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines			Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures			Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures			Atterberg limits below "A" line with *PI* greater than 7

Identification Procedures on Fraction Smaller than 380 μm Sieve Size		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size (The 75 μm sieve size is about the smallest particle visible to naked eye)	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate 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, elastic 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 (e.g. 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.

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LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
		Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
		Undisturbed 50mm diameter tube sample taken over depth indicated.
		Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose <15 0-4
	L	Loose 15-35 4-10
	MD	Medium Dense 35-65 10-30
	D	Dense 65-85 30-50
	VD	Very Dense >85 >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

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LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
		0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
		1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
		3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
		10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	