Geotechnical Investigation Report

GEOTECHNICAL REPORT FOR

12-14 ZOUCH ROAD, DENHAM COURT NSW

Prepared for:

NASTASI & ASSOCIATES

Reference: P1702_ 01 rev1

29 July 2019

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1 PROJECT BACKGROUND

Morrow Geotechnics Pty Ltd has undertaken a Geotechnical Investigation to provide geotechnical advice and recommendations for the proposed development at 12-14 Zouch Road, Denham Court NSW (the site).

1.1 Proposed Development

A Project Overview Site Plan for the proposed development has been provided at the time of preparation of this report. From the drawings provided and from discussions with the client, Morrow Geotechnics understands that the proposed development involves an construction of lightly loaded structures at or near existing grade, a large concrete hardstand area, access roads and car parking areas.

1.2 Investigation Intent

The purpose of the investigation is to provide geotechnical advice and recommendations specific to the ground conditions observed at site for the proposed development. These recommendations include:

- Building foundation options, including design parameters.
- Lateral earth pressures and pile design parameters.
- Lot classification in accordance with AS2870.
- Earthquake site classification in accordance with AS1170.4.
- Advice on groundwater level if encountered within the depth of investigation.
- Advice on geotechnical construction constraints.
- Salinity assessment and salinity management plan.
- Pavement design parameters (subgrade CBR, MDD, OMC and modulus of subgrade reaction).

1.3 Published Geological Mapping

Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Penrith 1:100,000 Geological Series Sheet 9030 (DMR 1991), indicates that the site overlies Bringelly Shale of the Wianamatta Group, generally comprising shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff.

1.4 Published Soil Landscapes

The Soil Conservation Service of NSW Penrith 1:100,000 Soil Landscapes Series Sheet 9030 (1st Edition) indicates that the residual landscape at the site likely comprises the Blacktown Landscape. This landscape type typically includes gently undulating rises with broad rounded crests and ridges with gently inclined slopes of typically < 5 %. Soils of the Blacktown Landscape generally comprises shallow to moderately deep (< 1.5 m) red and brown podzolic soils on upper slopes. These soils are noted to be typically moderately reactive and highly plastic.

2 OBSERVATIONS

2.1 Investigation Methods

Fieldwork was undertaken by Morrow Geotechnics on 27 June 2019. Work carried out as part of this investigation includes:

- Review of publicly available information from previous reports in the project area, published geological and soil mapping and government agency websites;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features, condition of surrounding structures and site conditions;
- Dial Before You Dig (DBYD) services search of proposed borehole locations;
- Drilling of eleven boreholes (BH1 to BH11), drilled by a ute mounted drill rig using solid flight augers equipped with a tungsten-carbide bit (TC bit). Dynamic Cone Penetration (DCP) tests were carried out adjacent to borehole locations to assess soil consistency and infer top of rock. Borehole locations are shown on **Figure 1** and borehole logs are presented in **Appendix A**;
- Groundwater observations within boreholes during drilling.

2.2 Subsurface Conditions

The stratigraphy at the site is characterised by topsoil and fill overlying residual clay and shale bedrock. Observations taken during the investigation have been used to produce a stratigraphic model of the site. The observed stratigraphy has been divided into four geotechnical units.

A summary of the subsurface conditions across the site, interpreted from the investigation results, is presented in **Table 1**. More detailed descriptions of subsurface conditions at the test locations are available in the borehole logs presented in **Appendix A**. The details of the method of soil and rock classification, explanatory notes and abbreviations adopted in the borehole logs are also presented in **Appendix A**.

TABLE 1 SUMMARY OF INFERRED SUBSURFACE CONDITIONS

Unit	Material	Comments
1	**Topsoil / Fill**	Generally low to medium plasticity silt topsoil with some sand, and silty clay fill. Unit 1 fill is inferred to be uncontrolled and poorly compacted.
2	**Natural Clay**	Generally medium to high plasticity silty clay with some sand and some fine to medium ironstone gravel. Unit 2 is generally of firm to hard consistency.
3	**Extremely Weathered Shale**	Generally extremely weathered, extremely low to very low strength shale.
4	**Class IV Shale**	Generally moderately weathered, very low to low strength shale grading stronger with depth.

TABLE 2 ENCOUNTERED GEOTECHNICAL CONDITIONS

Material		Unit 1 Fill	Unit 2 Residual Soil	Unit 3 Class V Shale	Unit 4 Class IV Shale
Approx. Depth Range of Unit [1] mBGL	**BH01**	0.0 to 0.2	0.2 to 1.7	1.7 to 2.1	2.1 +
	BH02	0.0 to 0.2	0.2 to 2.0	2.0 to 2.3	2.3 +
	BH03	0.0 to 0.2	0.2 to 1.8	1.8 to 2.7	2.7 +
	BH04	0.0 to 0.1	0.1 to 3.0	-	-
	BH05	0.0 to 0.1	0.1 to 1.8	1.8 to 2.6	2.6 +
	BH06	0.0 to 0.4	0.4 to 3.0	-	-
	BH07	0.0 to 1.2	1.2 to 3.0	-	-
	BH08	0.0 to 0.5	0.5 to 3.0	-	-
	BH09	0.0 to 0.2	0.2 to 1.1	1.1 to 2.2	2.2 +
	BH10	0.0 to 0.1	0.1 to 2.0	-	2.0 +
	BH11	0.0 to 0.2	0.2 to 1.3	-	1.3 +

Notes:

1 Depths shown are based on material observed within test locations and will vary across the site.

2.3 Groundwater Observations

Moderate seepage was observed within BH06 from 1.34 mBGL. Groundwater seepage was not noted within other boreholes drilled as part of the current investigation. It is likely that the relatively low permeability of silty clay soils at the site has masked the presence of seepage water within the soil profile. As soil permeability is low and excavation is not proposed for basements at the site the proposed development is not anticipated to impact on groundwater.

2.4 Laboratory Test Results

Fifteen soil samples were selected for laboratory testing. A summary of test results is provided in **Table 3** and **Table 4**.

TABLE 3 SUMMARY OF CHEMICAL LABORATORY TEST RESULTS

Sample ID	BH03 DS3	BH03 DS4	BH03 DS5	BH03 DS6	BH05 DS2	BH05 DS3	BH05 DS4	BH08 DS1	BH09 DS2	BH09 DS3	BH09 DS4	BH09 DS5
Depth	0.4m	0.9m	1.4m	1.9m	0.4m	0.9m	1.4m	0.5m	0.2m	0.4m	0.9m	1.4m
pH	6.7	4.6	6.1	6.2	6.3	6.0	-	6.2	6.2	4.8	6.0	6.2
Conductivity (µS/cm)	170	1100	390	290	390	460	-	470	160	230	340	690
Sulfate (mg/kg)	-	360	-	-	-	-	-	230	-	81	-	-
Chloride (mg/kg)	-	640	-	-	-	-	-	140	-	76	-	-
Exchangeable Sodium %	-	-	-	-	-	-	32.4	-	22.0	-	-	-
Cation Exchange Capacity (meq/100g)	-	-	-	-	-	-	4.1	-	2.9	-	-	-

TABLE 4 SUMMARY OF PAVEMENT DESIGN LABORATORY TEST RESULTS

Test/ Sample ID	BDS BH2 0.2 to 0.7 mBGL	BDS BH5 0.2 to 0.7 mBGL	BDS BH11 0.2 to 0.7 mBGL
Material Description [1]	Silty CLAY	Silty CLAY	Silty CLAY
Maximum Dry Density (t/m^3)	1.54	1.89	1.73
Optimum Moisture Content (%)	22.7	15.9	18.7
Swell (%)	1.8	0.2	0.5
California Bearing Ratio (%)	2.5	6.0	5.0

3 RECOMMENDATIONS

3.1 Excavation Retention

Minor excavation may be necessary for site regrading and services trenches. Temporary batters may be considered for retention during basement excavation only where adequate room for full batter construction is available. Temporary batter slopes of 1V:1H will be possible for all units above the water table provided that surface water is diverted away from the batter faces and batter heights are kept to less than 4m. Where batters extend beyond 4 m height benching may be required and further advice should be sought from a qualified geotechnical engineer. Permanent batters of 2H:1V may be employed for excavation design above the water table. Permanent batters will require surface protection or revegetation to prevent erosion and slaking.

For design of flexible shoring systems a triangular pressure distribution may be employed using the parameters provided in **Table 5**. For design of rigid anchored or braced walls, a trapezoidal earth pressure distribution should be used with a maximum pressure of $0.65.K_a.\gamma.H$ (kPa), where 'H' is the effective vertical height of the wall in metres.

TABLE 5 EARTH PRESSURE PARAMETERS

Material		Unit 1 Topsoil / Fill	Unit 2 Residual Soil	Unit 3 Class EW Shale	Unit 4 Class IV Shale
Bulk Unit Weight (kN/m^3)		16	18	22	23
Earth Pressure Coefficients	At rest, K_o	0.55	0.50	0.30	0.20
	Passive, K_p	2.66	3.00	4.00	4.50
	Active, K_a	0.38	0.33	0.20	0.15

Notes:

1 Unit Weight is based on visual assessment only, order of accuracy is approximately ±10%.
2 Earth pressures are provided on the assumption that the ground behind the retaining wall is flat and drained.

In addition, design of retaining walls should consider the following:

- Appropriate surcharge loading from construction equipment, vehicular traffic and neighbouring structures at finished surface level should be taken into account in the retention design. Surcharge loads on retention structures may be calculated using a rectangular stress block with an earth pressure coefficient of 0.5 applied to surcharge loads at ground surface level.
- Anchor design should ignore the contribution of any bonded length within a wedge which extends upwards at 45^o from the top of Unit 4 material to account for a failure wedge forming behind the shoring system.

3.2 Foundation Design

Shallow footings and slabs on Unit 2 or 3 material should be designed in accordance with AS2870:2011 based on a Site Classification of 'H1.' The site classification has been provided on the basis that the performance expectations set out in Appendix B of AS2870–2011 are acceptable and that future site maintenance will be undertaken in accordance with CSIRO BTF 18.

The parameters given in **Table 6** may be used for the design of pad footings and bored piles. Morrow Geotechnics recommends that a Preliminary Geotechnical Strength Reduction Factor (GSRF) of 0.4 is used for the design of piles in accordance with AS 2159:2009 if no allowance is made for pile testing during construction. Should pile testing be nominated, the GSRF may be reviewed and a value of 0.55 to 0.65 may be expected.

Ultimate geotechnical strengths are provided for use in limit state design. Allowable bearing pressures are provide for serviceability checks. These values have been determined to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing dimension.

TABLE 6 PAD FOOTING AND PILE DESIGN PARAMETERS

Material		Unit 1 Topsoil / Fill	Unit 2 Residual Soil	Unit 3 EW Shale	Unit 4 Class IV Shale
Allowable Bearing Pressure (kPa)		N/A	200	500	1000
Ultimate Vertical End Bearing Pressure (kPa)		N/A	600	1500	3000
Elastic Modulus (MPa)		3	12	50	120
Allowable Shaft Adhesion (kPa)	In Compression	0	20	50	100
	In Tension	0	10	25	50
Susceptibility to Liquefaction during an Earthquake		Medium	Low	Low	Low

Notes:

1 Side adhesion values given assume there is intimate contact between the pile and foundation material. Design engineer to check both 'piston' pull-out and 'cone' pull-out mechanics in accordance with AS4678-2002 Earth Retaining Structures.

2 Susceptibility to liquefaction during an earthquake is based on the following definition:
- Low - Medium to very dense sands, stiff to hard clays, and rock
- Medium - Loose to medium dense sands, soft to firm clays, or uncontrolled fill below the water table
- High - Very loose sands or very soft clays below the water table

To adopt these parameters we have assumed that the bases of all pile excavations are cleaned of loose debris and water and inspected by a suitably qualified Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used.

Selection of footing types and founding depth will need to consider the risk of adverse differential ground movements within the foundation footprint and between high level and deeper footings. Unless an allowance for such movement is included in the design of the proposed development we recommend that all new structures found on natural materials with comparable end bearing capacities and elastic moduli.

3.3 AS1170 Earthquake Site Risk Classification

Assessment of the material encountered during the investigation in accordance with the guidelines provided in AS1170.4-2007 indicates an earthquake subsoil class of Class B_e – Rock for the site.

3.4 Soil Aggressivity

Analysis of the pH, chloride & sulfate content and electrical conductivity of the soil against the guidelines provided in AS2159-2009 indicates:

- 'mildly aggressive' to buried concrete structural elements; and
- 'mildly aggressive' to buried steel structural elements.

Laboratory test certificates for aggressivity testing are included in **Appendix B**.

3.5 Design Subgrade CBR

Samples for laboratory testing were chosen to be representative of the natural subgrade material which will be encountered beneath pavement areas. The results of soaked CBR testing conducted on three subgrade samples indicated CBR values of between 2.5 % and 6.0 %. Morrow Geotechnics recommends a design subgrade CBR of 3 % is adopted for pavement design.

For controlled filling depths of less than or equal to 1m, the Japan Road Association method of assessing a weighted subgrade strength can be used, as follows:

$$CBR_W = (D_F \times CBR_F^{0.33} + (1-D_F) \times CBR_S^{0.33})^3$$

where: CBR_W = weighted subgrade CBR (%)
D_F = depth of filling (m)
CBR_F = CBR of filling material (%)
CBR_S = CBR of subgrade (%)

For example, if a 250 mm deep layer of controlled filling using CBR 30% material is placed over a subgrade with a CBR value of 3%, then a weighted subgrade CBR of 6.3% can be adopted for design.

3.6 Soil Salinity

A soil salinity assessment in accordance with the recommendations of Department of Land and Water Conservation, *Site Investigations for Urban Salinity*, 2002 has been carried out at the site. The laboratory Electrical Conductivity (EC) has multiplied by a factor varying from 7, based on the texture of the soil samples obtained, to obtain Corrected Electrical Conductivity designated as ECe as presented in **Table 7** below. In addition to this Exchangeable Sodium Percentage and Cation Exchange Capacity results have been compared with criteria within the guidelines.

TABLE 7 SOIL SALINITY / SODICITY INTERPRETATION

Sample ID	BH03 DS3	BH03 DS4	BH03 DS5	BH03 DS6	BH05 DS2	BH05 DS3	BH05 DS4	BH08 DS1	BH09 DS2	BH09 DS3	BH09 DS4	BH09 DS5
Conductivity (µS/cm)	170	1100	390	290	390	460	-	470	160	230	340	690
Corrected Electrical Conductivity (dS/m)	1.19	7.7	2.73	2.03	2.73	3.22	-	3.29	1.12	1.61	2.38	4.83
Exchangeable Sodium Percentage (%)	-	-	-	-	-	-	32.4	-	22.0	-	-	-
Cation Exchange Capacity (meq/100g)	-	-	-	-	-	-	4.1	-	2.9	-	-	-
Assessed Sodicity / Salinity	**Non Saline**	**Moderately Saline**	**Slightly Saline**	**Slightly Saline**	**Slightly Saline**	**Slightly Saline**	**Highly Sodic**	**Slightly Saline**	**Highly Sodic**	**Non Saline**	**Slightly Saline**	**Moderately Saline**

On the basis of laboratory testing undertaken as part of this investigation the site is assessed to be **slightly to moderately saline** and **highly sodic**.

When wet, sodic soils lose their structure and disperse into very small particles, the small particles fill the pore spaces in the soil effectively blocking them. This impermeable layer can severely impede water movement. Excessive water entering the profile may be prevented from draining further by the sodic layer and result in tunnelling soil erosion. Gullying or tunnelling can be an issue if the sodic subsoil is exposed to rainfall, or construction leads to an outlet developing for water ponded above a sodic layer. With a sodic layer near the surface erosion can be an issue. Plants may have problems establishing if erosion has removed the nutrients and the sodic crust is preventing air and water entering the soil profile. Stability for structures may also be an issue especially if the layer is thick. Calcium, mostly in the form of gypsum, is often added to sodic soil to address the balance between sodium and calcium in the soil.

To minimise the impact of the development on the water and salt processes on the site, possible management options might include:

- minimising water infiltration;
- the use of landscaping using native plants;
- sealing stormwater detention ponds;
- retention of deep rooted vegetation; or
- minimising soil disturbance such as compaction and cut and fill.

To minimise the impact of the water and salt processes on the development, possible management options may include:

- careful installation of damp proof courses;
- water proofing the slab;
- good site drainage; or
- the use of higher strength concrete with thicker cover and exposure class masonry.

4 RECOMMENDATIONS FOR FURTHER GEOTECHNICAL SERVICES

Further geotechnical inspections should be carried out during construction to confirm the geotechnical and hydrogeological model. These should include:

- All excavated material transported off site should be classified in accordance with NSW EPA 2014 - Waste Classification Guideline Part 1; Classifying Waste.
- A suitably qualified geotechnical engineer is to assess the condition of exposed material at foundation or subgrade level to assess the ability of the prepared surface to act as a foundation or as a subgrade.
- Regular inspections of battered and unsupported excavations, where proposed, to confirm geotechnical conditions and to assess the suitability of design assumptions and to provide further advice with regards to excavation retention/ support and proposed construction methodologies, if required.

5 STATEMENT OF LIMITATIONS

The adopted investigation scope was limited by the investigation intent. Further geotechnical inspections should be carried out during construction to confirm both the geotechnical model and the design parameters provided in this report.

Your attention is drawn to the document “Important Information”, which is included in **Appendix B** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Morrow Geotechnics, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

6 REFERENCES

AS1726:1993, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS2870:2011, *Residential Slabs and Footings*, Standards Australia.

AS3798:2007, *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia.

Chapman, G.A. and Murphy, C.L. (1989), Soil Landscapes of the Penrith 1:100000 sheet. Soil Conservation Services of NSW, Sydney.

NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

NSW Department of Mineral Resources (1991) Penrith 1:100,000 Geological Series Sheet 9030 (Edition 1). Geological Survey of New South Wales, Department of Mineral Resources.

Pells (2004) Substance and Mass Properties for the Design of Engineering Structures in the Hawkesbury Sandstone, Australian Geomechanics Journal, Vol 39 No 3

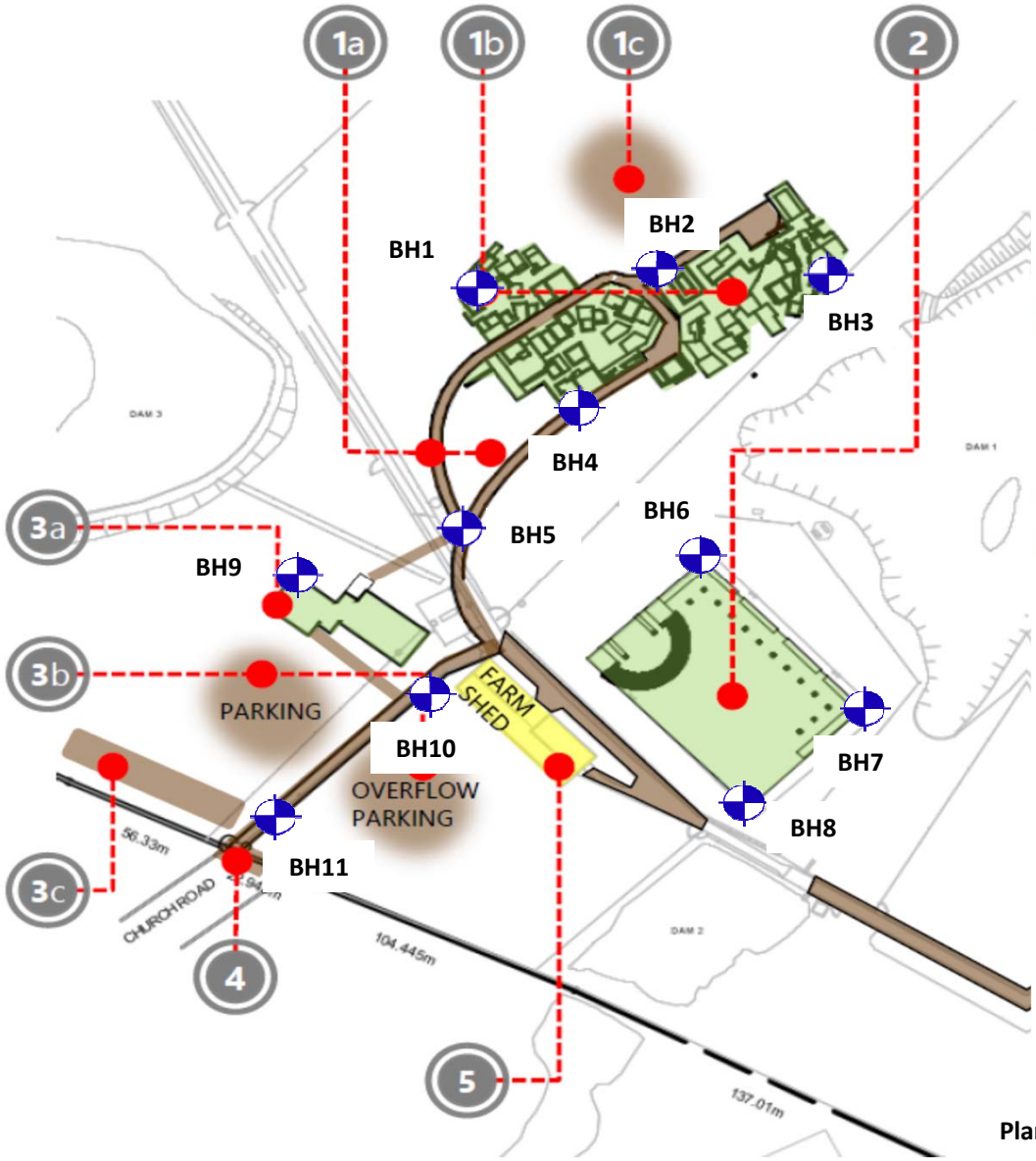
7 CLOSURE

Please do not hesitate to contact Morrow Geotechnics if you have any questions about the contents of this report.

For and on behalf of Morrow Geotechnics Pty Ltd,

James Brooker
Geotechnical Engineer

Alan Morrow
Senior Geotechnical Engineer



1. **BACKLOT PADDOCK** | a) access road
   | b) avs project set
   | c) screening mound
2. **PLAYING FIELD** | avs project set
3. **PADDOCK** | a) backlot production support
   | b) new car parking (25 space + 25 overflow)
   | c) landscaping (for screening)*
4. **BACK GATE** | upgrade branch access
5. **FARM SHED** | project storage (existing layout)

Plan Source: Site Plan - Project Overview, Branch Comittee, 21 June 2019

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Drawn	JB
Approved	AM
Date	08/07/2019
Scale	NTS

Nastasi & Associates
12-14 Zouch Road, Denham Court NSW
Geotechnical Investigation
Borehole Location Plan

Figure: **1**

Project: P1702

Appendix A

BOREHOLE LOGS AND EXPLANATORY NOTES

Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

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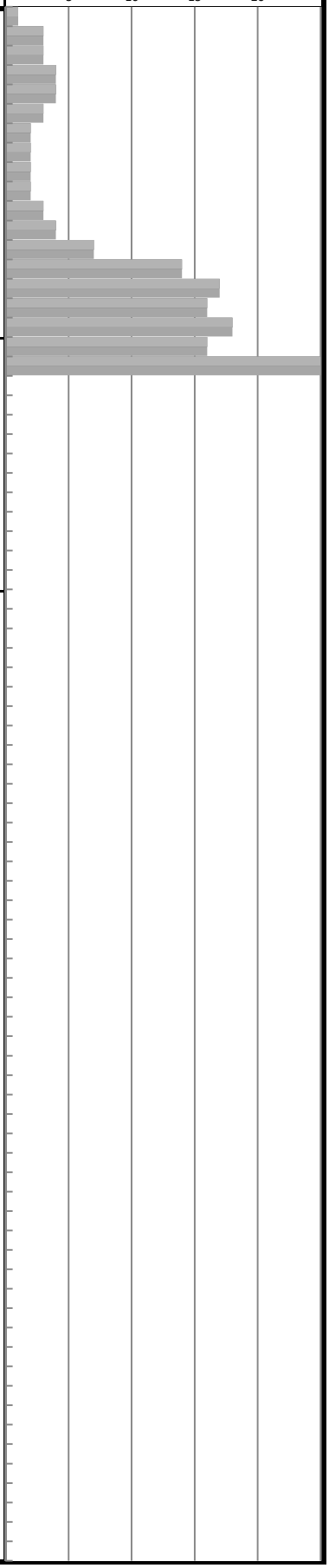
BH01

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE		MI	0.0	TOPSOIL - SILT, low to medium plasticity, dark brown, root fibres present	F	M< PL
				CI-CH	0.5	Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)	St	
						- becoming red-brown mottled pale grey from 0.6 m		
					1.0	- becoming pale grey mottled red-brown from 0.9 m		
				CI	1.5	- medium plasticity, becoming pale grey, trace of fine to medium sub-rounded gravel (ironstone) from 1.2 m	H	
	M			-	2.0	SHALE, pale grey, trace of clay bands, trace of ironstone bands, extremely weathered, inferred extremely low strength	-	-
	M-H				2.5	SHALE, brown, distinctly weathered, inferred very low strength		
					3.0	SHALE, brown, distinctly weathered, inferred low strength		
						End BH01 at 3.0 m Reached Target Depth		

DCP (blows per 100 mm)

5 10 15 20



Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

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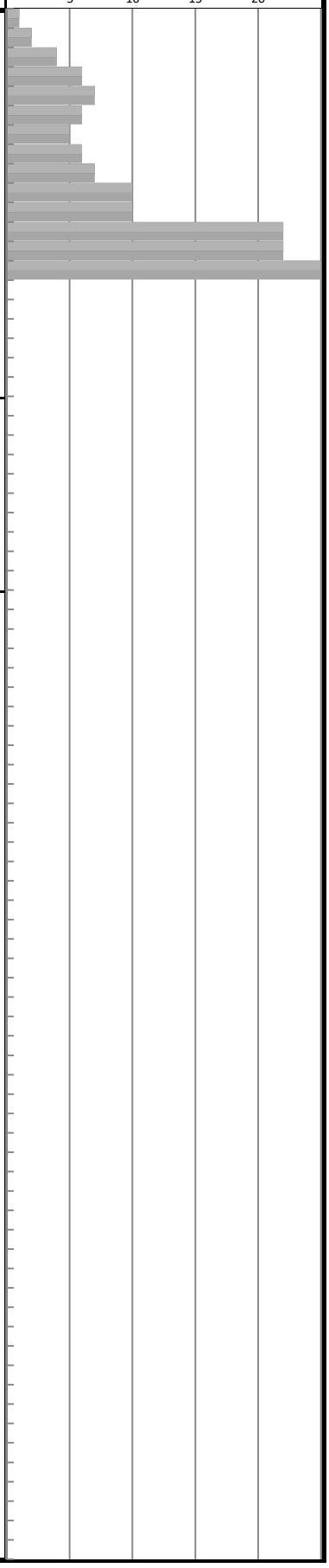
BH02

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE	BDS02-1 0.2-0.7 m	MI	0.0	TOPSOIL - Sandy SILT, low to medium plasticity, fine grained sand, dark brown, root fibres present	F	M< PL
				CI-CH	0.5	Silty CLAY, medium to high plasticity, orange-brown, trace of fine to medium sub-angular gravel (ironstone), (RESIDUAL SOIL)	St	
						- becoming mottled pale grey from 0.6 m		
					1.0			
							H	
					1.5			
				CL-CI		- low to medium plasticity, becoming brown from 1.6 m		
					2.0			
	M			-		SHALE, pale grey / brown, extremely weathered, inferred extremely low strength	-	-
	M-H				2.5	SHALE, dark brown, distinctly weathered, inferred very low to low strength		
					3.0			
						End BH02 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			

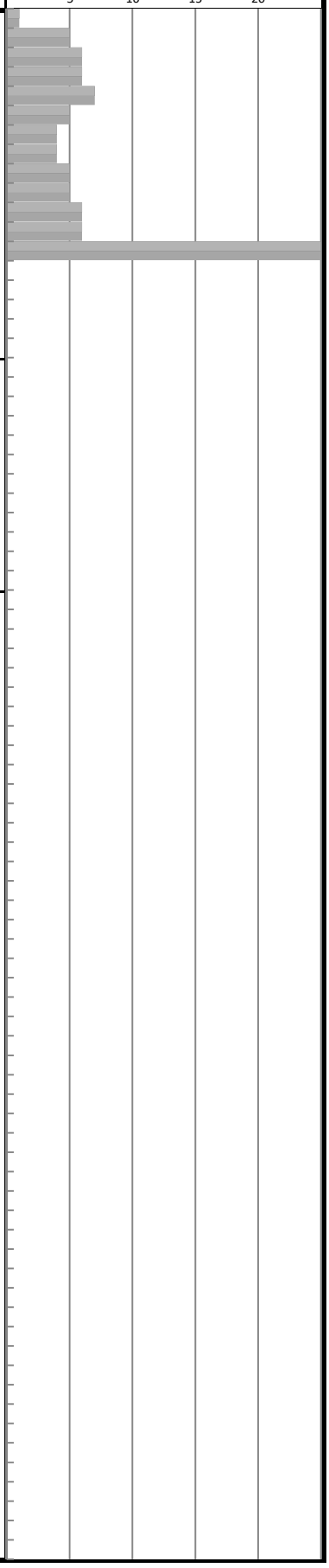
DCP (blows per 100 mm)



Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

BH03

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE	DS03-1 0.1-0.2 m DS03-2 0.2-0.3 m DS03-3 0.4-0.5 m DS03-4 0.9-1.0 m	MI	0.0	TOPSOIL - Sandy SILT, low to medium plasticity, fine grained sand, dark brown, root fibres present	St	M< PL
				CI-CH	0.5	Silty CLAY, medium to high plasticity, red-brown mottled grey, trace of fine to medium sub-angular gravel (ironstone), RESIDUAL SOIL)		
					1.0			
				CI	1.5	Silty CLAY, medium plasticity, brown / grey, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)		
	M		DS03-5 1.4-1.5 m DS03-6 1.9-2.0 m	-	2.0	SHALE, grey, extremely weathered, inferred extremely low strength	-	-
					2.5			
	M-H				3.0	SHALE, dark grey, distinctly weathered, inferred very low strength		
						End BH03 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			



Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

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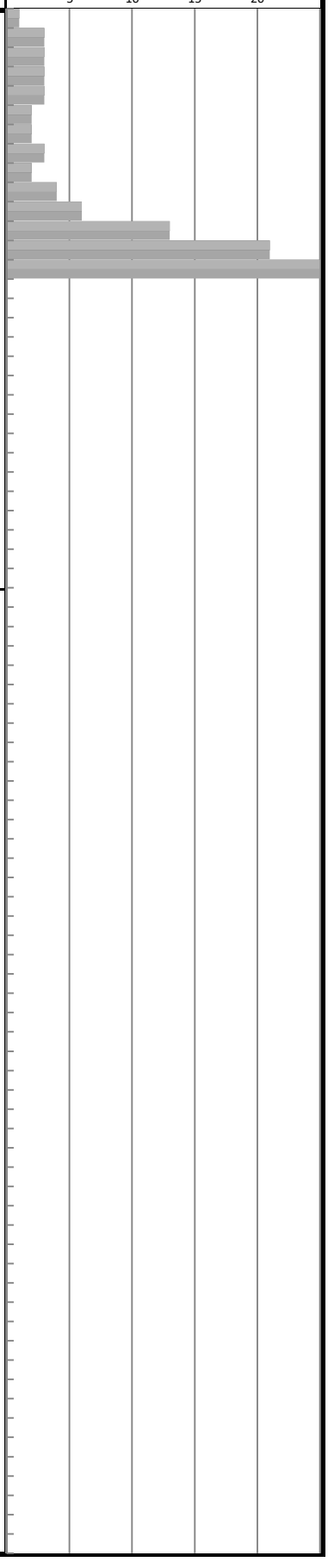
BH04

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE		MI		TOPSOIL - SILT, low to medium plasticity, dark brown, root fibres present	S	
				CI-CH	0.5	Silty CLAY, medium to high plasticity, red-brown, trace of fine to medium sub-angular gravel (ironstone), (RESIDUAL SOIL)	St	
					1.0	- becoming red-brown mottled grey from 0.8 m	H	M< PL
					1.5			
					2.0		-	
					2.5			
					3.0	- with fine to coarse sub-rounded gravel (ironstone) from 2.7 m		
						End BH04 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			

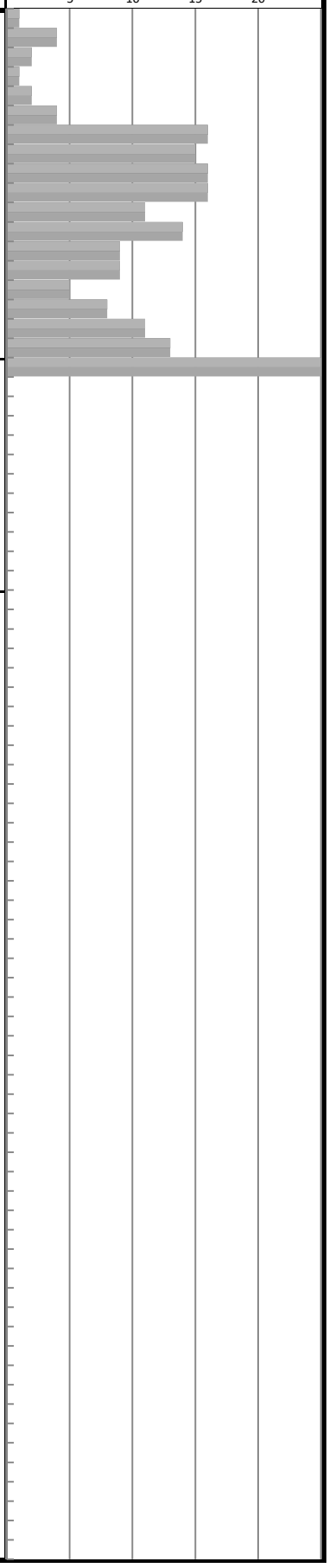


Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

BH05

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE	DS05-1 0.1-0.2 m BDS05-1 0.2-0.7 m DS05-2 0.4-0.5 m DS05-3 0.9-1.0 m DS05-4 1.4-1.5 m	Ml	0.0	TOPSOIL - SILT, low to medium plasticity, dark brown, root fibres present	S	M< PL
				Cl-CH	0.5	Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL) - with fine to coarse sub-angular gravel from 0.5 m	F-St	
					1.0		H	
				Cl	1.5	- medium plasticity, becoming pale grey from 1.5 m	VSt-H	
	M		DS05-5 1.9-2.0 m	-	2.0	SHALE, grey, extremely weathered, inferred extremely low strength	-	-
					2.5	SHALE, brown, distinctly weathered inferred very low strength		
					3.0	End BH05 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			

DCP (blows per 100 mm)



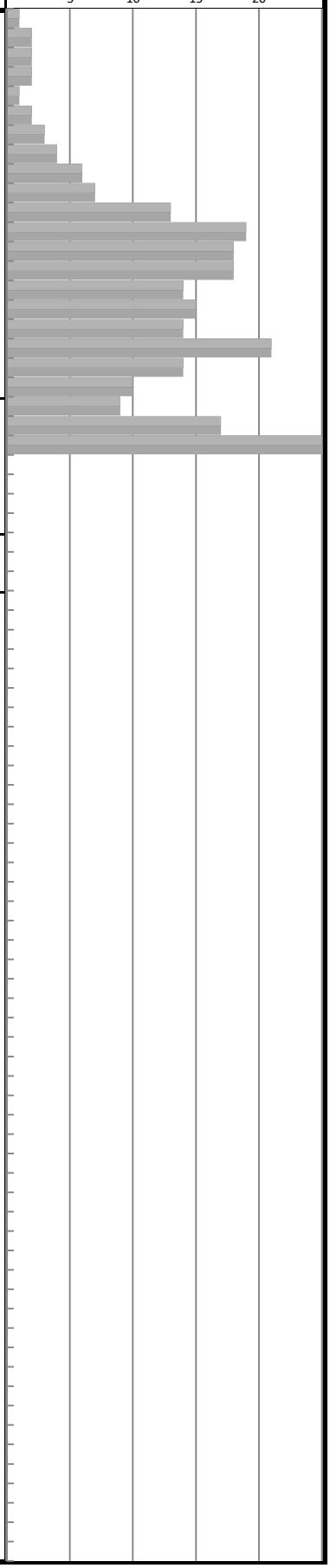
Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

morrow

BH06

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	Moderate seepage 1.3 m				FILL - Silty CLAY, medium to high plasticity, grey-brown, charcoal present	F	
					0.5	Silty CLAY, medium to high plasticity, red-brown mottled grey, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)	St	
				CI-CH	1.0			M~PL
					1.5	- with fine to medium sub-rounded gravel (ironstone) from 1.3 m	H	
					2.0	Silty CLAY, medium to high plasticity, pale grey, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)		
				CI	2.5	- medium plasticity from 2.0 m	-	M<PL
				CI-CH	3.0	Silty CLAY, medium to high plasticity, grey / dark grey, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)		M~PL
						End BH06 at 3.0 m Reached Target Depth		

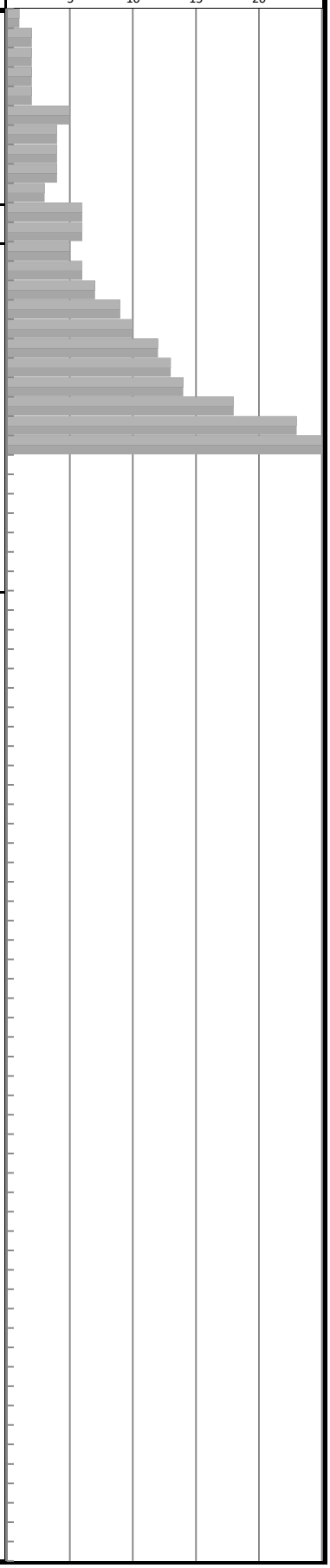
DCP (blows per 100 mm)



Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

BH07

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE		ML-MI	0.0	FILL - Sandy SILT, low to medium plasticity, fine to medium grained sand, dark brown, root fibres present	St	M< PL
				CI	0.5	FILL - Silty CLAY, medium plasticity, brown / grey-brown, trace of fine to coarse sub-rounded gravel (ironstone), finet to medium grained sand pockets, and charcoal present		
				MI	1.0	TOPSOIL - Sandy SILT, low to medium plasticity, fine to medium grained, grey / brown		M> PL
				CI-CH	1.5	Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)	VSt	M< PL
					2.0		H	
					2.5	Silty CLAY, medium to high plasticity, orange-brown, with fine to medium sub-rounded gravel (ironstone), trace of fine grained sand, (RESIDUAL SOIL)	-	
					3.0	End BH07 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			

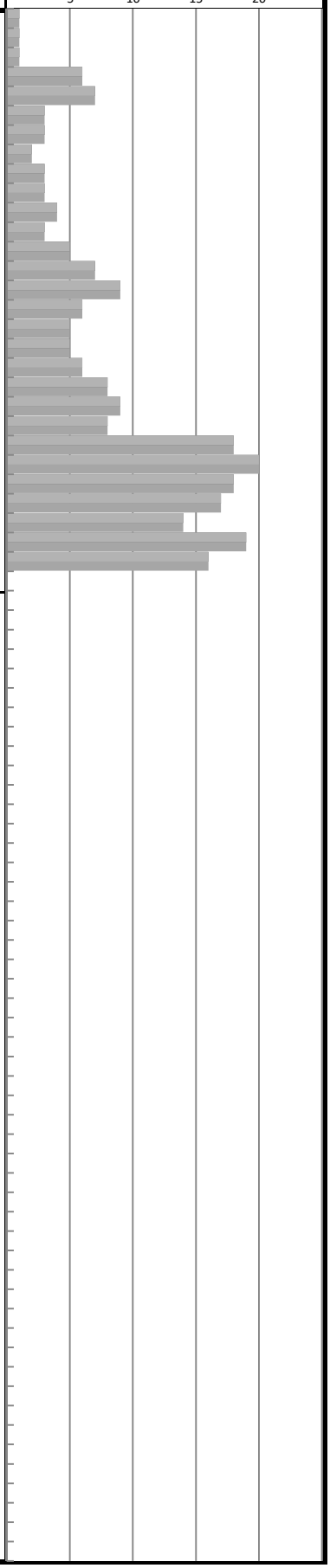


Project No:	P1702	Contractor:	Ideal Geotech	morrow	
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig		
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1		
		Logged:	JB		
		Date:	27/06/2019		

BH08

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE	DS08-1 0.5-0.6 m	MI		FILL - Sandy SILT, low to medium plasticity, fine to medium grained sand, dark brown, root fibres present		
				CI	0.5	FILL - Silty CLAY, medium plasticity, brown / grey-brown, trace of fine to coarse sub-rounded gravel (ironstone), finet to medium grained sand pockets, and charcoal present	F	
				CI-CH	1.0	Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)	St	M< PL
					1.5			
					2.0	- becoming orange-brown mottled grey from 1.7 m	VSt	
					2.5	Silty CLAY, medium to high plasticity, orange-brown, with fine to medium sub-rounded gravel (ironstone), trace of fine grained sand, (RESIDUAL SOIL)	H	
					3.0			
						End BH08 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			

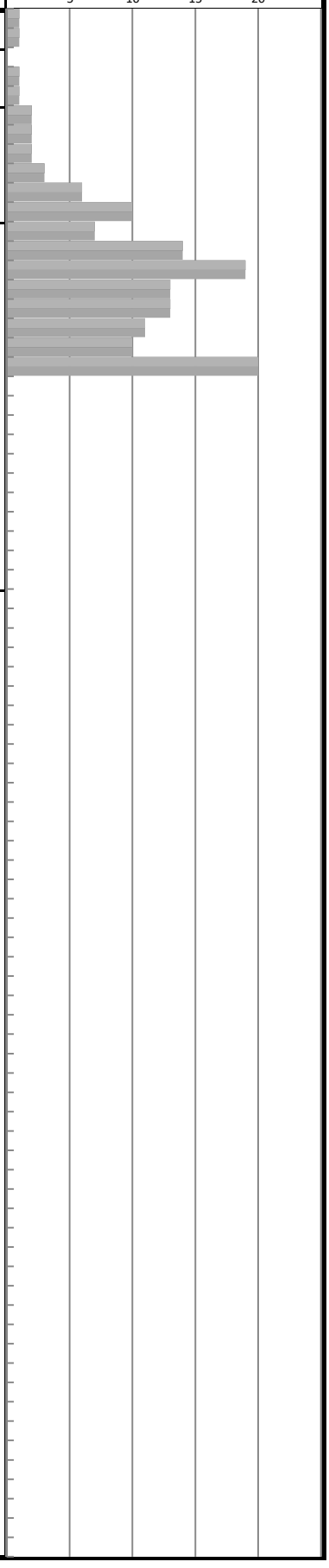
DCP (blows per 100 mm)



Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

BH09

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE	DS09-1 0.1-0.2 m	MI	0	TOPSOIL - SILT, low to medium plasticity, dark brown, root fibres present	VS	M> PL
			DS09-2 0.2-0.3 m	CI- CH	0.5	Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL) - becoming pale grey mottled red-brown from 0.4 m		M~ PL
			DS09-3 0.4-0.5 m				St	M< PL
			DS09-4 0.9-1.0 m		1.0		VSt	
	L-M		DS09-5 1.4-1.5 m		1.5	SHALE, grey, with clay bands, extremely weathered, inferred extremely low strength	H	
			DS09-6 1.9-2.0 m	-	2.0			-
	M				2.5	SHALE, dark grey, distinctly weathered, inferred low strength	-	
					3.0	End BH09 at 3.0 m Reached Target Depth		
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			



Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

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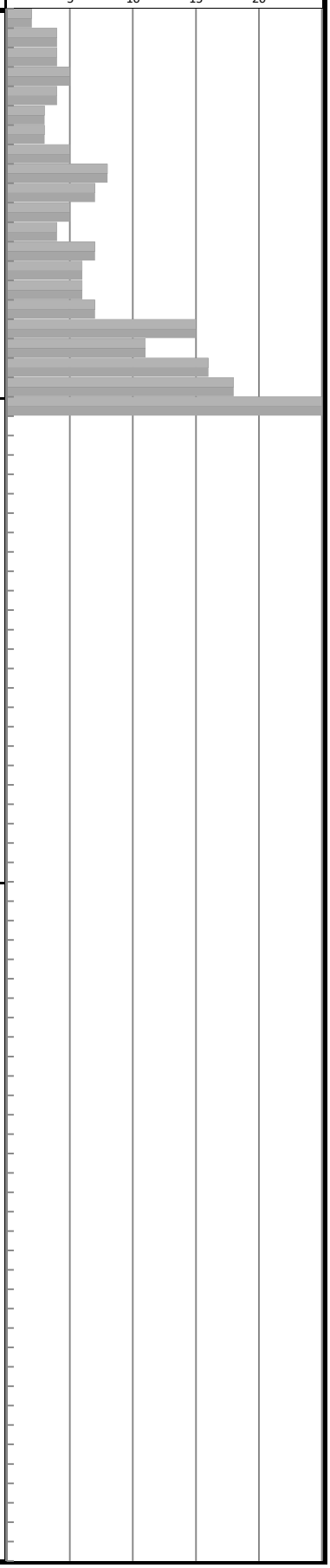
BH10

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE		MI	0.0	TOPSOIL - SILT, low to medium plasticity, dark brown, trace of fine grained sand, root fibres present	St	M< PL
						Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)		
					0.5			
				CI-CH		- becoming red-brown mottled grey from 0.7 m		
					1.0	- becoming pale grey, trace of fine to medium sub-rounded gravel from 1.0 m		
					1.5		VSt	
				CI		- medium plasticity from 1.5 m	H	
	M				2.0	SHALE, brown, distinctly weathered, inferred very low strength		
					2.5			
					3.0			
	M-H			-		SHALE, dark grey, distinctly weathered, inferred low strength	-	-
					3.5			
					4.0			
					4.5	End BH10 at 4.5 m Reached Target Depth		
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			

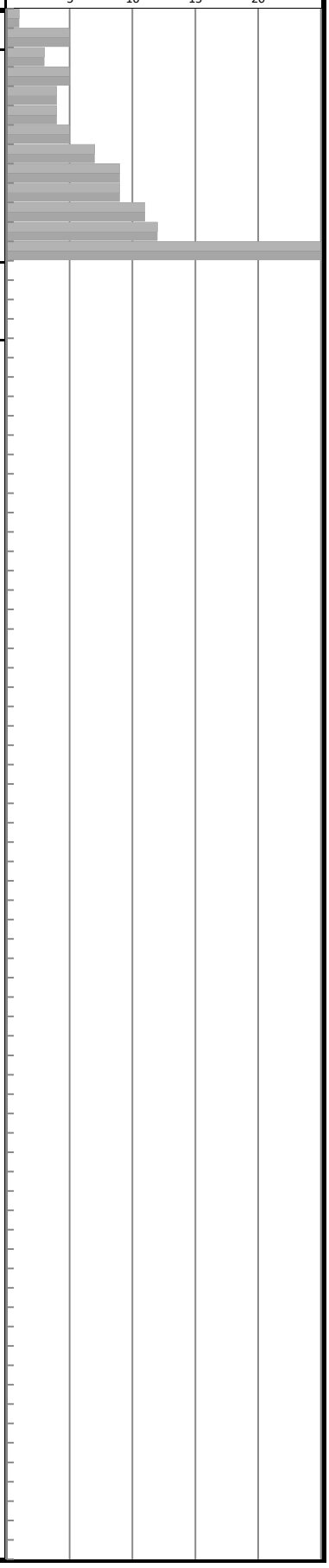


Project No:	P1702	Contractor:	Ideal Geotech
Client:	Nastasi & Associates	Drill Rig:	Ute-mounted rig
Project:	12-14 Zouch Road Denham Court NSW	Sheet	1 of 1
		Logged:	JB
		Date:	27/06/2019

morrow

BH11

Drilling Method	Resistance	Water	Sampling	USCS	Depth	Stratigraphy (Additional Observations)	Consistency/ Density	Moisture
ADT	L	GWNE	BDS11-1 0.2-0.7 m	MI		TOPSOIL - Sandy SILT, low to medium plasticity, fine grained sand, brown, trace of fine sub-angular gravel (ironstone), root fibres present	S	D
				CI-CH	0.5	Silty CLAY, medium to high plasticity, red-brown, trace of fine sub-angular gravel (ironstone), (RESIDUAL SOIL)	St	M< PL
					1.0		VSt	
							H	
	H			-	1.5	SHALE, dark grey / brown, distinctly weathered, inferred very low strength	-	-
						End BH11 at 1.7 m Practical Auger Refusal on Weathered Shale		
					2.0			
					2.5			
					3.0			
					3.5			
					4.0			
					4.5			
					5.0			
					5.5			
					6.0			
					6.5			
					7.0			
					7.5			
					8.0			



Soil and Rock Logging Explanatory Notes

GENERAL

Information obtained from site investigations is recorded on log sheets. The "Cored Drill Hole Log" presents data from an operation where a core barrel has been used to recover material - commonly rock. The "Non-Core Drill Hole - Geological Log" presents data from an operation where coring has not been used and information is based on a combination of regular sampling and insitu testing. The material penetrated in non-core drilling is commonly soil but may include rock. The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits, trenches, etc.

The heading of the log sheets contains information on Project Identification, Hole or Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material substance description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The common depth scale is 8m per drill log sheet and about 3-5m for excavation logs sheets.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is inevitable in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures. Material description and classifications are based on SAA Site Investigation Code AS 1726 - 1993 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

DRILLING

Drilling & Casing

ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
WB	Wash-bore drilling
RR	Rock Roller
NMLC	NMLC core barrel
NQ	NQ core barrel
HMLC	HMLC core barrel
HQ	HQ core barrel

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
M	Medium
H	High
VH	Very High

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

D	Disturbed
B	Bulk
U	Undisturbed
SPT	Standard Penetration Test
N	Result of SPT (sample taken)
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test

EXCAVATION LOGS

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

MATERIAL DESCRIPTION - SOIL

Classification Symbol - In accordance with the Unified Classification System (AS 1726-1993, Appendix A, Table A1)

Material Description - In accordance with AS 1726-1993, Appendix A2.3

Moisture Condition

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Consistency - In accordance with AS 1726-1993, Appendix A2.5

VS	Very Soft	< 12.5 kPa
S	Soft	12.5 – 25 kPa
F	Firm	25 – 50 kPa
St	Stiff	50 – 100 kPa
VSt	Very Stiff	100 – 200 kPa
H	Hard	> 200 kPa

Strength figures quoted are the approximate range of undrained shear strength for each class.

Density Index. (%) is estimated or is based on SPT results.

VL	Very Loose	< 15 %
L	Loose	15 – 35 %
MD	Medium Dense	35 – 65 %
D	Dense	65 – 85 %
VD	Very Dense	> 85 %

MATERIAL DESCRIPTION -ROCK

Material Description

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-1993, Appendix A3.1-A3.3 and Tables A6a, A6b and A7.

Core Loss

Is shown at the bottom of the run unless otherwise indicated.

Bedding

Thinly Laminated	< 6 mm
Laminated	6 - 20
Very Thinly Bedded	20 - 60
Thinly Bedded	60 - 200
Medium Bedded	200 – 600
Thickly Bedded	600 – 2000
Very Thickly Bedded	> 2000

Weathering - No distinction is made between weathering and alteration. Weathering classification assists in identification but does not imply engineering properties.

Fresh (F)	Rock substance unaffected by weathering
Slightly Weathered (SW)	Rock substance partly stained or discoloured. Colour and texture of fresh rock recognisable.
Moderately Weathered (MW)	Staining or discolouration extends throughout rock substance. Fresh rock colour not recognisable.
Highly Weathered (HW)	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture retained.
Extremely Weathered (EW)	Rock texture evident but material has soil properties and can be remoulded.

Strength - The following terms are used to described rock strength:

Rock Strength Class	Abbreviation	Point Load Strength Index, Is(50) (MPa)
Extremely Low	EL	< 0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	≥ 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical estimated strength by using:

° Diametral Point Load Test

Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown.

MATERIALS STRUCTURE/FRACTURES

ROCK

Natural Fracture Spacing - A plot of average fracture spacing excluding defects known or suspected to be due to drilling, core boxing or testing. Closed or cemented joints, drilling breaks and handling breaks are not included in the Natural Fracture Spacing.

Visual Log - A diagrammatic plot of defects showing type, spacing and orientation in relation to core axis.

Defects	———	Defects open in-situu or clay sealed
	– – – – –	Defects closed in-situ
	.....	Breaks through rock substance

Additional Data - Description of individual defects by type, orientation, in-filling, shape and roughness in accordance with AS 1726-1993, Appendix A Table A10, notes and Figure A2.

Orientation - angle relative to the plane normal to the core axis.

Type	BP	Bedding Parting
	JT	Joint
	SM	Seam
	FZ	Fracture Zone
	SZ	Shear Zone
	VN	Vein
	FL	Foliation
	CL	Cleavage
	DL	Drill Lift
	HB	Handling Break
	DB	Drilling Break
Infilling	CN	Clean
	X	Carbonaceous
	Clay	Clay
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
	MS	Secondary Mineral
	MU	Unidentified Mineral
Shape	PR	Planar
	CU	Curved
	UN	Undulose
	ST	Stepped
	IR	Irregular
	DIS	Discontinuous
Rougness	POL	Polished
	SL	Slickensided
	S	Smooth
	RF	Rough
	VR	Very Rough

SOIL

Structures - Fissuring and other defects are described in accordance with AS 1726-1993, Appendix A2.6, using the terminology for rock defects.

Origin - Where practicable an assessment is provided of the probable origin of the soil, eg fill, topsoil, alluvium, colluvium, residual soil.

Appendix B

LABORATORY CERTIFICATES

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Alan Morrow	Manager	Huong Crawford
Client	MORROW GEOTECHNICS PTY LTD	Laboratory	SGS Alexandria Environmental
Address	UNIT 5 12 WINCHESTER STREET CARLTON NSW 2218	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	(Not specified)	Telephone	+61 2 8594 0400
Facsimile	(Not specified)	Facsimile	+61 2 8594 0499
Email	alan@morrowgeo.com.au	Email	au.environmental.sydney@sgs.com
Project	**P1702 Denham Court**	SGS Reference	**SE194811 R0**
Order Number	(Not specified)	Date Received	28 Jun 2019
Samples	12	Date Reported	05 Jul 2019

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Bennet Lo
Senior Organic Chemist/Metals Chemis

Dong Liang
Metals/Inorganics Team Leader

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE194811.001 Soil 28 Jun 2019 DS 3-3 0.4-0.5m	SE194811.002 Soil 28 Jun 2019 DS 3-4 0.9-1.0m	SE194811.003 Soil 28 Jun 2019 DS 3-5 1.4-1.5m	SE194811.004 Soil 28 Jun 2019 DS 3-6 1.9-2.0m
Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 5/7/2019							
Chloride	mg/kg	0.25		-	**640**	-	-
Sulfate	mg/kg	0.5		-	**360**	-	-
pH in soil (1:2) Method: AN101 Tested: 4/7/2019							
pH (1:2)	pH Units	-		-	**4.5**	-	-
pH in soil (1:5) Method: AN101 Tested: 4/7/2019							
pH	pH Units	0.1		**5.7**	-	**5.1**	**5.2**
Conductivity (1:2) in soil Method: AN106 Tested: 4/7/2019							
Conductivity (1:2) @25 C*	µS/cm	1		-	**1100**	-	-
Resistivity (1:2)*	ohm cm	-		-	**930**	-	-
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 4/7/2019							
Conductivity of Extract (1:5 as received)	µS/cm	1		**140**	-	**350**	**260**
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		**170**	-	**390**	**290**
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 5/7/2019							
Exchangeable Sodium, Na	mg/kg	2		-	-	-	-
Exchangeable Sodium, Na	meq/100g	0.01		-	-	-	-
Exchangeable Sodium Percentage*	%	0.1		-	-	-	-

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE194811.001 Soil 28 Jun 2019 DS 3-3 0.4-0.5m	SE194811.002 Soil 28 Jun 2019 DS 3-4 0.9-1.0m	SE194811.003 Soil 28 Jun 2019 DS 3-5 1.4-1.5m	SE194811.004 Soil 28 Jun 2019 DS 3-6 1.9-2.0m
Moisture Content Method: AN002 Tested: 3/7/2019							
% Moisture	%w/w	0.5		**15**	**16**	**11**	**8.7**

Parameter	Units	LOR	Sample Number: SE194811.005 Sample Matrix: Soil Sample Date: 28 Jun 2019 Sample Name: DS 5-2 0.4-0.5m	SE194811.006 Soil 28 Jun 2019 DS 5-3 0.9-1.0m	SE194811.007 Soil 28 Jun 2019 DS 5-4 1.4-1.5m	SE194811.008 Soil 28 Jun 2019 DS 8-1 0.5-0.6m
Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 5/7/2019						
Chloride	mg/kg	0.25	-	-	-	**140**
Sulfate	mg/kg	0.5	-	-	-	**230**
pH in soil (1:2) Method: AN101 Tested: 4/7/2019						
pH (1:2)	pH Units	-	-	-	-	**6.2**
pH in soil (1:5) Method: AN101 Tested: 4/7/2019						
pH	pH Units	0.1	**5.3**	**5.0**	-	-
Conductivity (1:2) in soil Method: AN106 Tested: 4/7/2019						
Conductivity (1:2) @25 C*	µS/cm	1	-	-	-	**470**
Resistivity (1:2)*	ohm cm	-	-	-	-	**2100**
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 4/7/2019						
Conductivity of Extract (1:5 as received)	µS/cm	1	**330**	**410**	-	-
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**390**	**460**	-	-
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 5/7/2019						
Exchangeable Sodium, Na	mg/kg	2	-	-	**940**	-
Exchangeable Sodium, Na	meq/100g	0.01	-	-	**4.1**	-
Exchangeable Sodium Percentage*	%	0.1	-	-	**32.4**	-

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE194811.005 Soil 28 Jun 2019 DS 5-2 0.4-0.5m	SE194811.006 Soil 28 Jun 2019 DS 5-3 0.9-1.0m	SE194811.007 Soil 28 Jun 2019 DS 5-4 1.4-1.5m	SE194811.008 Soil 28 Jun 2019 DS 8-1 0.5-0.6m
Moisture Content Method: AN002 Tested: 3/7/2019							
% Moisture	%w/w	0.5		**13**	**12**	**13**	**5.2**

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name SE194811.009 Soil 28 Jun 2019 DS 9-2 0.2-0.3m	SE194811.010 Soil 28 Jun 2019 DS 9-3 0.4-0.5m	SE194811.011 Soil 28 Jun 2019 DS 9-4 1.9-1.0m	SE194811.012 Soil 28 Jun 2019 DS 9-5 1.4-1.5m
Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 5/7/2019						
Chloride	mg/kg	0.25	-	**75**	-	-
Sulfate	mg/kg	0.5	-	**81**	-	-
pH in soil (1:2) Method: AN101 Tested: 4/7/2019						
pH (1:2)	pH Units	-	-	**4.8**	-	-
pH in soil (1:5) Method: AN101 Tested: 4/7/2019						
pH	pH Units	0.1	**5.2**	-	**5.0**	**5.2**
Conductivity (1:2) in soil Method: AN106 Tested: 4/7/2019						
Conductivity (1:2) @25 C*	µS/cm	1	-	**230**	-	-
Resistivity (1:2)*	ohm cm	-	-	**4300**	-	-
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 4/7/2019						
Conductivity of Extract (1:5 as received)	µS/cm	1	**130**	-	**280**	**510**
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**160**	-	**340**	**590**
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 3/7/2019						
Exchangeable Sodium, Na	mg/kg	2	**660**	-	-	-
Exchangeable Sodium, Na	meq/100g	0.01	**2.9**	-	-	-
Exchangeable Sodium Percentage*	%	0.1	**22.0**	-	-	-

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE194811.009 Soil 28 Jun 2019 DS 9-2 0.2-0.3m	SE194811.010 Soil 28 Jun 2019 DS 9-3 0.4-0.5m	SE194811.011 Soil 28 Jun 2019 DS 9-4 1.9-1.0m	SE194811.012 Soil 28 Jun 2019 DS 9-5 1.4-1.5m
Moisture Content Method: AN002 Tested: 3/7/2019							
% Moisture	%w/w	0.5		**19**	**3.3**	**18**	**13**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Conductivity (1:2) in soil Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity (1:2) @25 C*	LB177731	µS/cm	1	<1	7%	102%
Resistivity (1:2)*	LB177731	ohm cm	-		7%	NA

Conductivity and TDS by Calculation - Soil Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity of Extract (1:5 as received)	LB177730	µS/cm	1	<1	10%	98%
Conductivity of Extract (1:5 dry sample basis)	LB177730	µS/cm	1		10%	98%

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: ME-(AU)-[ENV]AN122

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Exchangeable Sodium, Na	LB177619	mg/kg	2		99%
Exchangeable Sodium, Na	LB177619	meq/100g	0.01	<0.01	NA
Exchangeable Sodium Percentage*	LB177619	%	0.1		NA

pH in soil (1:2) Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery
pH (1:2)	LB177731	pH Units	-	2%	100%

pH in soil (1:5) Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery
pH	LB177730	pH Units	0.1	0%	100%

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: ME-(AU)-[ENV]AN245

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Chloride	LB177694	mg/kg	0.25	<0.25	59%	102%
Sulfate	LB177694	mg/kg	0.5	<0.5	16%	99%

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1 M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is referenced to Rayment and Lyons, 2011, sections 15D3 and 15N1.-
AN245	Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

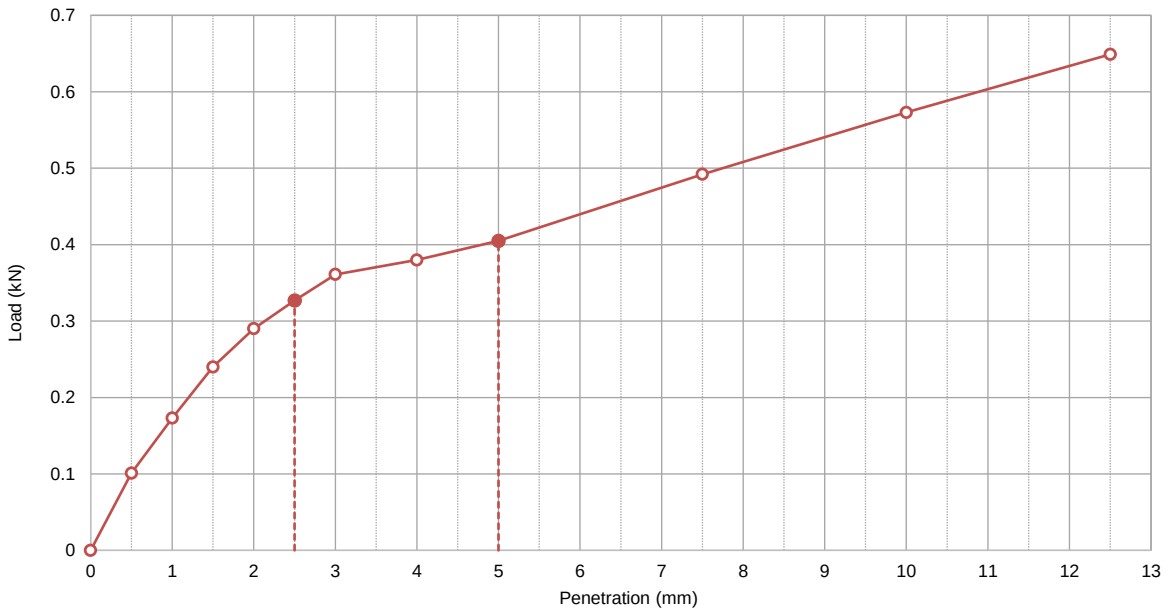
The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au.pv.sgsvr/en-gb/environment.

CALIFORNIA BEARING RATIO REPORT

Client	Morrow Geotechnics	**Source**	CBR02
Address	PO Box 4069, Carlton, NSW, 2218	**Sample Description**	Sandy Gravelly CLAY
Project	Denham Court (P1702)	**Report No.**	S50084-CBR
Job No.	S19326	**Sample No.**	S50084

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client	**Date Sampled:**	27/06/2019
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		**Density & Moisture**	**Achieved**	**Target**
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	101.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	97.5	98.0
Sample Curing Time (hrs)	168 hrs	Dry Density - At Compaction (t/m³)	1.50	1.51
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.48	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	1.8	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	22.9	
Maximum Dry Density - MDD (t/m³)	1.54	Moisture Content - Top 30mm (%)	31.6	
Optimum Moisture Content - OMC (%)	22.7	Moisture Content - Remainder (%)	26.8	

Material CBR Value (%): **2.5** **at a penetration of** **2.5** **mm**

Notes:

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Authorised Signatory:

29/07/2019

Chris Lloyd — Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

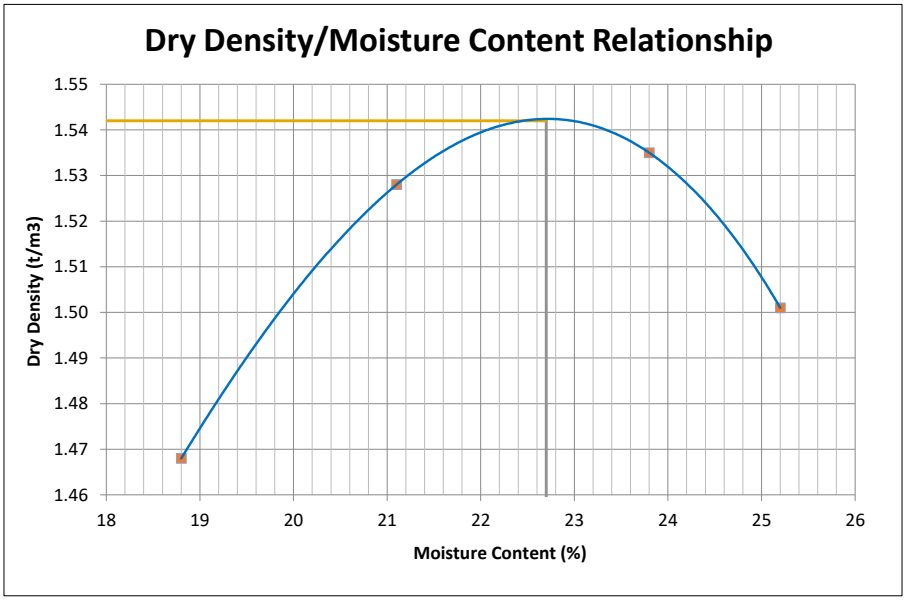
DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	Morrow Geotechnics	**Source**	CBR02
Address	PO Box 4069, Carlton, NSW, 2218	**Sample Description**	Silty Gravelly CLAY
Project	Denham Court (P1702)	**Report No**	S50084-MDD
Job No	S19326-1	**Sample No**	S50084

Test Procedure:
- ☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction
- ☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling: Sampled by Client **Date Sampled:** 27/06/2019

Preparation: Prepared in accordance with the test method



Maximum Dry Density (t/m^3)	1.542
Optimum Moisture Content (%)	22.7
Oversize Retained on 19mm sieve (%)	0.0
Oversize Retained on 37.5mm sieve (%)	0.3
Curing Time	174 hrs
Liquid Limit Determination	Technician Assessment

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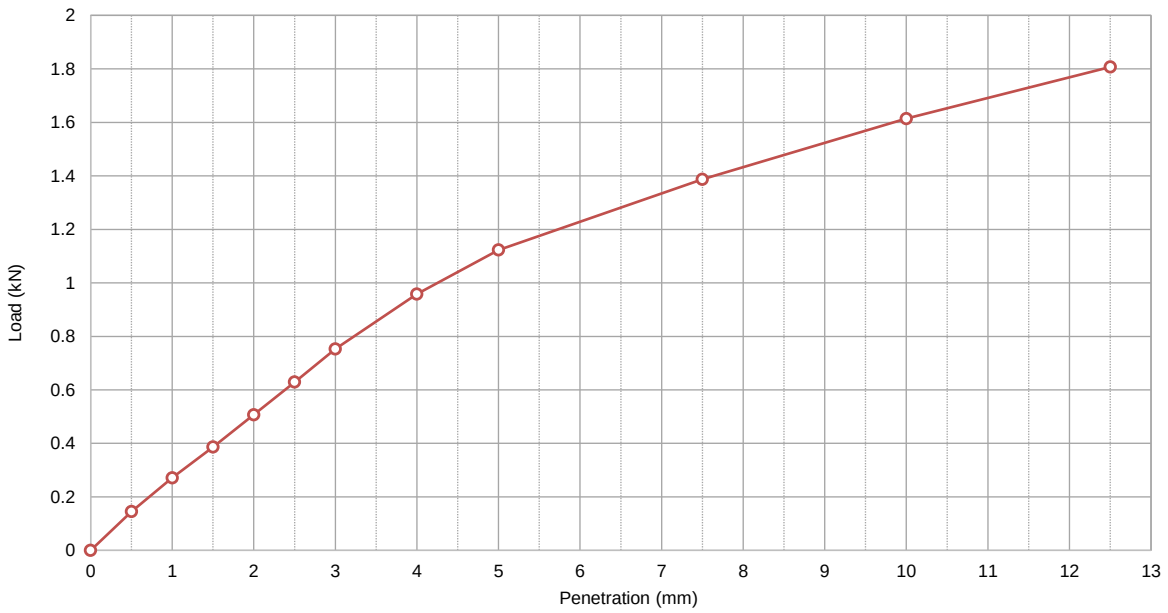
CALIFORNIA BEARING RATIO REPORT

Client	Morrow Geotechnics	**Source**	CBR05
Address	PO Box 4069, Carlton, NSW, 2218	**Sample Description**	Silty CLAY
Project	Denham Court (P1702)	**Report No.**	S50085-CBR
Job No.	S19326	**Sample No.**	S50085

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client	**Date Sampled:**	27/06/2019
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		**Density & Moisture**	**Achieved**	**Target**
Retained on 19.0mm Sieve (%)	2	Lab Moisture Ratio - LMR (%)	101.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	98.0	98.0
Sample Curing Time (hrs)	118 hrs	Dry Density - At Compaction (t/m³)	1.85	1.85
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.85	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.2	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	16.1	
Maximum Dry Density - MDD (t/m³)	1.89	Moisture Content - Top 30mm (%)	18.2	
Optimum Moisture Content - OMC (%)	15.9	Moisture Content - Remainder (%)	16.8	

Material CBR Value (%): **6** **at a penetration of** **5.0** **mm**

Notes:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

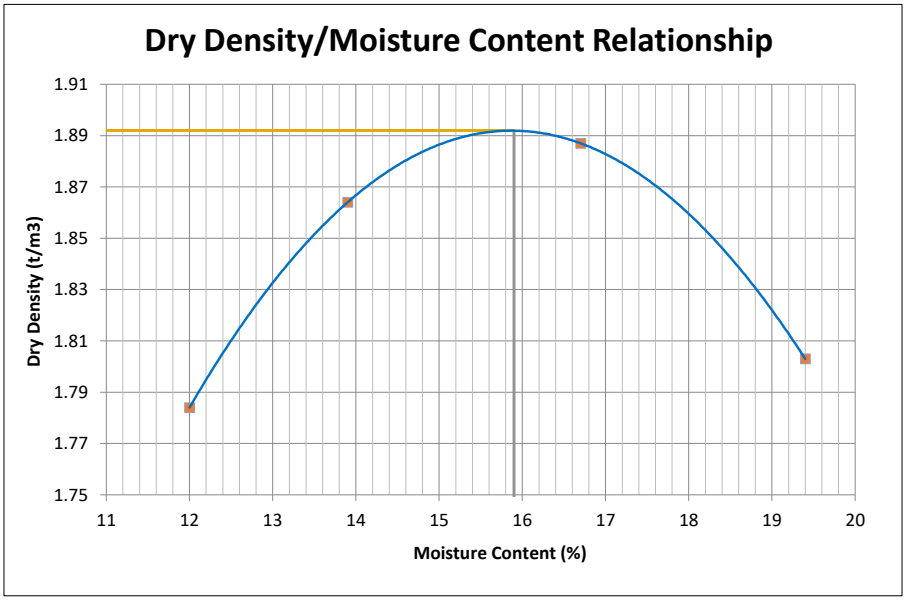
Client	Morrow Geotechnics	**Source**	CBR05
Address	PO Box 4069, Carlton, NSW, 2218	**Sample Description**	Silty CLAY
Project	Denham Court (P1702)	**Report No**	S50085-MDD
Job No	S19326-1	**Sample No**	S50085

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client	**Date Sampled:**	27/06/2019
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.892
Optimum Moisture Content (%)	15.9
Oversize Retained on 19mm sieve (%)	1.6
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	98 hrs
Liquid Limit Determination	Technician Assessment

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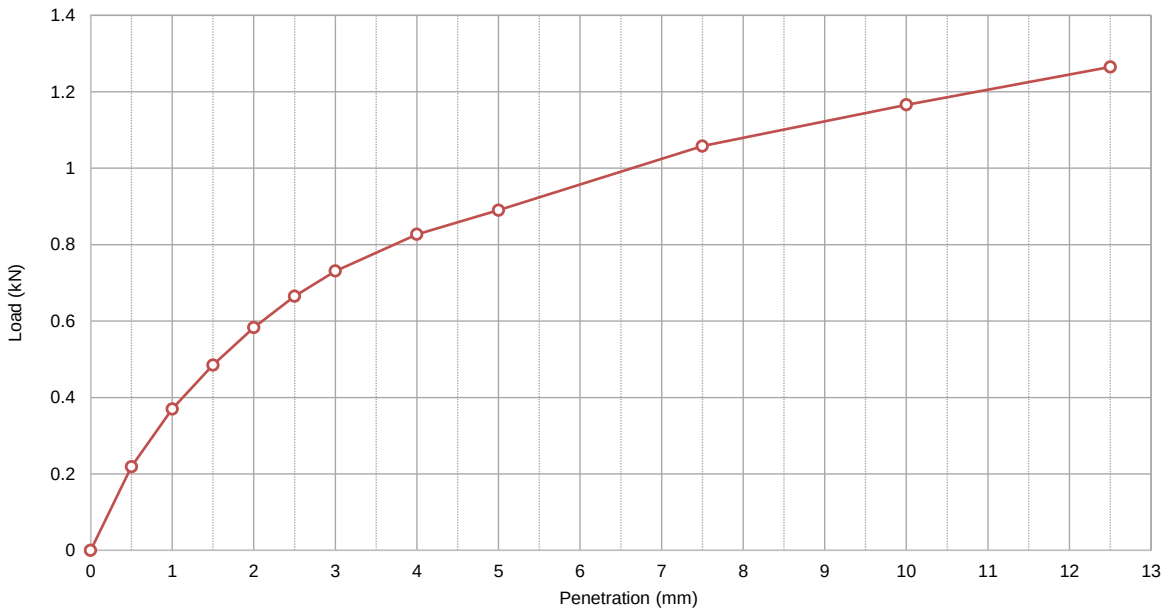
CALIFORNIA BEARING RATIO REPORT

Client	Morrow Geotechnics	**Source**	CBR11
Address	PO Box 4069, Carlton, NSW, 2218	**Sample Description**	Silty CLAY
Project	Denham Court (P1702)	**Report No.**	S50086-CBR
Job No.	S19326	**Sample No.**	S50086

Test Procedure:				
☑	AS 1289.6.1.1	☐	RMS T117	California Bearing Ratio
☑	AS 1289.5.1.1	☐	RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
☐	AS 1289.5.2.1	☐	RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
☑	AS 1289.2.1.1	☐	RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client	**Date Sampled:**	27/06/2019
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		**Density & Moisture**	**Achieved**	**Target**
Retained on 19.0mm Sieve (%)	1	Lab Moisture Ratio - LMR (%)	101.5	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	97.5	98.0
Sample Curing Time (hrs)	116 hrs	Dry Density - At Compaction (t/m³)	1.69	1.70
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.68	
Surcharge Mass Applied (kg)	4.5	Specimen Swell (%)	0.5	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	18.9	
Maximum Dry Density - MDD (t/m³)	1.73	Moisture Content - Top 30mm (%)	21.1	
Optimum Moisture Content - OMC (%)	18.7	Moisture Content - Remainder (%)	20.3	

Material CBR Value (%): **5** **at a penetration of** **2.5** **mm**

Notes:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

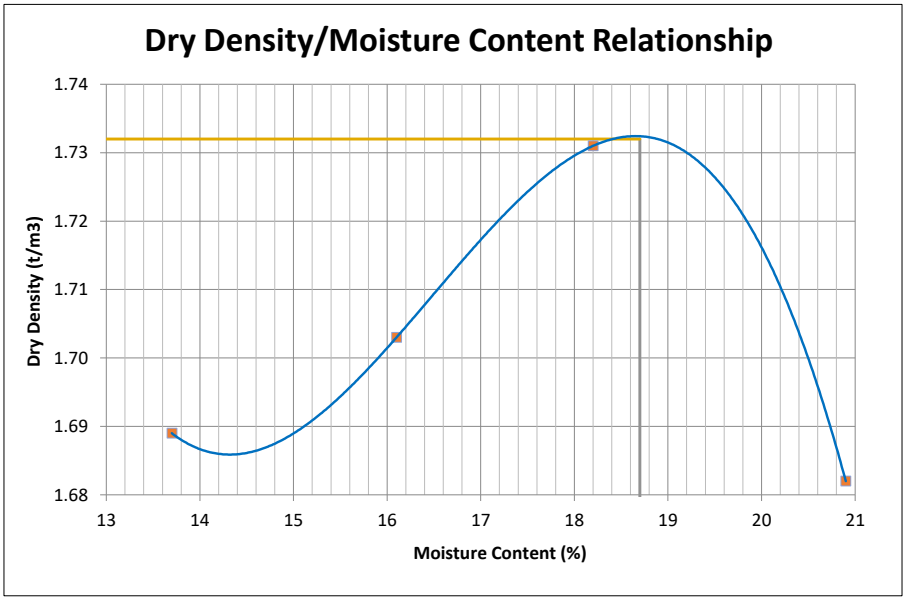
Client	Morrow Geotechnics	**Source**	CBR11
Address	PO Box 4069, Carlton, NSW, 2218	**Sample Description**	Silty CLAY
Project	Denham Court (P1702)	**Report No**	S50086-MDD
Job No	S19326-1	**Sample No**	S50086

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client	**Date Sampled:**	27/06/2019
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.732
Optimum Moisture Content (%)	18.7
Oversize Retained on 19mm sieve (%)	0.7
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	102 hrs
Liquid Limit Determination	Technician Assessment

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10/07/2019

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Alexandria NSW 2015

Appendix C

IMPORTANT INFORMATION

Important Information

This Document has been provided by Morrow Geotechnics Pty Ltd subject to the following limitations:

This Document has been prepared for the particular purpose outlined in Morrow Geotechnics' proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

The scope and the period of Morrow Geotechnics' Services are as described in Morrow Geotechnics' proposal, and are subject to restrictions and limitations. Morrow Geotechnics did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. The scope of services may have been limited by such factors as time, budget, site access or other site conditions. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Morrow Geotechnics in regards to it. Any advice given within this document is limited to geotechnical considerations only. Other constraints particular to the project, including but not limited to architectural, environment, heritage and planning matters may apply and should be assessed independently of this advice.

Conditions may exist which were undetectable given the limited nature of the enquiry Morrow Geotechnics was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required. No geotechnical investigation can provide a full understanding of all possible subsurface details and anomalies at a site.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Morrow Geotechnics' opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Morrow Geotechnics to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Morrow Geotechnics for incomplete or inaccurate data supplied by others.

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that Morrow Geotechnics be notified of any variations and be provided with an opportunity to review the recommendations of this report.

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