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13 September 2021
Our ref: KA/C12009

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Via email: michaela.coe@chc.com.au

Attention: Michaela Coe

PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

We are pleased to present our geotechnical investigation report for the proposed Blessed Carlo College located at the southeast corner of Lignum Road and Kiely Road, in Moama, NSW.

The report outlines the methods and results of exploration, describes site subsurface conditions and provides recommendations for building footing design, excavation conditions, preparation of subgrades, stability of cut and fill batters, and site drainage advice.

Should you require any further information regarding this report, please do not hesitate to contact our office.

Yours faithfully
ACT Geotechnical Engineers Pty Ltd

Jeremy Murray
Director
Senior Geotechnical Engineer

CLARKE HOPKINS CLARKE

PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

JULY 2021

CLARKE HOPKINS CLARKE

PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

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CLARKE HOPKINS CLARKE

PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

1 INTRODUCTION

At the request of Clarke Hopkins Clarke, ACT Geotechnical Engineers Pty Ltd carried out a geotechnical investigation for the proposed Blessed Carlo College to be located at the southeast corner of Lignum Road and Kiely Road, in Moama, NSW.

The project involves the construction of a K-12 school, which could comprise an admin building, library/resource centre, primary learning community, art, science, and tech buildings, a secondary learning community, a performance/amenity building, a sports stadium, sports courts and sports fields, a pick up/drop off area, staff carparking, and overflow parking. The aim of the investigation was to:

(i) Identify subsurface conditions including the extent and nature of any fill materials, soil strata, bedrock type and depth, and groundwater presence.

(ii) Advise on excavation conditions and suitability of excavated material for use as structural fill.

(iii) Provide site classification to AS2870 "Residential Slabs & Footings".

(iv) Advise on suitable footings systems, founding depths, allowable bearing pressures and design parameters for ground slabs.

(v) Provide guidelines for construction of controlled fill platforms.

(vi) Advise on stable batter slopes and retaining wall design parameters.

(vii) Provide subgrade CBR value(s) for pavement design.

(viii) Drainage and other geotechnical advice.

2 SITE DESCRIPTION & GEOLOGY

The ~150m x 320m site is located at the southeast quadrant of the Lignum Road/Kiely Road intersection in Moama, NSW. The lot is legally described as Lot 76 of DP751159. The site is on the outskirts of Moama, adjoining a proposed residential development. The lot is a greenfield site and previously used for farming purposes. The lot is generally flat, except for a ~1.5m deep depression, surrounded by small mounds, observed at the northwest corner of the site.

Figure 1 shows the site locality. Figure 2 is a recent aerial photograph showing the present site layout.

The 1:250,000 Bendigo Geology map (Reference 1) documents the site to be underlain by Quaternary age fluvial stream, valley-backfill and floodplain deposits comprising clay, sand, silt and gravel.

3 INVESTIGATION METHODS

To establish the subsurface conditions, a 5T excavator with a 300mm auger attachment was used to drill twenty (20) boreholes, designated BH01 to BH20, on 22 July 2021. The boreholes were terminated in alluvial soils at the required 2m/4m depth. The subsurface profiles were logged in general accordance with AS1726-2017. The locations of the boreholes are shown on Figure 2, and the detailed logs are included in Appendix A.

Definitions of geotechnical engineering terms used in the report on the borehole logs, including a copy of the USCS chart, are provided in Appendix C.

4 INVESTIGATION RESULTS

4.1 Subsurface Conditions

The subsurface conditions of the proposed development were investigated by twenty (20) boreholes designated BH01 to BH20. The borehole logs in Appendix A can be referred to for more detail. Investigation boreholes found the subsurface profile to comprise:

Geological Profile	Typical Depth Interval	Description
TOPSOIL	0.0m to 0.1m/0.4m	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm, loose.
ALLUVIUM	0.1m/0.4m to >2.0m/4.0m	SAND, Silty SAND, Silty Clayey SAND, Clayey SAND, Clayey SILT, Sandy CLAY; fine to coarse sand, low to medium plasticity fines, brown, dark brown, orange-brown, orange-grey, light brown, dry to moist, loose to dense, firm to very stiff.

Numerous mature trees were observed along the northern and western boundaries of the lot. A ~1.5m deep depression with mature trees was also observed near the northwest corner of the site (near BH05), which is expected to be filled to level.

4.2 Groundwater

Groundwater was not encountered and the soils were mostly dry. However, temporary, perched seepages could be encountered following rainfall within the more pervious soils.

4.3 Laboratory Testing

4.3.1 California Bearing Ratio

Three representative samples of the expected subgrade soil, designated 1A/1D were taken and sampled on 22 July 2021, and have been tested in a NATA-accredited laboratory for standard compaction, four-day soaked CBR value.

Results of standard compaction & soaked CBR tests performed on the soil samples are summarised in Table 1 below. The CBR test specimens were compacted to a nominal 98%StdMDD at about optimum moisture content, and soaked for four days prior to testing. All tests were conducted in accordance with the relevant Australian Standards. The NATA certificates are attached.

Table 1 - Test Results Summary

Sample No.	BH6	BH12	BH19
Depth of sample	**0.5m – 0.9m**	**0.7m – 1.2m**	**0.5m – 1.0m**
Material Description	**ALLUVIUM;** Silty Clayey SAND; fine to coarse sand, low plasticity fines, brown, dry, medium dense.	**ALLUVIUM;** SAND / Silty SAND; fine to medium grained sand, low plasticity silt, grey-brown, dry, loose to medium dense.	**ALLUVIUM;** SAND /Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry, medium dense to dense.
USCS (visually assessed)	SC-SM	SM	SP-SC
Std. Max. Dry Density (t/m^3)	1.60	1.64	1.71
Opt. Moisture Content (%)	23.0	21.0	19.0
Field Moisture Content (%)	23.0	20.8	19.0
Laboratory Density Ratio (%)	97.5	98.0	98.5
CBR Value (4-day soak) (%)	**2.0**	**3.0**	**5.0**

4.3.2 SPOCAS, Salinity and Sodicity Test Results

Results of the acid sulphate testing are summarised in Table 2 below. Full details are provided on the NATA test certificates attached.

TABLE 2 - Laboratory SPOCAS Test Results Summary

Sample No.	**BH5**	**BH12**	**BH19**
Depth	0.5m	0.6m	0.5m
pH_{KCl} (before oxidation)	6.6	8.9	8.2
pH_{OX} (after oxidation)	7.0	9.2	8.7
Total Actual Acidity (mol H^+/tonne)	<5	<5	<5
Total Potential Acidity (mol H^+/tonne)	<5	<5	<5
Total Sulphidic Acidity (mol H^+/tonne)	<5	<5	<5
a-Net Acidity (mol H^+/tonne)	<5	<5	<5
Liming Rate (kg $CaCo_3$/tonne)	<0.75	<0.75	<0.75
Salinity (mg/kg)	4,600	2,700	5,300
Electrical Conductivity (dS/m)	0.194	0.096	0.232
Exchangeable Sodium Percentage (%)	4	6	12

The tested soils did not become more acidic, which suggests that iron sulphides and sulphidic material are not present. Based on the ASSMAC 1998 "Acid Sulphate Soil Manual" guidelines the level of environmental risk for this development is rated as "low".

5 DISCUSSION & RECOMMENDATIONS

5.1 Site Classification

5.1.1 Primary School, Secondary School, Admin/Staff Building, Reception Building

Due to the presence of mature trees within the influence distance of the proposed structures, the sites are designated as a Class "P" (problem) site in accordance with AS2870.

With consideration to the reactivity of the soils within the depth of suction change, in terms of potential shrink-swell movements that may occur due to the soil moisture changes, including the additional suction induced by the trees in accordance with the method described by AS2870-2011 Appendix H, a characteristic ground surface movement "ys", is estimated to be between 20mm to 30mm. Therefore the surface movement is equivalent to that of a Class "M" (moderately reactive) site.

Should earthworks (cut or fill) be undertaken on the site, or other activities which may cause abnormal moisture conditions to impact the soils within or near the building envelope beyond those addressed herein, the site classification shall be reassessed.

5.1.2 Music Hall, Sports Hall, Performance Area, Sacred Space, Library

The residual/ alluvial/colluvial soils at the site within the depth of suction change are moderately reactive in terms of potential shrink-swell movements that may occur due to soil moisture changes. The characteristic ground surface movement "ys", as defined by AS2870 for the range of normal soil moisture conditions is estimated to be between 20mm to 40mm for the encountered subsurface profile described in Section 2. The site is therefore Class "M" (moderately reactive).

Normal moisture conditions are those caused by seasonal and regular climatic effects.

Should earthworks (cut or fill) be undertaken on the site, or other activities which may cause abnormal moisture conditions to impact the soils within or near the building envelope beyond those addressed herein, the site classification shall be reassessed.

5.2 Building Footings

AS2870 provides "deemed-to-comply" footing/slab designs, which for a Class "M" site includes stiffened rafts, stiffened footing slabs, waffle rafts, and strip and/or pad footings with above ground floors. Footings and slabs should be designed in accordance with the principles of AS2870.

For the areas classified as Class P, footing design shall be undertaken in accordance with engineering principles, based upon the requirements on AS2870 and the characteristic ground surface movement estimate of 20mm to 30mm.

For structures founded at existing grade, footings, including thickened sections of slabs forming footings should be founded below any topsoil or uncontrolled fill soils. Shallow footings could be founded in any newly placed controlled fill following removal of any topsoil material (see Section 5.6). Alternatively, footings could be founded on piers extending to dense/very stiff alluvial soil.

If designing footings based on engineering principles, recommended allowable end-bearing pressures for various footing systems and likely foundation materials are provided in Table 3.

TABLE 3
Recommended Allowable End-Bearing Pressures for Footings

Foundation Material Type	Depth Below Existing Surface Level	Allowable End-Bearing Pressure			Allowable Shaft Adhesion on Bored Piers	
		Strips	Pads	Bored Piers	Downward Loading	Uplift
Newly-Placed Controlled Fill	-	100kPa	125kPa	200kPa	-	-
Alluvial Soils (stiff or better)	Below 0.3m/1.4m	100kPa	125kPa	200kPa	20kPa	10kPa

All footings should be inspected and approved by an experienced geotechnical engineer to confirm the foundation material and design values, and to ensure the excavations are clean and stable.

Ground slabs can be constructed on the natural soils, following the removal of any topsoil and uncontrolled fill material. Following excavation to required level, slab areas on soil should be proof-rolled by a pad foot roller to check for any weak, wet or deforming soils that may require replacement. Suitable replacement fill should be compacted in not thicker than 150mm layers to not less than 98%StdMDD.

5.3 Excavation Conditions & Use of Excavated Material

Proposed excavation depths have not been advised. The soils within the upper 2.0m/4.0m are readily diggable by backhoe and medium sized excavator; however, hard digging conditions due to rock fragments within the soil units ("floaters") could be encountered.

The low/medium plasticity alluvial soils can be used in controlled fill construction of building platforms, although rock particles should be broken down to <75mm size. The existing topsoil should not be used in controlled fill construction.

If imported fill is required, a suitable select fill material would include a low or medium plasticity soil such as clayey sand or gravelly clayey sand, containing between 25% and 50% fines less than 0.075mm size (silt and clay), and no particles greater than 75mm size.

5.4 Stable Excavation Batters

Temporary site excavations to 1.5m depth can be formed at 1(H):1(V), although loose fill should be cut back at 2(H):(V). If required and space allows, deeper temporary cuts can be formed at 2(H):1(V) or benched at 1.5m intervals in soils. A geotechnical engineer should inspect all cut batters during construction to confirm stability. Exposed temporary batters should be protected from the weather by black plastic pinned to the face with link-wire mesh, or similar.

Permanent cut & fill batter slopes should be formed at no steeper than 2(H):1(V) in soil and EW bedrock and be protected against erosion by shotcreting, stone pitching or other suitable methods. Alternatively permanent excavations can be supported by structural retaining walls.

5.5 Low Retaining Walls

Retaining walls constructed in an open excavation, with the gap between the excavation face and the wall backfilled later, can be designed for an earth pressure distribution given by:

$$\sigma_h = (K\gamma' h) + Kq$$

where,

σ_h is the horizontal earth pressure acting on the back of the wall, in kPa

K is the dimensionless coefficient of earth pressure; this can be assumed to be 0.4 when the top of the wall is unrestrained horizontally, and 0.6 when the top of the wall is restrained (i.e. by building slabs etc.)

γ' is the effective unit weight of the backfill, and can be assumed to be $20kN/m^3$ for a lightly compacted soil backfill

h is the height of the backfill, in metres

q is any uniform distributed vertical surcharge acting on the top of the backfill, in kPa

Apart from structural restraints such as floor slabs, resistance to overturning and sliding of retaining walls is provided by frictional and adhesive resistance on the base, and by passive resistance at the toe of the wall. For a natural soil or controlled fill foundation, an ultimate base friction factor (tanδ) of 0.4, base adhesion (c) of 5kPa, and allowable passive earth pressure coefficient Kp=2.5 can be used for calculation of sliding resistance.

Free-draining granular backfill or synthetic fabric drains should be installed behind all walls. These should connect to weep holes and/or a collector drain, and ultimately to the stormwater system. Granular backfill should be wrapped in a suitable filter fabric to minimise infiltration of silt/clay fines

5.6 Controlled Fill Construction

For construction of any new fill foundation platforms and road subgrades, it is recommended that:

- Areas be fully stripped of all topsoil and uncontrolled fill material. A general stripping depth of up to 0.1m/0.4m is recommended. Stripped foundations should be proof-rolled by a vibratory pad-foot roller of not less than 9 tonne static mass to check for any weak or wet areas that would require replacement. No fill should be placed until a geotechnical engineer has confirmed the suitability of the foundation.

- Controlled fill comprising suitable site excavated or imported materials of not greater than 75mm maximum particle size, be compacted in not greater than 150mm layers to not less than 98%StdMDD at about OMC.

- Fill placement and control testing be overviewed and certified by a geotechnical engineer at Level 1 or 2 involvement of AS3798 – 2007 "Guidelines on Earthworks for Commercial & Residential Developments" (Reference 3).

5.7 Earthquake Site Factor

Table 2.3 of AS1170.4 "Minimum Design Loads on Structures - Part 4: Earthquake Loads" (Reference 4) lists the earthquake acceleration coefficients for major centres to be considered in structural design. The Moama area has an acceleration coefficient of 0.10.

Section 4.2 of AS1170.4 "Minimum Design Loads on Structures – Part 4: Earthquake Loads" lists the site sub-soil classes to be considered in structural design. The site is classified as a "Class C_e – Shallow Soil Site".

5.8 Design CBR Values

On-grade carpark, and access ramp subgrades should be stripped of all topsoil and uncontrolled fill, and soil subgrades then proof-rolled by a pad-foot roller to check for any wet or otherwise weak spots which may require additional removal. Suitable replacement fill can be compacted in not thicker than 150mm layers, to not less than 98%StdMDD.

On-grade pavements are expected to comprise natural soils or controlled fill, and pavements can be designed for a subgrade CBR value of 2%, when compacted to 98%StdMDD. A geotechnical engineer should inspect prepared subgrades to confirm design values, and preferably view a proof-roll to identify any soft spots or other weaknesses.

5.9 SPOCAS, Salinity and Sodicity

The tested soils did not become more acidic, which suggests that iron sulphides and sulphidic material are not present. Based on the ASSMAC 1998 "Acid Sulphate Soil Manual" guidelines the level of environmental risk for this development is rated as "low".

According to the Department of Natural Resources and Environment (DNRE) and the Murray-Darling Basin Commission (MDBC) guideline (Reference 4), the site soils salinity is 'low', and soils are classified as 'S0 – Non-Saline' to 'S1 – Slightly Saline'. The ESP value of less than 15% indicates non-sodic soils.

6.0 Site Drainage

Groundwater was not encountered during the investigation. The permanent groundwater table is expected to be well below expected excavations, although temporary perched seepages will be present following rain, but should be readily controllable through the use of pumps during construction.

Suitable surface drainage should be provided to ensure rainfall run-off or other surface water cannot pond against buildings or pavements. Drainage should be provided behind all retaining walls, and subsoil drains should be installed along the upslope sides of access roads and carparks.

ACT Geotechnical Engineers Pty Ltd

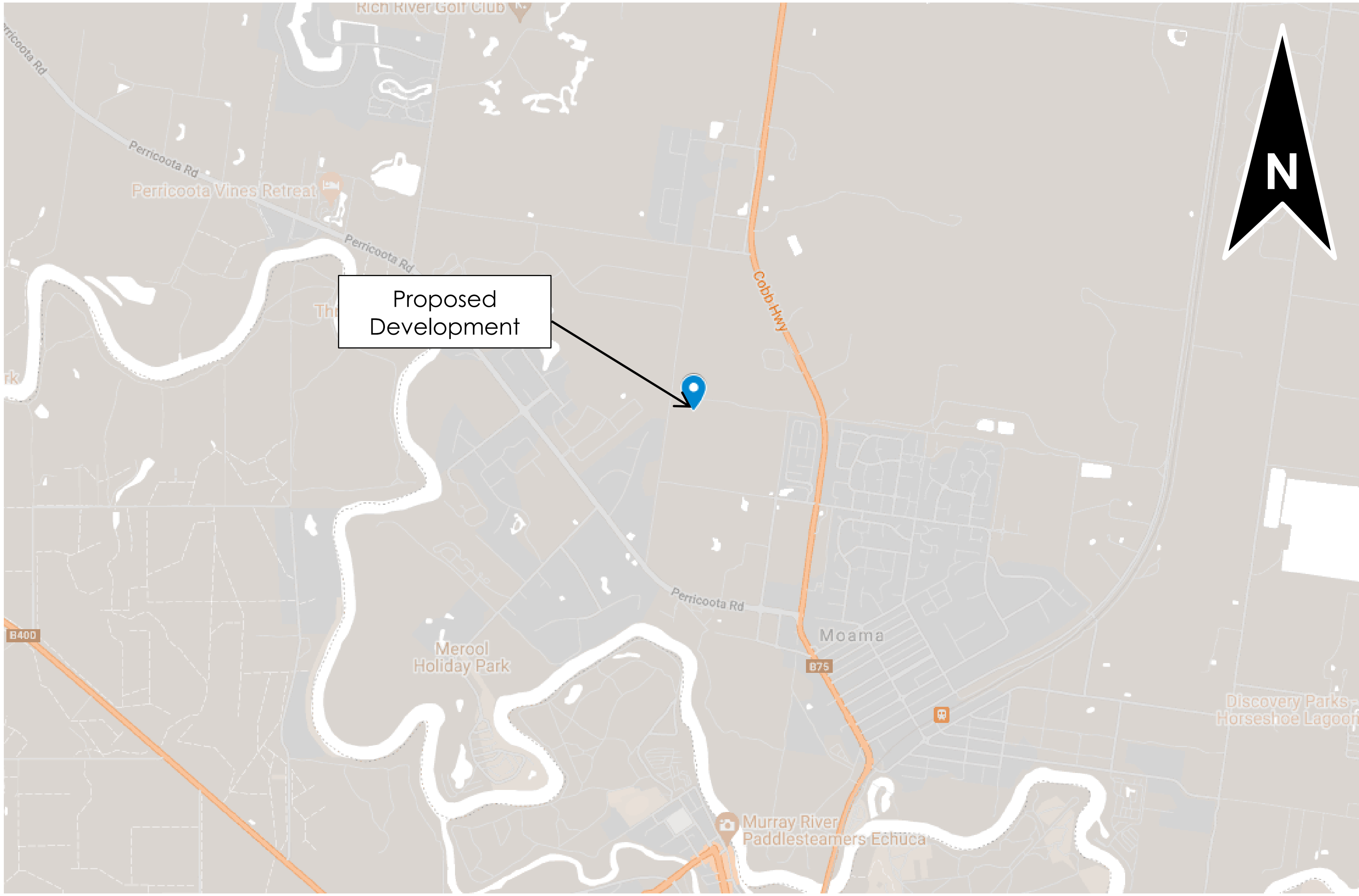
REFERENCES

1 Edwards, J. & Slater, K.R. (compilers), 2001. Bendigo SJ 55-1 Edition 3, 1:250 000 Geological Map Series. 1:250 000 geological map. Geological Survey of Victoria.

2 Standards Australia, "AS2870 – Residential Slabs & Footings", 2011.

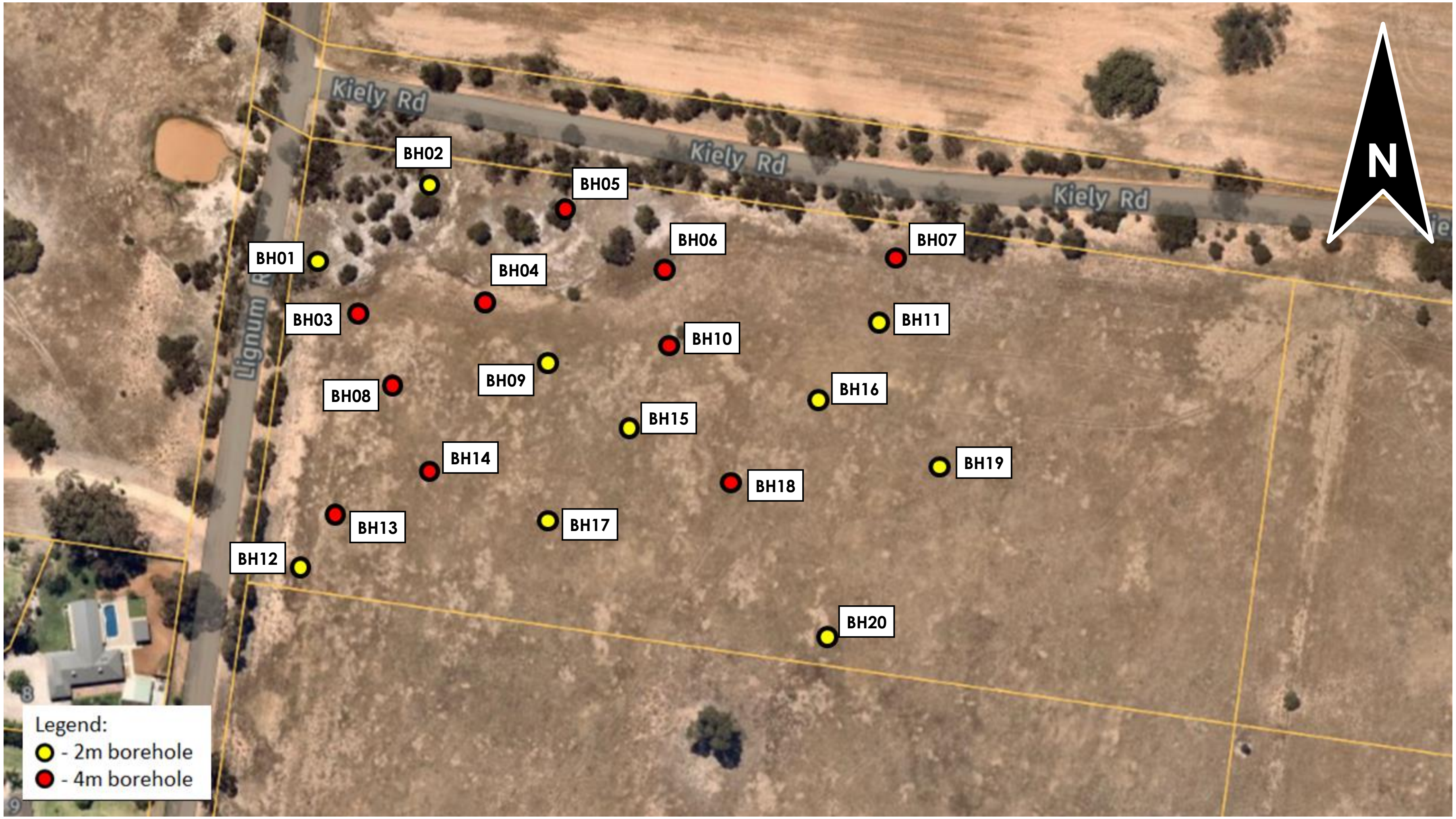
3 AS3798, "Guidelines on earthworks for commercial and residential developments".

4 Standards Australia, "AS1170.4 – 2007 – Minimum Design Loads on Structures – Part 4 Earthquake Loads".



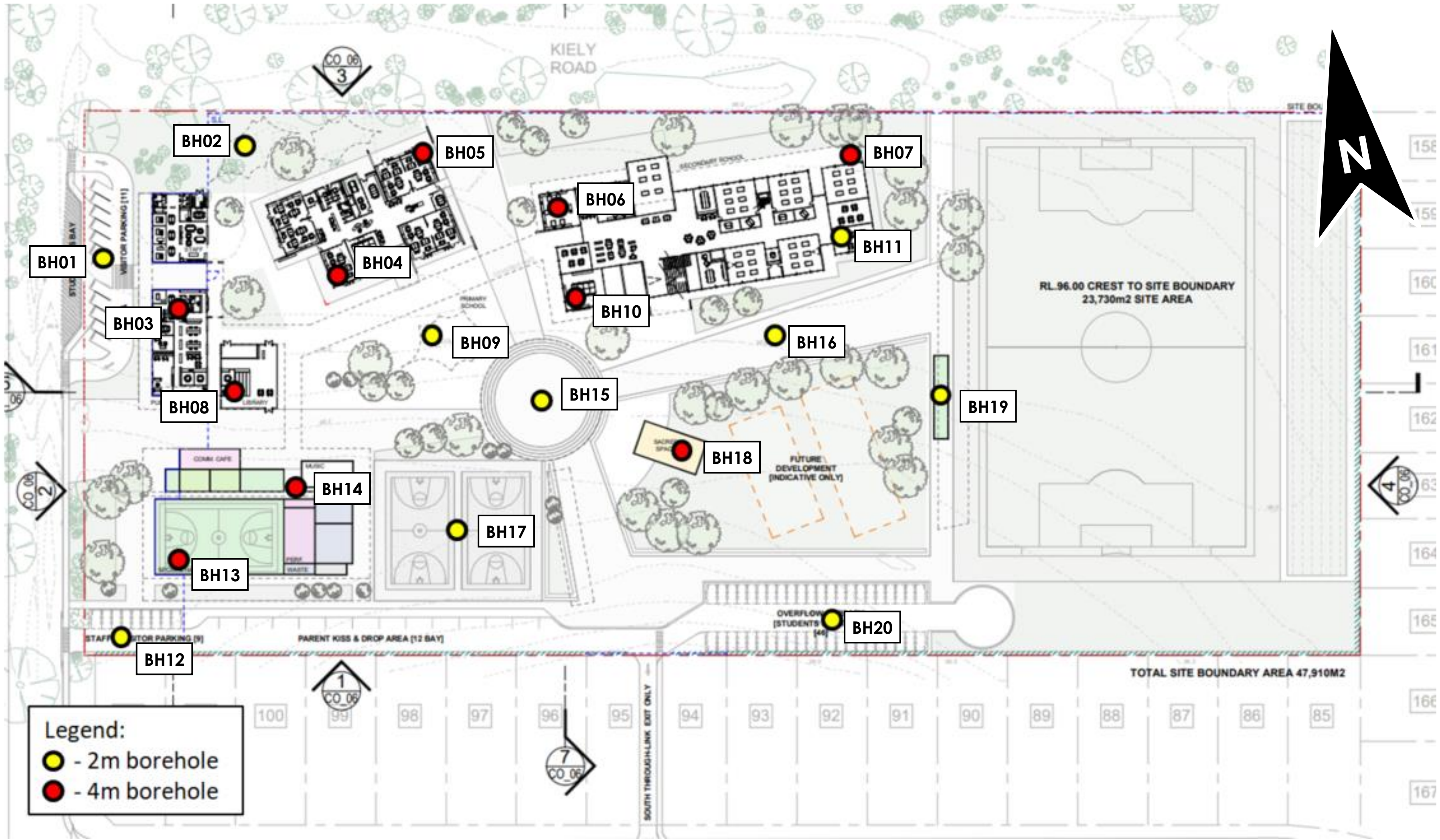
CLARKE HOPKINS CLARKE ACT
PROPOSED BLESSED CARLO COLLEGE - LIGNUM ROAD/KIELY ROAD, MOAMA, NSW
SITE LOCALITY

ACT Geotechnical Engineers Pty Ltd	C12009	FIGURE 1



CLARKE HOPKINS CLARKE ACT
PROPOSED BLESSED CARLO COLLEGE - LIGNUM ROAD/KIELY ROAD, MOAMA, NSW
AERIAL PHOTOGRAPH AND BOREHOLE LOCATIONS

ACT Geotechnical Engineers Pty Ltd	C12009	FIGURE 2



CLARKE HOPKINS CLARKE ACT

PROPOSED BLESSED CARLO COLLEGE - LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

SITE PLAN AND BOREHOLE LOCATIONS

ACT Geotechnical Engineers Pty Ltd	C12009	FIGURE 3

APPENDIX A
Borehole Logs BH01 to BH20

Borehole Log

Borehole No.	BH01
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.3		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm, tree root @0.2m.	LOOSE		TOPSOIL
			1.4		SM	Silty SAND; fine to coarse sand, low plasticity clay, light brown, dry.	LOOSE TO MEDIUM DENSE		ALLUVIUM
			2		SC	Clayey SAND; fine to coarse sand, low plasticity clay, trace gravel to 10mm, yellow-brown/grey-brown, dry.	MEDIUM DENSE		
						BOREHOLE TERMINATED AT 2m			

Depth scale: 1.0, 2.0, 3.0, 4.0, 4.5

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

Borehole Log

Borehole No.	BH02
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.3		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.7		SM	Silty SAND; fine to medium grained sand, low plasticity silt, light brown, dry.	LOOSE TO MEDIUM DENSE		ALLUVIUM
			1.0 1.7		SC-SM	Silty SAND / Silty Clayey SAND; fine to coarse sand, low plasticity fines, grey-brown, dry.	MEDIUM DENSE		
			2.0		ML	Clayey SILT; low plasticity fines, light brown, dry.	VERY STIFF		
			3.0 4.0 4.5			BOREHOLE TERMINATED AT 2m			

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

Borehole Log

Borehole No.	BH03
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.7		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			1.0 1.5		SW-SC	SAND / Clayey SAND; fine to coarse sand, low plasticity clay, yellow-brown, grey-brown, dry.	MEDIUM DENSE		
			2.0 3.0 3.1		SW-SC	SAND / Clayey SAND; fine to coarse sand, low plasticity clay, orange-brown, dry.	MEDIUM DENSE TO DENSE		
			3.8		SM	Silty SAND; fine to medium grained sand, low plasticity silt, pale brown/light grey, dry.	MEDIUM DENSE		
			4.0		SP	SAND; fine to medium grained sand, white, dry.	MEDIUM DENSE TO DENSE		
			4.5			BOREHOLE TERMINATED AT 4m			

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

Borehole Log

Borehole No.	BH04
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.3		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.6		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			1.0 1.4		SM	Silty SAND; fine to coarse sand, low plasticity clay, brown, dry.	LOOSE TO MEDIUM DENSE		
			2.0 2.6		SC-SM	Clayey Silty SAND; fine to coarse sand, low plasticity fines, grey-brown, dry. bec	MEDIUM DENSE		
			3.0 3.7		SW-SC	SAND / Clayey SAND; fine to coarse sand, low plasticity clay, orange-brown, dry.	MEDIUM DENSE TO DENSE		
			4.0		SP	SAND; fine to medium grained sand, white, dry.	MEDIUM DENSE TO DENSE		
			4.5			BOREHOLE TERMINATED AT 4m			

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

Borehole Log

Borehole No.	BH05
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
					SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.4		SC-SM	Silty Clayey SAND; fine to coarse sand, low to medium plasticity fines, grey-brown, dry to moist (less than plastic limit), becomes brown at 0.8m.	MEDIUM DENSE		ALLUVIUM
			1.0						
			2.0						
			2.5		SP-SC	SAND/Clayey SAND; fine to coarse sand, low to medium plasticity clay, orange-brown, grey-orange, dry.	DENSE		
			3.0						
			4.0			BOREHOLE TERMINATED AT 4m			
			4.5						

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

ACT Geotechnical Engineers

ACT Geo Engineers

Borehole Log

Borehole No.	BH06
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
				SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
		0.4		SC-SM	Silty Clayey SAND; fine to coarse sand, low plasticity fines, brown, dry.	MEDIUM DENSE		ALLUVIUM
		1.0						
		1.7		CL	Silty Sandy CLAY; low to medium plasticity clay, fine to medium grained sand, grey, dry.	VERY STIFF		
		2.0						
		2.4		SC-SM	Silty Clayey SAND; fine to coarse sand, low plasticity fines, grey-brown, dry.	DENSE		
		3.0						
		3.4		CL-CH	Sandy CLAY; medium plasticity clay, fine to medium grained sand, orange-grey, dry.	VERY STIFF TO HARD		
		4.0			BOREHOLE TERMINATED AT 4m			
		4.5						

Logged By : KA　Date : 22/7/21　Checked By : JM　Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

ACT Geotechnical Engineers

ACT Geo Engineers

Borehole Log

Borehole No.	BH07
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
		0.0–0.3		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
		0.3–0.4		CL	Sandy CLAY; low to medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
		0.4–0.7		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry.	LOOSE TO MEDIUM DENSE		
		0.7–1.8		SM	Silty SAND; fine to medium grained sand, low plasticity silt, some low to medium plasticity clay, grey-brown, dry to moist.	MEDIUM DENSE		
		1.8–2.5		CL	Silty Sandy CLAY; low to medium plasticity clay, fine to medium grained sand, grey, dry.	VERY STIFF		
		2.5–3.6		SC-SM	Silty Clayey SAND; fine to coarse sand, low plasticity fines, grey-brown, dry.	DENSE		
		3.6–4.0		CL-CH	Sandy CLAY; medium plasticity clay, fine to medium grained sand, orange-grey mottled, dry.	VERY STIFF TO HARD		
		4.0			BOREHOLE TERMINATED AT 4m			
		4.5						

Logged By : KA | Date : 22/7/21 | Checked By : JM | Date : 22/7/21

Borehole Log

Borehole No.	BH08
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.4		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			0.8		SM	Silty SAND; fine to coarse sand, low plasticity clay, light brown, dry.	LOOSE TO MEDIUM DENSE		
			1.0 2.0 2.8		SM	Silty SAND; fine to coarse sand, low plasticity silt, brown, yellow-brown, orange-brown, dry.	MEDIUM DENSE		
			3.0 4.0		SP-SC	SAND/Clayey SAND; fine sand, some low plasticity clay, orange-brown, dry. becomes orange-grey at 3.4m depth	MEDIUM DENSE		
			4.5			BOREHOLE TERMINATED AT 4m			

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

Borehole Log

Borehole No.	BH09
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.9		SM	Silty SAND; fine to coarse sand, low plasticity clay, light brown, dry.	LOOSE TO MEDIUM DENSE		ALLUVIUM
			2		SM	SAND/Silty SAND; fine to coarse sand, low plasticity clay, orange-brown, dry.	MEDIUM DENSE		
						BOREHOLE TERMINATED AT 2m			

Depth scale: 1.0, 2.0, 3.0, 4.0, 4.5

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

Borehole Log

Borehole No.	BH10
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
		0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
		0.4		SC	Clayey SAND; fine to coarse sand, low plasticity clay, brown, moist.	LOOSE TO MEDIUM DENSE		ALLUVIUM
		0.9		SM	Silty SAND; fine to coarse sand, low plasticity clay, light brown, dry.	LOOSE TO MEDIUM DENSE		
		1.0 1.6		SM	Silty SAND; fine to coarse sand, low plasticity silt, grey-brown, dry.	MEDIUM DENSE		
		2.0 3.0 3.5		SP-SC	SAND / Clayey SAND; fine to coarse sand, low plasticity clay, orange-brown, dry.	MEDIUM DENSE TO DENSE		
		4.0		SP-SC	SAND / Clayey SAND; fine to medium grained sand, low plasticity clay, orange-grey, dry.	MEDIUM DENSE TO DENSE		
		4.5			BOREHOLE TERMINATED AT 4m			

Logged By : KA Date : 22/7/21 Checked By : JM Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

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Borehole Log

Borehole No.	**BH11**
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
		0.15		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
		0.3		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
		1.0		SM	Silty SAND; fine to medium grained sand, low to medium plasticity silt, some low to medium plasticity clay, brown, dry.	MEDIUM DENSE		
		2.0			BOREHOLE TERMINATED AT 2m			
		3.0						
		4.0						
		4.5						

Logged By : KA Date : 22/7/21 Checked By : JM Date : 22/7/21

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Borehole Log

Borehole No.	**BH12**
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
				SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
		0.1		SM	Silty SAND; fine to medium grained sand, low plasticity silt, light brown, dry.	LOOSE		ALLUVIUM
		0.6		SM	SAND / Silty SAND; fine to medium grained sand, low plasticity silt, grey-brown, dry.	LOOSE TO MEDIUM DENSE		
		1.0						
		1.2		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry.	MEDIUM DENSE TO DENSE		
		2.0 2			BOREHOLE TERMINATED AT 2m			
		3.0						
		4.0						
		4.5						

Logged By : KA Date : 22/7/21 Checked By : JM Date : 22/7/21

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Borehole Log

Borehole No.	BH13
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.4		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			1.0 1.1		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry.	LOOSE TO MEDIUM DENSE		
			2.0 3.0 3.6		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry.	MEDIUM DENSE TO DENSE		
			4.0		SP-SC	SAND/Clayey SAND; fine to medium grained sand, low plasticity clay, orange-grey, dry.	MEDIUM DENSE TO DENSE		
			4.5			BOREHOLE TERMINATED AT 4m			

Logged By :	KA	Date :	22/7/21	Checked By :	JM	Date :	22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

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Borehole Log

Borehole No.	BH14
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.15		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.4		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			0.9		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry.	LOOSE TO MEDIUM DENSE		
			1.0 2.0 3.0 3.6		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry. becomes low to medium plasticity at ~2.8m	MEDIUM DENSE TO DENSE		
			4.0		SP-SC	SAND/Clayey SAND; fine to medium grained sand, low plasticity clay, orange-grey, dry.	MEDIUM DENSE TO DENSE		
			4.5			BOREHOLE TERMINATED AT 4m			

Logged By : KA   Date : 22/7/21   Checked By : JM   Date : 22/7/21

Borehole Log

Borehole No.	BH15
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.1		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.3		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			0.7		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry.	LOOSE TO MEDIUM DENSE		
			1.0 / 2.0		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, dry.	MEDIUM DENSE		
			3.0 / 4.0 / 4.5			BOREHOLE TERMINATED AT 2m			

Logged By : KA Date : 22/7/21 Checked By : JM Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

Borehole Log

Borehole No.	BH16
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.4		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			0.9		SM	Silty SAND; fine to medium grained sand, low to medium plasticity silt, brown, dry.	MEDIUM DENSE		
			1.0 2		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry. becomes low to medium plasticity at ~2.8m	MEDIUM DENSE TO DENSE		
			2.0			BOREHOLE TERMINATED AT 2m			
			3.0						
			4.0						
			4.5						

Logged By :	KA	Date :	22/7/21	Checked By :	JM	Date :	22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

Borehole Log

Borehole No.	BH17
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
		0.1		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
				CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
		0.5		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry. becomes low to medium plasticity at ~2.8m	MEDIUM DENSE TO DENSE		
		1.0						
		2.0			BOREHOLE TERMINATED AT 2m			
		3.0						
		4.0						
		4.5						

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

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Borehole Log

Borehole No.	**BH18**
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples	Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
		0.15		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
		0.5		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
		0.8		SM	Silty SAND; fine to medium grained sand, low to medium plasticity silt, brown, dry.	MEDIUM DENSE		
		1.0 2.0 3.0 3.4		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry.	MEDIUM DENSE TO DENSE		
		4.0		SP-SC	SAND/Clayey SAND; fine to medium grained sand, low plasticity clay, orange-grey, dry.	MEDIUM DENSE TO DENSE		
		4.5			BOREHOLE TERMINATED AT 4m			

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

Borehole Log

Borehole No.	BH19
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure (Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure)	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.5		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			1.0		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, orange-brown, yellow-brown, dry. becomes low to medium plasticity at ~2.8m	MEDIUM DENSE TO DENSE		
			2.0			BOREHOLE TERMINATED AT 2m			
			3.0						
			4.0						
			4.5						

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

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Borehole Log

Borehole No.	BH20
Sheet	1 of 1
Job No.	C12009

CLIENT: CLARKE HOPKINS CLARKE

PROJECT: PROPOSED BLESSED CARLO COLLEGE
LIGNUM ROAD/KIELY ROAD, MOAMA, NSW

Location : SEE REPORT

Collar Level : Not Known
Angle From Vertical : 0°
Bearing : N.A.

Equipment Type : 5T EXCAVATOR WITH AUGER
Hole Diameter : 300mm

Samples		Casing	Depth Metres	Graphic Log	U.S.C.S.	Material Description, Structure Soil Type: Plasticity or Particle Characteristics, Colour, Secondary and Minor Components, Moisture, Structure	Consistency or Relative Density	Field Test Results	Geological Profile
			0.2		SM	Silty SAND; fine to medium grained sand, low plasticity silt, brown, dry to moist, with grass rootlets, trace gravel to 5mm.	LOOSE		TOPSOIL
			0.4		CL-CH	Sandy CLAY; medium plasticity clay, fine to coarse sand, brown, moist.	FIRM TO STIFF		ALLUVIUM
			1.0 2.0		SP-SC	SAND/Clayey SAND; fine sand, low plasticity clay, yellow-brown, dry.	MEDIUM DENSE TO DENSE		
			3.0 4.0 4.5			BOREHOLE TERMINATED AT 2m			

Logged By : KA	Date : 22/7/21	Checked By : JM	Date : 22/7/21

BOREHOLE/EXCAVATION LOG C12009.GPJ ACT GEO.GDT 28/7/21

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APPENDIX B
Laboratory Test Results

Material Test Report

J & A Geotech Testing Pty Ltd

Canberra Laboratory
Unit 2, 25 Dacre Street Mitchell ACT 2911
Phone: (02) 6255 5363
Email: justin.smith@jageotech.com.au

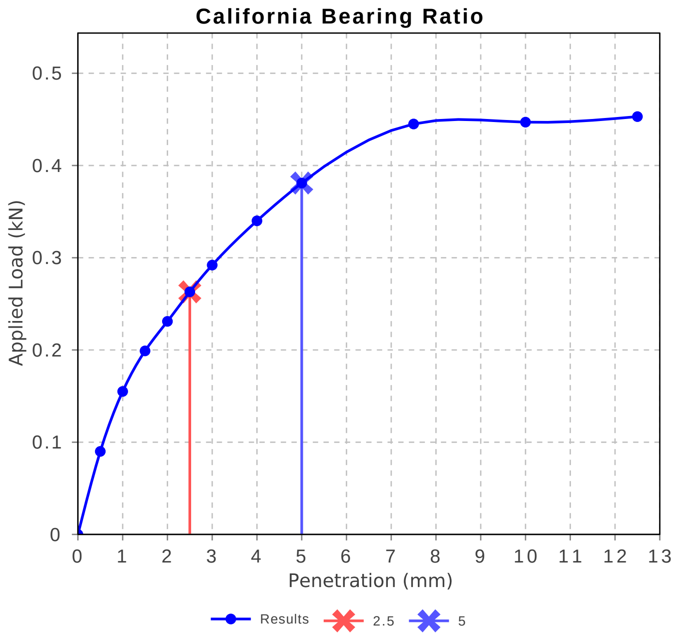
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Justin Smith
Managing Director

NATA Accredited Laboratory Number: 19979

Report Number: **CP21702-1**
Issue Number: 1
Date Issued: 05/08/2021
Client: ACT Geotechnical Engineers Pty Ltd
Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number: CP21702
Project Name: Lignum Road
Project Location: Moama, N.S.W
Client Reference: C12009
Work Request: 3244
Sample Number: CS3244A
Date Sampled: 26/07/2021
Dates Tested: 26/07/2021 - 04/08/2021
Sampling Method: Sampled by Client
The results apply to the sample as received
Preparation Method: AS 1289.1.1 - Sampling and preparation of soils
Site Selection: Selected by Client
Sample Location: **BH6, Depth: 0.5m - 0.9m**
Material: On Site Material

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.60		
Optimum Moisture Content (%)	23.0		
Laboratory Density Ratio (%)	97.5		
Laboratory Moisture Ratio (%)	100.0		
Moisture Content at Placement (%)	23.0		
Moisture Content Top 30mm (%)	30.7		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		
The maximum load has been reached for the CBR Machine. Maximum Applied Load kN, Penetration at Maximum Applied Load mm.			



Material Test Report

J & A Geotech Testing Pty Ltd
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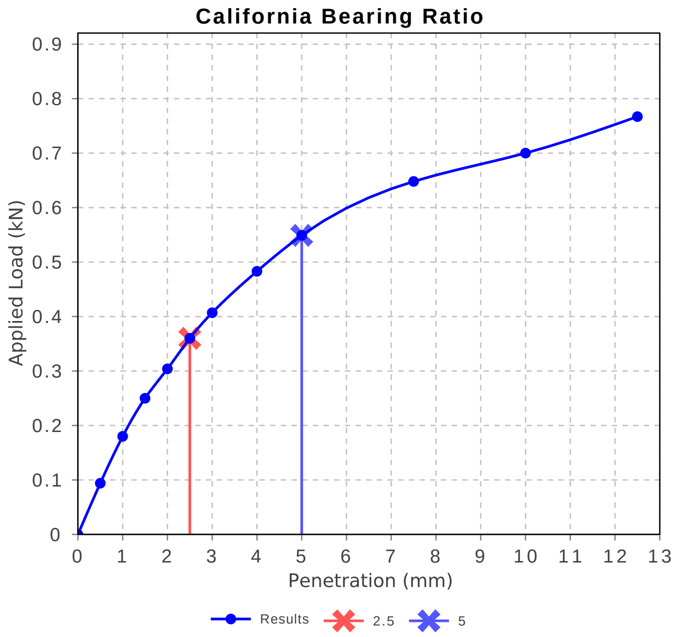
Accredited for compliance with ISO/IEC 17025 - Testing

WORLD RECOGNISED ACCREDITATION

Approved Signatory: Justin Smith
Managing Director
NATA Accredited Laboratory Number: 19979

Report Number:	**CP21702-1**
Issue Number:	1
Date Issued:	05/08/2021
Client:	ACT Geotechnical Engineers Pty Ltd Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number:	CP21702
Project Name:	Lignum Road
Project Location:	Moama, N.S.W
Client Reference:	C12009
Work Request:	3244
Sample Number:	CS3244B
Date Sampled:	26/07/2021
Dates Tested:	26/07/2021 - 31/07/2021
Sampling Method:	Sampled by Client *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Site Selection:	Selected by Client
Sample Location:	**BH12, Depth: 0.7m - 1.2m**
Material:	On Site Material

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**3.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.64		
Optimum Moisture Content (%)	21.0		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	100.0		
Moisture Content at Placement (%)	20.8		
Moisture Content Top 30mm (%)	27.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.1		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		
The maximum load has been reached for the CBR Machine. Maximum Applied Load kN, Penetration at Maximum Applied Load mm.			



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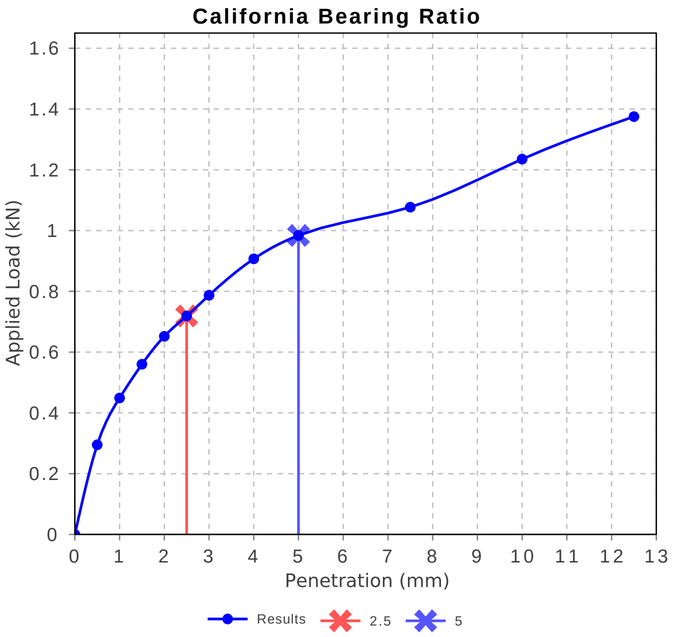
Report Number:	**CP21702-1**
Issue Number:	1
Date Issued:	05/08/2021
Client:	ACT Geotechnical Engineers Pty Ltd Unit 5/9 Beaconsfield St, Fyshwick ACT 2609
Project Number:	CP21702
Project Name:	Lignum Road
Project Location:	Moama, N.S.W
Client Reference:	C12009
Work Request:	3244
Sample Number:	CS3244C
Date Sampled:	26/07/2021
Dates Tested:	26/07/2021 - 31/07/2021
Sampling Method:	Sampled by Client *The results apply to the sample as received*
Preparation Method:	AS 1289.1.1 - Sampling and preparation of soils
Site Selection:	Selected by Client
Sample Location:	**BH19, Depth: 0.5m - 1.0m**
Material:	On Site Material

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	visual		
Maximum Dry Density (t/m^3)	1.71		
Optimum Moisture Content (%)	19.0		
Laboratory Density Ratio (%)	98.5		
Laboratory Moisture Ratio (%)	100.0		
Moisture Content at Placement (%)	19.0		
Moisture Content Top 30mm (%)	24.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	48.6		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		
The maximum load has been reached for the CBR Machine. Maximum Applied Load kN, Penetration at Maximum Applied Load mm.			



sPOCAS + %S w/w				
Our Reference		274838-1	274838-2	274838-3
Your Reference	UNITS	BH-5	BH-12	BH-19
Depth		0.5	0.6	0.5
Type of sample		Soil	Soil	Soil
Date prepared	-	02/08/2021	02/08/2021	02/08/2021
Date analysed	-	02/08/2021	02/08/2021	02/08/2021
pH_{kcl}	pH units	6.6	8.9	8.2
TAA pH 6.5	moles H^+/t	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01
pH_{Ox}	pH units	7.0	9.2	8.7
TPA pH 6.5	moles H^+/t	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+/t	<5	<5	<5
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01
ANC_E	% $CaCO_3$	0.43	1.8	0.92
a-ANC_E	moles H^+/t	85	350	180
s-ANC_E	%w/w S	0.14	0.56	0.29
S_{KCl}	%w/w S	0.08	0.01	0.08
S_P	%w/w	0.11	0.02	0.07
S_{POS}	%w/w	0.02	<0.005	<0.005
a-S_{POS}	moles H^+/t	14	<5	<5
Ca_{KCl}	%w/w	0.22	0.17	0.16
Ca_P	%w/w	0.26	0.66	0.26
Ca_A	%w/w	0.048	0.49	0.10
Mg_{KCl}	%w/w	0.12	0.14	0.11
Mg_P	%w/w	0.15	0.26	0.21
Mg_A	%w/w	0.023	0.13	0.095
S_{HCl}	%w/w S	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]	[NT]
a-S_{NAS}	moles H^+/t	[NT]	[NT]	[NT]
s-S_{NAS}	%w/w S	[NT]	[NT]	[NT]
Fineness Factor	-	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<5	<5	<5
s-Net Acidity	%w/w S	<0.01	<0.01	<0.01
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75
s-Net Acidity without -ANCE	%w/w S	0.02	<0.01	<0.01
a-Net Acidity without ANCE	moles H^+/t	14	<5	<5
Liming rate without ANCE	kg $CaCO_3$/t	1.1	<0.75	<0.75

ESP/CEC				
Our Reference		274838-1	274838-2	274838-3
Your Reference	UNITS	BH-5	BH-12	BH-19
Depth		0.5	0.6	0.5
Type of sample		Soil	Soil	Soil
Date prepared	-	02/08/2021	02/08/2021	02/08/2021
Date analysed	-	02/08/2021	02/08/2021	02/08/2021
Exchangeable Ca	meq/100g	26	20	7.5
Exchangeable K	meq/100g	0.7	1.1	0.7
Exchangeable Mg	meq/100g	8.2	14	9.4
Exchangeable Na	meq/100g	1.3	2.2	2.4
Cation Exchange Capacity	meq/100g	37	37	20
ESP	%	4	6	12

Misc Inorg - Soil				
Our Reference		274838-1	274838-2	274838-3
Your Reference	UNITS	BH-5	BH-12	BH-19
Depth		0.5	0.6	0.5
Type of sample		Soil	Soil	Soil
Date prepared	-	29/07/2021	29/07/2021	29/07/2021
Date analysed	-	29/07/2021	29/07/2021	29/07/2021
Estimated Salinity*	mg/kg	4,600	2,700	5,300

Method ID	Methodology Summary
Inorg-034	Soil samples are extracted and measured using a conductivity cell and dedicated meter.
Inorg-064	sPOCAS determined using titrimetric and ICP-AES techniques. Based on National acid sulfate soils sampling and identification methods manual June 2018. Ideally samples should be received in the laboratory at <4oC. Please refer to SRA for sample temperature on receipt.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.

QUALITY CONTROL: sPOCAS + %S w/w						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			02/08/2021	2	02/08/2021	02/08/2021		02/08/2021	[NT]
Date analysed	-			02/08/2021	2	02/08/2021	02/08/2021		02/08/2021	[NT]
pH $_{kcl}$	pH units		Inorg-064	[NT]	2	8.9	8.9	0	96	[NT]
TAA pH 6.5	moles H^+/t	5	Inorg-064	<5	2	<5	<5	0	93	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	2	<0.01	<0.01	0	[NT]	[NT]
pH $_{Ox}$	pH units		Inorg-064	[NT]	2	9.2	9.1	1	92	[NT]
TPA pH 6.5	moles H^+/t	5	Inorg-064	<5	2	<5	<5	0	110	[NT]
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	2	<0.01	<0.01	0	[NT]	[NT]
TSA pH 6.5	moles H^+/t	5	Inorg-064	<5	2	<5	<5	0	[NT]	[NT]
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	2	<0.01	<0.01	0	[NT]	[NT]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	2	1.8	1.8	0	[NT]	[NT]
a-ANC_E	moles H^+/t	5	Inorg-064	<5	2	350	350	0	[NT]	[NT]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	2	0.56	0.56	0	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	2	0.01	0.009	11	[NT]	[NT]
S_P	%w/w	0.005	Inorg-064	<0.005	2	0.02	0.02	0	[NT]	[NT]
S_{POS}	%w/w	0.005	Inorg-064	<0.005	2	<0.005	0.007	33	[NT]	[NT]
a-S_{POS}	moles H^+/t	5	Inorg-064	<5	2	<5	<5	0	[NT]	[NT]
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	2	0.17	0.17	0	[NT]	[NT]
Ca_P	%w/w	0.005	Inorg-064	<0.005	2	0.66	0.59	11	[NT]	[NT]
Ca_A	%w/w	0.005	Inorg-064	<0.005	2	0.49	0.42	15	[NT]	[NT]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	2	0.14	0.13	7	[NT]	[NT]
Mg_P	%w/w	0.005	Inorg-064	<0.005	2	0.26	0.26	0	[NT]	[NT]
Mg_A	%w/w	0.005	Inorg-064	<0.005	2	0.13	0.13	0	[NT]	[NT]
S_{HCl}	%w/w S	0.005	Inorg-064	<0.005	2	[NT]	[NT]		[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-064	<0.005	2	[NT]	[NT]		[NT]	[NT]
a-S_{NAS}	moles H^+/t	5	Inorg-064	<5	2	[NT]	[NT]		[NT]	[NT]
s-S_{NAS}	%w/w S	0.01	Inorg-064	<0.01	2	[NT]	[NT]		[NT]	[NT]
Fineness Factor	-	1.5	Inorg-064	<1.5	2	1.5	1.5	0	[NT]	[NT]
a-Net Acidity	moles H^+/t	5	Inorg-064	<5	2	<5	<5	0	[NT]	[NT]
s-Net Acidity	%w/w S	0.01	Inorg-064	<0.01	2	<0.01	<0.01	0	[NT]	[NT]
Liming rate	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	2	<0.75	<0.75	0	[NT]	[NT]
s-Net Acidity without -ANCE	%w/w S	0.01	Inorg-064	<0.01	2	<0.01	<0.01	0	[NT]	[NT]

QUALITY CONTROL: sPOCAS + %S w/w					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
a-Net Acidity without ANCE	moles H^+/t	5	Inorg-064	<5	2	<5	<5	0	[NT]	[NT]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	2	<0.75	<0.75	0	[NT]	[NT]

QUALITY CONTROL: ESP/CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			02/08/2021	[NT]	[NT]	[NT]	[NT]	02/08/2021	[NT]
Date analysed	-			02/08/2021	[NT]	[NT]	[NT]	[NT]	02/08/2021	[NT]
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	113	[NT]
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	113	[NT]
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	114	[NT]
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	[NT]	[NT]	[NT]	[NT]	114	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			29/07/2021	[NT]	[NT]	[NT]	[NT]	29/07/2021	[NT]
Date analysed	-			29/07/2021	[NT]	[NT]	[NT]	[NT]	29/07/2021	[NT]
Estimated Salinity*	mg/kg	5	Inorg-034	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

APPENDIX C
Definitions of Geotechnical Engineering Terms

DESCRIPTION AND CLASSIFICATION OF SOILS

The methods of description and classification of soils used in this report are based on the Australian Standard 1726 – 1993, Geotechnical site investigations. In general, descriptions cover the following properties – soil type, colour, secondary grain size, structure, inclusions, strength or density and geological description.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy clay) on the following basis:

Classification	**Particle Size**
Clay	Less than 0.002mm
Silt	0.002mm to 0.06mm
Sand	0.06mm to 2.00mm
Gravel	2.00mm to 60.00mm
Cobbles	60mm (63mm) to 200mm
Boulders	>200mm

Soils are also classified according to the Unified Soil Classifications System which is included in this Appendix. Rock types are classified by their geological names.

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The terms are defined as follows:

Consistency	**Shear Strength su(kPa) (Representative Undrained Shear)**	
Very soft	< 12	<2 (~SPT "N")
Soft	12 - 25	2-4
Firm	25 - 50	4-8
Stiff	50 – 100	8-15
Very Stiff	100 – 200	15-30
Hard	> 200	>30

Non-cohesive soils are classified on the basis of relative density, generally from the results of in-situ standard penetration tests as below:

Term	**Relative Density (%)**	**SPT Blows/300mm 'N'**
Very loose	< 15	<4
Loose	15-35	4-10
Medium dense	35-65	10-30
Dense	65-85	30-50
Very Dense	>85	>50

SAMPLING

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are generally taken by one of two methods:

1. Driving or pushing a thin walled sample tube into the soil and withdrawing with a sample of soil in a relatively undisturbed state.

2. Core drilling using a retractable inner tube (R.I.T.) core barrel.

Such samples yield information on structure and strength in additions to that obtained from disturbed samples 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 are given in the report.

PENETRATION TESTING

The relative density of non-cohesive soils is generally assessed by in-situ penetration tests, the most common of which is the standard penetration test. The test procedure is described in Australian Standard 1289 “Testing Soils for Engineering Purposes” Testing Soils for Engineering Purposes” – Test No. F3.1.

The standard penetration test is carried out by driving a 50mm diameter split tube penetrometer of standard dimensions under the impact of a 63 kg hammer having a free fall of 750mm.

The “N” value is determined as the number of blows to achieve 300mm of penetration (generally after disregarding the first 150mm penetration through possibly disturbed material). The results of these tests can be related empirically to the engineering properties of the soil.

The test is also used to provide useful information in cohesive soils under certain conditions, a good quality disturbed sample being recovered with each test. Other forms of in situ testing are used under certain conditions and where this occurs, details are given in the report.

DEFINITIONS OF ROCK, SOIL, AND DEGREES OF CHEMICAL WEATHERING

GENERAL DEFINITIONS – ROCK AND SOIL

ROCK In engineering usage, rock is a natural aggregate of minerals connected by strong and permanent cohesive forces.

Note: Since “strong” and “permanent” are subject to different interpretations, the boundary between rock and soil is necessarily an arbitrary one.

SOIL In engineering usage, soil is a natural aggregate of mineral grains which can be separated by such gentle mechanical means as agitation in water, can be remoulded and can be classified according to the Unified Soil Classification System. Three principal classes of soil recognized are:

Residual soils: soils which have been formed in-situ by the chemical weathering of parent rock. Residual soil may retain evidence of the original rock texture or fabric or, when mature, the original rock texture may be destroyed.

Transported soils: soils which have been moved from their places of origin and deposited elsewhere. The principal agents of erosion, transport and deposition are water, wind and gravity. Two important types of transported soil in engineering geology and materials investigations are:

Colluvium – a soil, often including angular rock fragments and boulders, which has been transported downslope predominantly under the action of gravity assisted by water. The principle forming process is that of soil creep in which the soil moves after it has been weakened by saturation. It may be water borne for short distances.

Alluvium – a soil which has been transported and deposited by running water. The larger particles (sand and gravel size) are water worn.

Lateritic soils: soils which have formed in situ under the effects of tropical weathering include all reddish residual and non residual soils which genetically form a chain of material ranging from decomposed rock through clay to sesqui-oxide rich crusts. The term does not necessarily imply any compositional, textural or morphological definition; all distinctions useful for engineering purposes are based on the differences in geotechnical characteristics.

ROCK WEATHERING DEFINITIONS

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

The degrees of rock weathering may be gradational. Intermediate stages are described by dual symbols with the prominent degree of weathering first (e.g. EW-HW).

The various degrees of weathering do not necessarily define strength parameters as some rocks are weak, even when fresh, to the extent that they can be broken by hand across the fabric, and some rocks may increase in strength during the weathering process.

Fresh drill cores of some rock types, such as basalt and shale may disintegrate after exposure to the atmosphere due to slaking, desiccation, expansion or contraction, stress relief or a combination of any of these factors.

AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS

This classification system provides a standardised terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable. Where other rock types are encountered, such as in dykes, standard geological descriptions are used for rock types and the same descriptions as below are used for strength, fracturing and weathering.

Under this system rocks are classified by Rock Type, Strength, Stratification Spacing, Degree of Fracturing and Degree of Weathering. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc) where these are relevant.

ROCK TYPE DEFINITIONS

ROCK TYPE	DEFINITION
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments.
Sandstone:	More than 50% of the rock consists of sand sized (0.06 to 2mm) grains.
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated.
Claystone:	More than 50% of the rock consists of silt or clay sized particles and the rock is not laminated.
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated.

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

STRATIFICATION SPACING

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

DEGREE OF FRACTURING

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

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

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 Society of Rock Mechanics.

Term	Point Load Index Is(50) MPa	Field Guide	Approx qu MPa*
Extremely Weak:	0.03	Easily remoulded by hand to a material with soil properties.	0.7
Very Weak:	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.	2.4
Weak:	0.3	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.	7
Medium Strong:	1	A piece of core 150mm long x 50mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
Strong: (SW)	3	A piece of core 150mm long x 50mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very Strong (SW)	10	A piece of core 150mm long x 50mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely Strong (Fr)	>10	A piece of core 150mm long x 50mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	>240

The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ration to the point load index of 24:1. This ratio may vary widely.

Unified Soil Classification System (Metricated)
Data for Description Indentification and Classification of Soils

MAJOR DIVISIONS				Group Symbol	Graphic Symbol	TYPICAL NAME	FIELD IDENTIFICATION: GRAVELS AND SANDS – GRADATIONS		NATURE OF FINES	DRY STRENGTH	Group Symbol	LABORATORY CLASSIFICATION: % [2] < 0.06mm	PLASTICITY OF FINE FRACTION			NOTES
COARSE GRAINED SOILS	More than 50% by dry mass, less than 60mm is greater than 0.06mm.	GRAVELS	More than 50% of coarse grains are greater than 2.0mm	GW		Well graded gravels and gravel-sand mixtures, little or no fines	GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	GW	0-5	-	>4	Between 1 and 3	1. Identify Fines by the method given for fine grained soils.
				GP		Poorly graded gravels and gravel-sand mixtures, little or no fines	POOR	Predominantly one size or range of sizes			GP	0-5	-	Fails to comply with above		2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.06mm size) is greater than 5% and less than 12%.
		GRAVELLY SOILS		GM		Silty gravels, gravel-sand-silt mixtures	GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	GM	12-50	Below 'A' line and Ip >7	-	-	Borderline classifications require the use of dual symbols eg SP-SM GW-GC
				GC		Clayey gravels gravel-sand-clay mixtures			Fines are plastic (1)		GC	12-50	Above 'A' line and Ip > 7	-	-	
		SANDS	More than 50% of coarse grains are greater than 2.0mm	SW		Well graded sands and gravelly sands, little or no fines	GOOD	Wide range in grain size	"Clean" materials (not enough fines to band coarse grains)	None	SW	0-5	-	>6	between 1 and 3	
				SP		Poorly graded sands and gravelly sands, little or no fines	POOR	Predominantly one size or range of sizes			SP	0-5	-	Fails to comply with above		
		SANDY SOILS		SM		Silty sand, sand-silt mixtures	GOOD TO FAIR	"Dirty" materials (Excess of fines)	Fines are non-plastic (1)	None to medium	SM	12-50	Below 'A' line or Ip < 4	-	-	
				SC		Clayey sands, sand-clay mixtures			Fines are plastic (1)		SC	12-50	Above 'A' line and Ip > 7	-	-	

DESCRIPTIVE DATA (coarse grained soils): Give typical name, indicate approximate percentages of sand and gravel, maximum size, angularity, surface condition and hardness of the coarse grains, local or geological name and other perfinent descriptive information, symbols in parenthesis.

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, 10mm maximum size, rounded and sub angular sand grains coarse to fine, about 15% non-plastic fines with low dry strength, well compacted and moist in place, light brown alluvial sand, (SM)

SILT AND CLAY FRACTION
Fraction smaller than 0 20mm AS sieve size

MAJOR DIVISIONS			Group Symbol	Graphic Symbol	TYPICAL NAME	DRY STRENGTH	DILATANCY	TOUGHNESS	Group Symbol		PLASTICITY OF FINE FRACTION
FINE GRAINED SOILS	More than 50% by dry mass, less than 6mm is less than 0.06mm	Liquid Limit less than 50%	ML		Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	None to low	Quick to slow	None	ML	More than 50% passing 0.06mm	Below 'A' line
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium	CL		Above 'A' line
			OL		Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low	OL		Below 'A' line
		Liquid Limit more than 50%	MH		Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.	Low to medium	Slow to none	Low to medium	MH		Below 'A' line
			CH		Inorganic clays of high plasticity, fat clays.	High to very high	None	High	CH		Above 'A' line
			OH		Organic clays of medium to high plasticity.	Medium to high	None to very slow	Low to medium	OH		Below 'A' line
			Pt		Peat muck and other highly organic soils.	Readily identified by colour, odour, spongy feel and generally by fibrous texture			Pt*	*Effervescence with H2O2	

DESCRIPTIVE DATA (fine grained soils): 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 geological name and r pertinent descriptive information, symbols in parenthesis.

For undisturbed soil add information on structure, stratification, consistancy in undisturbed and remoulded states, moisture and drainage conditions.

EXAMPLE
Clayey Silt, brown, low plasticity, small percentage of fine sand, numerous vertical root-holes, firm and dry in place, fill, (ML).

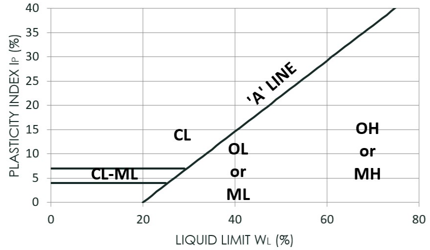
Determine approximate percentages of material over 60mm size, maximum size, shape, surface texture, hardness of material, geological description. Identify on estimated percentage mass of the various fractions.

COARSE GRAINED SOILS: More than half of the material less than 60mm is larger than 0.06mm

FINE GRAINED SOILS: More than half of the material less than 50mm is less than 0.06mm

0.05mm is about the smallest particle visible to the naked eye

Use the gradation curve of material passing 60mm for classification of fractions according to criteria given under "Major Division".



PLASTICITY CHART
FOR CLASSIFICATION OF FINE GRAINED SOILS

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Limitations in the Use and Interpretation of this Geotechnical Report

Our Professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject development and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive borehole and test pit logs, cross- sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory bore holes, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory bore holes and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between conducting this investigation and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and the recommendations considering the changed conditions and time lapse.

The summary bore hole and test pit logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the test holes progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The bore hole and test pit logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at the other locations may differ from conditions occurring at these bore hole and test pit locations. Also, the passage of time may result in a change in the soil conditions at these test locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, bore holes or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report: nor can our company be responsible for any construction activity on sites other than the specific site referred to in this report.