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Geotechnical Investigation Report

St Anthony of Padua Catholic School Austral

135-165 Tenth Avenue and 140 - 170 Eleventh Avenue, Austral, NSW 2179

Prepared for: Sydney Catholic Schools

Report Number: 6930-GR-1-1

Report Date: 13 April 2018

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Alliance Geotechnical Pty Ltd

10 Welder Road, Seven Hills, NSW

Phone: 1800 288 188 – Email: geotech@allgeo.com.au - Web: www.allgeo.com.au

DOCUMENT CONTROL

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APPROVAL

Author Signature		**Approver Signature**	
Name	Sahar Mamouri	**Name**	Suren Karasu
Title	Senior Geotechnical Engineer	**Title**	Principal Geotechnical Engineer

TABLE of CONTENTS

ATTACHMENTS

1. INTRODUCTION

This report presents the findings of a geotechnical investigation undertaken by Alliance Geotechnical Pty Ltd (AG) for Sydney Catholic Schools based on AG's fee proposal reference No. 714, dated 27th February 2018.

The site is located at 135-165 Tenth Avenue and 140 - 170 Eleventh Avenue, Austral, NSW 2179. The proposed development is St Anthony of Padua Catholic School and it includes 2, 3 & 4 storey buildings, a Gym, Church, surrounding landscapes and carpark facilities. One of the carparks is proposed to be an underground carpark. It is understood that a portion of the site (125 & 125A Tenth Ave.) is proposed for future development and a part of the proposed development includes ELC and Kindergarten buildings with associated car park currently under construction.

The purpose of this investigation is to summarise the findings of the geotechnical investigation, provide geotechnical recommendations including design parameters for the proposed development. The results of the geotechnical investigation are described in Section 3 (Geotechnical Investigation).

1.1. Proposed Development

The following existing documents were made available to AG by the client:

- "Site Plan-Proposed", drawing No. DA005, Project No. 4032, prepared by Munns Sly Moore Architects;
- Site survey plan, ref. No. 41240DT, sheet 1 to 11, prepared by LTS Lockley, dated 17/10/2014;
- Geotechnical Investigation report, Ref. No. 29566Srpt, prepared for 140 Eleventh Ave. Austral by JK Geotechnics, dated 22 July 2016.

Based on the provided documents, AG has the following appreciation:

- The proposed development consists of three 2-storey buildings, three 3-storey buildings and one four-storey building. The remainder of the proposed single storey buildings includes Hall/ Gymnasium, Church, Hall and Trade Training Centre.
  AG was advised by the client that an underground carpark is proposed to be constructed at the north-western side of the site, under the proposed landscaping area and the Hall/Gymnasium. The depth of the proposed underground carpark is not known to AG. Therefore, for the purpose of this report it is assumed to be a single level of basement 3m deep.
  There are other proposed carparks located at the western and south-eastern sides (as per the Site plan provided by the client). It is also proposed to construct Market Gardens, spaces for outdoor activities, a Piazza and a driveway along the eastern side.

- A portion of the north-eastern side of the site which was known as No. 140 Eleventh Ave is currently under construction with a few school buildings already in use. A geotechnical investigation was undertaken in this portion of the site by JK Geotechnics. This area and the location of the drilled boreholes are indicated on Drawing 6930-GR-1-A.

- Future developments are proposed for the south-eastern side of the site. This area is marked on Drawing 6930-GR-1-A.

1.2. Project Objectives

The objectives of this geotechnical investigation are to assess the subsurface conditions and provide geotechnical engineering comments and recommendations relating for the following:

- Geotechnical subsurface and groundwater conditions;
- Excavation and shoring for the underground carpark;
- Retaining structure design parameters;
- Geotechnical parameters for footing design;
- CBR and Young's Modulus parameters required for design of pavements.

1.3. Scope of Work

In order to achieve the project objectives, the following scope of work was carried out for the geotechnical investigation:

- Review of geological maps;
- Obtain Dial Before You Dig (DBYD) plans;
- Site walkover inspection during the fieldwork to gain an appreciation of the existing conditions and features;
- Drilling of 14 boreholes across the site to a maximum depth of 6m bgl[1];
- Carry out Standard Penetration Tests (SPTs) to evaluate soil strength at 1.5m depth intervals;
- Carry out 6 Dynamic Cone Penetrometer (DCP) tests to assess shallow soil strength;
- Collection of 3 soil samples for laboratory Atterberg Limits & Linear Shrink;
- Collection of 3 bulk soil samples for CBR tests;
- Prepare a geotechnical investigation report summarising the findings of the geotechnical investigation and provide recommendations for the proposed development.

2. BACKGROUND INFORMATION

2.1. Site Location and Description

The site is located on Lots 809, 812, 841-843 DP 2475, known as 135-165 Tenth Avenue and 140 - 170 Eleventh Avenue, within the semi-rural area of Austral. The general site location is shown in Figure 1.

Figure 1- General Site Location Map

[1] below the ground level

The site is located on a hill sloping towards the Kemps Creek located approximately 300m to the southwest.

The site is bounded by semi-rural properties to the east, Eleventh Avenue to the north, Fourth Avenue to the west and Tenth Avenue to the south.

At the time of carrying out the investigation, the site was covered by grass and trees with a few semi-rural dwellings on each lot. The site photos taken during the fieldwork are enclosed in Appendix A.

The site is located within an undulating terrain. The survey plan indicates that the current surface levels vary by approximately 8m over a distance of 280m. The highest section of the site is at an approximate RL 73m[2] at the north-eastern side and varies to RL 65 m at the south-western corner. As such, the site has a general slope of 2 degrees to the south-west.

2.2. Regional Geology

The 1:100,000 NSW Department of Mineral Resources Geological Map of the Penrith Region indicates the site is underlain by Bringelly Shale (Rwb) of the Mesozoic dating back to the middle Triassic period. The formation is generally described as *Shale, carbonaceous claystone, Claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff.*

Bringelly Shale is a component of the Wianamatta group of sedimentary rocks in the Sydney basin. Residual soils derived from Bringelly Shale typically comprise high plasticity clays with low bearing strength.

The investigation confirmed that the site is underlain by residual soils overlaying the shale bedrock. Figure 2 shows the site location on the geological map.

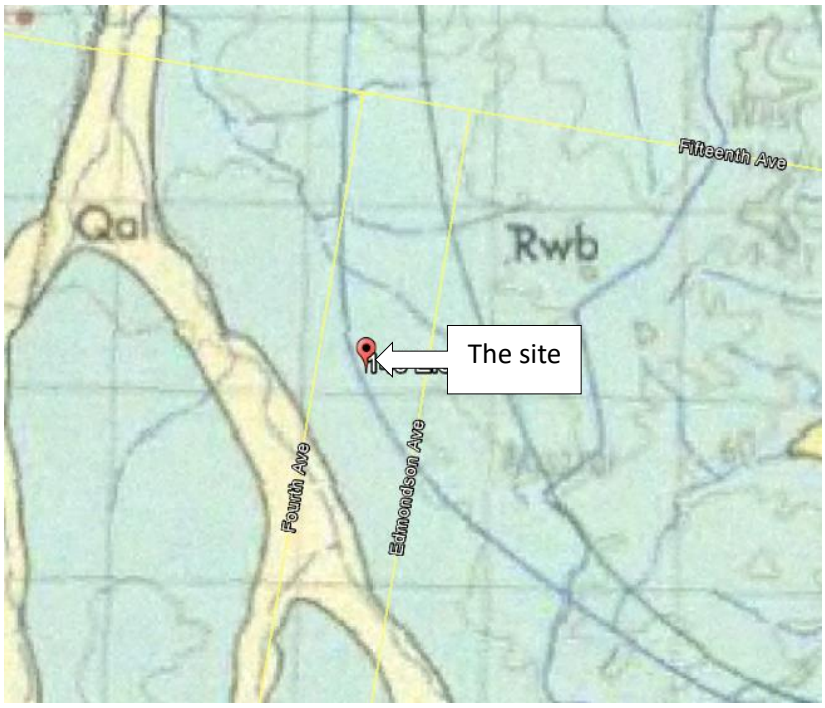


Figure 2- Extract from the Geological Map of Penrith

[2] All the real levels shown in this report are relative to AHD.

2.3. Previous Geotechnical Investigation

A previous geotechnical investigation was undertaken in the north-eastern side of the site known as (No. 140 Eleventh Ave) by JK Geotechnics in 2016. During the investigation, 10 boreholes were drilled. The borehole locations are shown on drawing 6930-GR-1-A in Appendix B. As shown on the drawing, seven (7) of the boreholes are located within the area which is currently partially completed. These previous boreholes were considered by AG to develop the site geotechnical model.

Silty clay topsoil was encountered in all boreholes to depths generally ranging 0.2m to 0.4m. Fill comprising dark brown silty clay fill with inclusions of root fibres was encountered below the topsoil in JK-BH7 to JK-BH9, and extended to depths between 1.0m and 1.2m. The material was very moist and poorly compacted. Residual silty clay of medium to high plasticity, stiff to hard consistency was encountered beneath the topsoil and fill in all boreholes. Boreholes JK-BH4 to JK-BH9 were terminated in the residual silty clay profile at depths between 1.5m and 1.95m bgl.

Weathered shale bedrock was encountered in boreholes JK-BH1 to JK-BH3 and borehole JK-BH10 at depths between 1.3m (JK-BH10) and 3.0m (JK-BH2). The shale bedrock encountered was generally extremely to distinctly weathered and of extremely low to low strength. This upper 'weak' profile extended to the borehole termination depths between 1.5m and 5.0m. The rest of the boreholes (JK-BH4 to JK-BH9) were shallow boreholes terminated between an approximate depths of 1.5m to 2m.

All boreholes were 'dry' during and on completion of drilling. No long-term groundwater level monitoring was carried out.

3. GEOTECHNICAL INVESTIGATION

3.1. Fieldwork

AG undertook the site investigation on 23rd of March 2018. Two AG Geotechnical Engineers observed drilling of 14 boreholes (BH1 to BH14) to a maximum depth of 6m bgl. Two drilling rigs were mobilised on site for the borehole drilling. The boreholes were drilled using a Hanjin 8D drilling rig and Christie Engineering drilling rig (Rig 7) operated by BG Drilling. The boreholes were advanced by solid flight 100 mm diameter auger with a TC (Tungsten Carbide) drill bit. 3 of the boreholes were terminated at an approximate depth of 1.5m bgl (target depth) and 11 of the boreholes were terminated upon encountering the TC bit refusal. The location of the boreholes are shown on the Borehole Location Plan (Drawing 2740-GR-1-A) enclosed in Appendix B. The approximate borehole locations were determined by measuring from the existing site features.

During the site investigation, the subsurface strata encountered were logged by AG's experienced geotechnical engineers and SPTs were undertaken at 1.5m depth intervals to assess the soil strength. 6 DCP tests were also undertaken to assess the shallow soils consistency. The borehole logs and DCP tests result are enclosed in Appendix C.

Soil samples were collected for geotechnical laboratory testing comprising Atterberg Limits and CBR as described in Section 4 and Soil Salinity tests which will be reported in a separate report (6930-ER-1-2, dated 9th April 2018).

3.2. Results of Geotechnical Investigation

3.2.1. Subsurface Condition

The inferred subsurface soil profiles at the borehole locations are summarised in Table 1. Detailed borehole logs (BH1 to BH14) are presented in Appendix C. The approximate location of the boreholes in relation to the proposed developments is shown on Drawing 6930-GR-1-B, Appendix B.

Table 1 - Summary of Subsurface Condition

Borehole (No.)	Borehole Ground Surface Elevation	-	-	Unit 1	Unit 2	Unit 3	Borehole Depth
		Topsoil Silty clay	**Fill** Sandy Gravel	**Residual Soil** stiff to hard silty clay	**VL St. Shale (Class V)**	**L. St. Shale (Class IV)**	
	(m)	(m)	(m)	(m)	(m)	(m)	(m)
BH1	RL 73	0.0 – 0.3	-	0.3 – 1.6	1.6 – 2.8 (at top ~ RL 71.4)	Below 2.8 (~ RL 70.2)	2.8
BH2	RL 72.9	0.0 – 0.3	-	0.3 – 1.7	1.7 – 2.7 (at top ~ RL 71.2)	Blow 2.7 (~ RL 70.2)	2.7
BH3	RL 72.9	-	0.0 – 0.2	0.2 – 2.4	2.4 – 3.1 (at top ~ RL 70.5)	Below 3.1 (~ RL69.8)	3.1
BH4	RL 71.1	0.0 – 0.2	-	0.2 – 1.5	1.5 – 1.6 (at top ~ RL 69.6)	-	1.6
BH5	RL 71.5	0.0 – 0.2	-	0.2 – 1.3	1.3 – 2.4 (at top ~ RL 70.2)	Below 2.4 (~ RL69.1)	2.4
BH6	RL 72.7	0.0 – 0.2	-	0.2 – 2.7	2.7 – 4.7 (at top ~ RL 70)	Below 4.7 (~ RL 68)	4.7
BH7	RL 72.8	0.0 – 0.2	-	0.2 – 2.1	2.1 – 3.8 (at top ~ RL 70.7)	Below 3.8 (~ RL 69)	3.8
BH8	RL 72.5	-	0.0 – 0.1	0.1 – 1.9	1.9 – 2.1 (at top ~ RL 70.6)	-	2.1
BH9	RL 68.8	0.0 – 0.1	-	0.1 – 1.5	1.5 – 2.3 (at top ~ RL 67.3)	Below 2.3 (~ RL 66.5)	2.3
BH10	RL 66.8	0.0 – 0.2	-	0.2 – 3.3	3.3 – 4.6 (at top ~ RL 63.5)	Below 4.6 (~ RL 62.2)	4.6
BH11	RL 69.8	0.0 – 0.2	-	0.2 – 1.7	1.7 – 2.2 (at top ~ RL 68.1)	Below 2.2 (~ RL 67.6)	2.2
BH12	RL 73.2	0.0 – 0.2	-	0.2 – 1.5	-	-	1.5
BH13	RL 75	0.0 – 0.2	-	0.2 – 2.9	2.9 – 6.0 (at top ~ RL 72.1)	Below 6 (~ RL 69)	6.0
BH14	RL 75	0.0 – 0.15	-	0.15 – 3.0	3.0 – 4.5 (at top ~ RL 72)	Below 4.5 (~ RL 70.5)	4.5

Legend:
VL St.: Very Low Strength
L. St.: Low Strength

Based on the soil and rock material recovered during auger drilling and in-situ tests of SPT and DCP (the results are presented in the attached borehole logs and DCP test sheet, in Appendix C), the subsurface condition is summarised as:

Topsoil

The site is mainly underlain by silty clay topsoil with an approximate thickness of 0.2m.

Residual Soil (Unit 1)

The identified residual silty clay soils were characterised as medium to high plasticity as it is derived from Bringelly Shale bedrock. The depth of the residual soil is variable across the site between approximate depths of 1.3m in BH5 and 3.3m in BH10. The residual soils generally comprising very stiff consistency becoming hard with the depth except for boreholes BH8, BH10, BH13 & BH14, where the residual soils are characterised as mainly stiff.

Bedrock

The residual silty clay material is underlain by extremely weathered, very low strength shale inferred to be Class V. The very low strength shale was generally encountered at a shallower depth across the western part of the site, north-eastern corner and at the location of BH11, between approximate depths of 1.3m and 2.4m. This area is indicated as Area A on Drawing 6930-GR-1-B. The very low strength shale was encountered between an approximate depth of 2.7m and 3.3m at the southern side of the site which is shown as Area B on Drawing No. 6930-GR-1-B.

The boreholes (excluding BH4, BH8 & BH12) were terminated upon encountering TC bit refusal on low strength shale (Class IV) or potentially medium strength shale. Generally, the Class IV shale is anticipated to be encountered at an approximate RL 70m at the western and northern side, declining to RL 68m in BH6 and RL 62m in BH10.

3.2.2. Groundwater Seepage

Groundwater seepage was not observed during the auger drilling of the boreholes. However, it should be noted that groundwater seepage condition and is subject to seasonal and climatic conditions and may vary across the site. It is expected the groundwater seepage occurs through the interface of residual soil and bedrock. Referring to the site topography and location, it may flow towards the southwest.

4. LABORATORY TESTS

4.1. Laboratory Test Results

Laboratory tests were carried out in accordance with AS1289-2006 in a NATA-registered soils laboratory on selected soil samples collected during the drilling of the boreholes.

The laboratory tests were undertaken on:

- 3 Atterberg Limits tests samples to determine the soil plasticity;
- 3 CBR test samples to provide CBR value for pavement design;

The detailed results of the laboratory tests are presented in Appendix D and the test results are summarised in Table 2 and Table 3.

Table 2 - Summary of Atterberg Limits Tests and Emerson Crumb

Borehole	Depth (m)	Atterberg Limits			
		Moisture (%)	LL (%)	PL (%)	PI (%)
BH1	0.5 – 1.0	14.3	59	13	46
BH6	1.5 – 1.9	13.1	46	14	32
BH13	0.5– 0.8	21	67	16	51

Legend:

LL: Liquid Limit LS: Linear Shrinkage
PL: Plastic Limit PI: Plastic Index

Table 3 - Summary of CBR Test – 4 Days Soaked

Location	Depth (m)	OMC (%)	MDD (t/m³)	CBR (%)	Material Type
BH4	0.5 – 1.0	16	1.59	1.0	Silty Clay
BH8	0.5 – 1.0	23.5	1.64	4.0	Clay
BH12	0.8 – 1.5	19.5	1.70	2.5	Silty Clay

Legend:

MDD: Maximum Dry Density

OMC: Optimum Moisture Content CBR: California Bearing Ratio

5. COMMENTS AND RECOMMENDATIONS

5.1. Groundwater Seepage Control

As described in Section 3.2.2, groundwater seepage was not observed during the geotechnical investigation. However, it is expected the groundwater seepage may occur through the interface of residual soil and bedrock during the excavations for the proposed single level of the underground car park. As such, the construction works should plan to keep the excavation base dry and provide safe and stable working platform by controlling the groundwater seepage by using sump pump method.

The groundwater seepage level may fluctuate following the seasonal rainfall changes.

5.2. Underground Carpark Excavation

At this stage, AG was provided only with the concept Site Plan. Therefore, the Underground Carpark level and setbacks from the boundaries are unknown for AG at this stage. It is assumed that the proposed single level of basement excavation will be extended to a depth of 3m bgl.

The excavation for the proposed carpark is expected to encounter topsoil and very stiff to hard silty clay extending to an approximate depth of 1.7m bgl. Very low strength shale (Class V) is anticipated to be encountered at an approximate RL 71.2m, underlying the residual silty clay soils. The bedrock below the depth of investigation is expected to consist of low (or potentially medium) strength shale (Class IV or better) which could be confirmed following the drilling of a cored deeper borehole. Therefore, it is expected that the base of the single level underground carpark could be founded within Class IV shale.

Excavations through the overlying soils and very low strength (Class V) to low strength (Class IV) shale are expected to be readily achieved using conventional earthworks excavation equipment.

If the excavations are to extend into the bedrock of potentially medium or high strength (which are not confirmed to the depth of the excavation) the excavation may require larger excavators (i.e. 30 tonnes) and the use of ripping or rock impact breakers. Low vibration equipment near the site boundaries where vibrations could impact on adjacent road infrastructures.

The maximum 5 mm/s vibration limit is expected to be achieved provided that rock breaker equipment and excavation methods are restricted as indicated in Table 4.

Table 4 - Recommendations for Rock Breaking Equipment

Distance from Adjacent Structure (m)	Maximum Peak Particle Velocity 5 mm/s	
	Equipment	Operating Limit (% of Maximum Capacity)
1.5 to 2.5	hand-operated jack-hammer only	100
2.5 to 5.0	300 kg Rock Hammer	50
5.0 to 10.0	300 kg Rock Hammer or 600 kg Rock Hammer	100 50

A dilapidation survey on nearby road infrastructures is recommended to be undertaken prior to the commencement of any site excavations.

5.3. Temporary Batter Slopes

Temporary batter slopes may be feasible for the proposed carpark basement depending on the construction sequence while it has sufficient set back from the adjacent structure or infrastructure. Unsupported excavations in soil and Class V shale should not extend below the 'zone of influence' of any adjacent structures, road and infrastructures (i.e. a 45° line drawn from the foundation level of any adjacent structure).

The recommended maximum permanent and temporary cue batter slopes are presented in Table 5 for the soils above the groundwater seepage level.

It is recommended that excavation methodology be prepared or reviewed by a geotechnical engineer and structural drawings of the shoring system be reviewed by a geotechnical engineer.

Table 5 - Maximum Excavation Batter Slopes

Material	Maximum Cut Batter Slope (H: V)	
	Permanent	Temporary *
Fill / topsoil	N/A	1.5: 1
Residual stiff to hard residual Clay	N/A	1: 1
Very low strength shale (Class V)	1 : 1 **	1: 2
Low strength shale (Class IV)	1 : 1.5**	1: 4
*Any temporary cuts in soils should be covered to maintain natural moisture and could remain unsupported for a duration of 2 to 3 weeks. ** Subject to inspection by a Geotechnical Engineer and carrying out remedial works if recommended (shotcrete, rock bolting, etc.).		

5.4. Excavation Support

If the unsupported temporary slopes are not feasible for the proposed basement excavations, it should be supported by a properly designed shoring system. The type of the retaining structure for the basement excavation can be in a form of soldier piles with reinforced shotcrete infill panels and drainage provided behind the shotcrete panels.

Piles would need to be extended below the proposed excavation base. A minimum socket depth of 0.5m below the excavation base in low strength (Class IV) or better bedrock is recommended for the shoring system piles and the final socket depth should be advised and confirmed by the design engineer.

The retention system will need to be designed and detailed by a structural engineer. The parameters provided in Table 6 can be used for design. The design of basement support could be incorporated into the permanent basement walls of the structure.

The specific requirements for excavation support are to be assessed by an experienced geotechnical engineer as the excavation proceeds. It is recommended that every 1.5m depth of the excavation be inspected by an experienced geotechnical engineer before shotcreting.

5.5. Lateral Earth Pressure Coefficients

Earth retaining structures should be designed in accordance with AS 4678 recommendations using the preliminary geotechnical parameters set out in Table 6.

Earth retaining structures should be designed to withstand the applied lateral pressures of the subsurface soil layers, together with the existing live surcharge loads within the zone of influence of the structure. For the design of flexible retaining structures, where some lateral movement is acceptable, an 'active' lateral earth pressure coefficient is recommended (k_a). If it is critical to limit the horizontal deformation of a retaining of an earth pressure coefficient 'at rest' should be considered (k_o).

If the retaining system is to be constructed with top to bottom bracing or anchoring method, the retaining wall should be preliminarily designed using trapezoidal stress distribution. The anchored shoring system may be modelled utilising finite element numerical analysis methods. In this case, surcharge pressure should be added to the above stress distribution.

It is recommended that the structural engineering drawings for the development provide details of the retaining walls, including foundation bearing capacity, footings, surface drainage and subsoil drainage provisions.

Table 6- Parameters for Retaining Structure Design

Unit	Geotechnical Parameter	C' (kPa)	$\emptyset'$ (degrees)	γ (KN/m^3)	K_a	K_o	E (MPa)	ϑ
2	Very Stiff to Hard Silty Residual Clay	3	28	19	0.36	0.53	50	0.3
3	Vl. St. Shale (Class V)	30	28	23	0.36	0.53	75	0.25
4	L. St. or better shale (Class IV)	50	30	23	0.33	0.5	150	0.25

Legend:
$\emptyset'$: Effective Friction Angle
γ : Unit Weight
K_a: Active earth pressure
K_o: Earth pressure at rest
E: Elasticity Modulus
ϑ: Poisson's Ratio
c': Effective Cohesion

5.6. Foundations

5.6.1. Shallow foundations

The proposed educational buildings can be founded on shallow or deep footings considering the applied building's load. However, it should be considered that the medium to highly plastic residual silty clay soil is vulnerable to experience significant deformations due to seasonal soil moisture changes. Design of shallow foundations can adopt an allowable bearing capacity of 100kPa with a minimum 300mm embedment depth into very stiff to hard clay.

The underground carpark base is expected to be located within the low strength (Class IV) shale. The slab may be founded directly on Class IV shale at the basement level. The design parameters considered appropriate for underground carpark are presented in Table 8.

It is recommended to found each building on the same foundation stratum to minimise the risk of differential foundation movement/settlement.

Before pouring concrete, the excavations for the shallow footings should be inspected by an experienced geotechnical engineer to confirm the design assumptions and also to confirm that the bases of the footing excavations are clean and free of soft, loose, wet or disturbed soils.

Table 7 – Geotechnical Design Parameters for Shallow Foundation

Unit	Layer	Serviceability End Bearing Pressure (kPa)	Elastic Modulus (MPa)
3	VL. St. Shale (Class V)	700	75
4	L. St. or better Shale (Class IV)	1500	150

5.6.2. Deep Foundations

For the multi-storey buildings, the footings could be founded on deep footing founded on bedrock. The design parameters considered appropriate for the deep foundations are presented in Table 8.

If the deep footing is adopted, it is recommended that pile to be designed in accordance with AS 2159-2009 Piling – Design and Installation and design factors presented in clause 4.3 of this Standard should be applied.

Table 8 – Geotechnical Design Parameters for Deep Foundation

Unit	Layer	Approximate Depth (m)	Serviceability End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)	Elastic Modulus (MPa)
3	VL. St. Shale (Class V)	RL 70 to RL 67	700	70	50
4	L. St. or better Shale (Class IV)	RL 66.5 to RL 69	1000	100	150

Inspections should be undertaken during the pilling works or before lowering the reinforcement cage and pouring concrete. An experienced geotechnical engineer should confirm the design socket depths and also confirm that the base of the piles are clean and free of soft, loose, wet or disturbed soils.

The soil aggressivity class should be considered for the purpose of selecting/ designing durable footings in contact with site soils. As presented in AG's Salinity Assessment report No. 6930-ER-1-2, dated 9th April 2018, the soil aggressivity is assessed in conjunction with AS2159 – 2009 to classify the aggressivity of the soils for concrete and steel piles.

The laboratory analytical results of the samples analysed, indicate that the exposure classification[3] of the soils assessed to a depth of 1.5m below the ground surface would be:

- Concrete piles – non-aggressive; and
- Steel piles – mild to moderate aggressive.

[3] Table 6.4.2 (C) and Table 6.5.2 (C) in AS 2159-2009 Piling – Design and Installation

5.7. CBR Value for Pavement Design and Subgrade Preparation

CBR samples were taken at three locations:

- BH12 located in the proposed carpark at the southeastern side (Tenth Avenue frontage);
- BH4 located in the proposed carpark at along the western side (Fourth Avenue frontage); and,
- BH8 located in the proposed a driveway along the eastern side of the site.

A lower CBR value of 1.0% and 2.5% were observed in BH4 and BH12, respectively, which may be indicative of the need of subsoil drainage and soil stabilisation with lime/gypsum. Once the pavement and subgrade have been adequately drained and soil stabilised, the subgrade may exhibit a higher CBR value. As such, we have adopted a value of **3.0%** for the pavement design, which would be indicative of subgrade soils within the asphalt parking lots once subsoil drainage has been installed. We consider this value to be representative of the laboratory tests and the DCP test results we have carried out on site.

Based on the results of CBR laboratory tests, the suggested parameters for the design of the pavements on the residual clayey material are as following:

- CBR: 3%
- Elasticity (Young's) Modulus: 15 MPa
- Subgrade Reaction (k): 25 kPa/mm

AG recommends the following construction practice be adopted when preparing the subgrade layer and prior to the placement of the base and subbase layers:

- Strip topsoil across the site and remove any localised soft material. Remove unsuitable material from the site (e.g. deleterious material).
- After excavation to the design subgrade level, the exposed surface will require inspecting and proof rolling in the presence of a senior GITA (Geotechnical Inspection and Testing Authority) or geotechnical engineer who will identify and delineate any areas of soft or unsuitable subgrade material or where the design CBR value is considered to be not achievable. The proof roll should be carried out using a 10 to 12-tonne smooth drum roller over the entire subgrade area 6 to 8 passes under low speed and in static mode.

- Following the inspection and proof roll, areas of soft or unsuitable subgrade where the design CBR is considered to be not achievable shall be excavated to a suitable foundation level. Where ponding of free water is observed, subsoil drainage should be installed to the satisfaction of a geotechnical engineer. The excavated areas should then be filled using imported select granular fill (defined as a low plasticity material with a soaked CBR value of at least 15 percent) placed in layers not exceeding 200mm thick.

- Using a 10 to 12 smooth tonne roller the replaced select fill layers (following moisture conditioning if required) shall be compacted until a minimum dry density ratio of 100% standard (AS 1289 5.1.1, 5.4.1, 5.8.1) is achieved and the in-situ moisture content of the layer is within ± 2% of standard optimum (AS 1289 2.1.1, 5.1.1, 5.4.1, 5.8.1) at the time of carrying out the field density testing.

- Further proof rolling using the same specified roller and procedure outlined above shall be carried out. Field density testing in accordance with AS 1289 2.1.1, 5.1.1, 5.4.1 & 5.8.1 should then be carried out on the subgrade at intervals recommended by the GITA.

Following the satisfactory proof rolling of the subgrade layer and complying relative compaction test results (as shown in Table 9), the pavement construction may advance to the placement of the subbase layer, followed by the placement of the pavement base layer.

Table 9- Recommended Compaction Parameters for Proposed Pavement

Layer	Material	Compaction Requirement
Wearing Course	AC10	As per Council's requirement
Base Course	DGB20 to RTA3051	98% Modified Dry Density Ratio (AS 1289 5.2.1, 5.4.1)
Subbase Course	DGS40 to RTA3051 or crushed sandstone from certified stockpiles with a nominal particle size of 75mm, 4-day soaked CBR not less than 40% and PI less than 12.	98% Modified Dry Density Ratio (AS 1289 5.2.1, 5.4.1)
Subgrade	In situ clay, proof rolled with a minimum 10-tonne smooth roller.	100% Standard Dry Density Ratio (AS 1289 5.1.1, 5.4.1)

Following placement of the subbase and base layers field density testing in accordance with AS 1289 2.1.1, 5.2.1, 5.4.1, and 5.8.1 will need to be carried out on both the subbase and base layers. Testing should again be conducted at the discretion of the GITA.

All materials to be used for the respective pavement layers should be in accordance with the Councils Civil Works Construction Specification (2005). The compaction requirements for the subgrade, subbase and base layers are shown in Table 9.

5.8. Fill Placement & Compaction

If it is necessary to place and compact fill materials to establish the ground levels, all fill should be placed as defined in Australian Standard "AS 3798 -2007– Earthworks for residential and commercial developments". All the fills should be a controlled fill for the later reclassify of the fill.

Filling materials should not contain vegetation or other organic matter. It is recommended that all compaction control testing in areas that will support structures and pavements be undertaken under appropriate supervision by an approved GITA.

Filling material should be placed with density ratio and moisture content specified in Table 10.

Table 10 - Compaction specifications

Fill	Loose layer thickness (mm)	Minimum compaction ratio	Moisture
Engineered fill to support pavement, subgrades and structures	250	100%	$\pm$ 2 % OMC

OMC – Optimum Moisture Content (for compaction)

Granular fill is preferred although clay soils may be suitable for general filling provided they are of low to medium plasticity. The maximum particle size for any placed fill should be a 75mm nominal diameter. The granular fill shall be compacted to achieve a minimum density ratio of 70%.

Shale and clayey materials may be used for general filling for the purposes of landscaping or non-structural fill material. General filling with a compaction ratio of less than 98%, cannot be relied on as appropriate foundation strata for the shallow footings, to support pavement and subgrades.

5.8.1.1. Fill Embankment Batters

All designed fill batters should be constructed no steeper than 2.5:1 (horizontal: vertical). All batters must be protected against erosion by vegetating the exposed surface as soon as possible following construction and incorporate toe and spoon drains as means of controlling surface water flows on the batters.

6. LIMITATIONS

Alliance Geotechnical Pty Ltd (AG) has prepared this report for the site located at 135-165 Tenth Avenue and 140 - 170 Eleventh Avenue, Austral, NSW 2179, in accordance with AG's fee proposal and Terms of Engagement. This geotechnical report has been prepared for Sydney Catholic Schools for this project and for the purposes outlined in this report. This report cannot be relied on for other projects, other parties on this site or any other site. The comments and recommendations provided in this report are based on the assumption that the geotechnical recommendations contained in this report will be fully complied with during the design and construction of the proposed site development

The borehole investigation and testing results provided in this report are indicative of the subsurface conditions at the site only at the specific sampling and testing locations, and to the depths drilled at the time of the investigation. Subsurface conditions can change significantly due to geological and human processes. Where variations in conditions are encountered further geotechnical advice should be sought from AG.

References

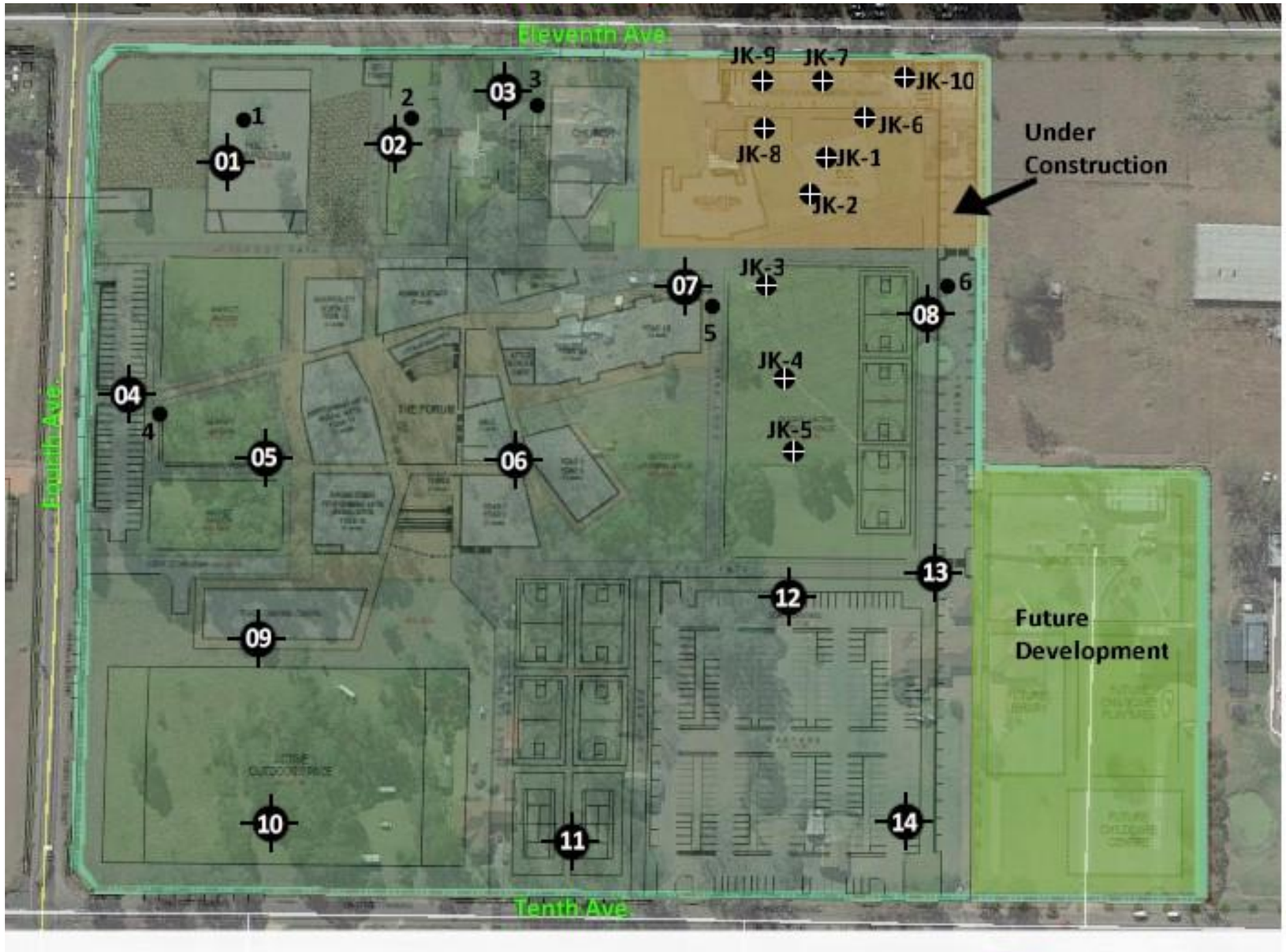
- AS 1170.4-2007 – Structural Design Actions- Earthquake Actions in Australia
- AS1726-1993 - Geotechnical Site Investigations
- AS 1289 – 2006 - Method of testing soils for engineering purposes
- AS 2870-2011 - Residential slabs and Footings Construction
- AS 2159-2009 - Piling - Design and Installation
- AS 3798 – 2007 - Guidelines on Earthworks for Commercial and Residential Developments
- AS 4678 – Earth Retaining Structures
- Pells et al "Foundations on Sandstone and Shale in the Sydney Region" AGJ, 1998
- The 1:100,000 NSW Department of Mineral Resources Geological Map of Penrith

APPENDIX A
Site Photographs

Photo 1 – AG's Site Investigation – Looking the west

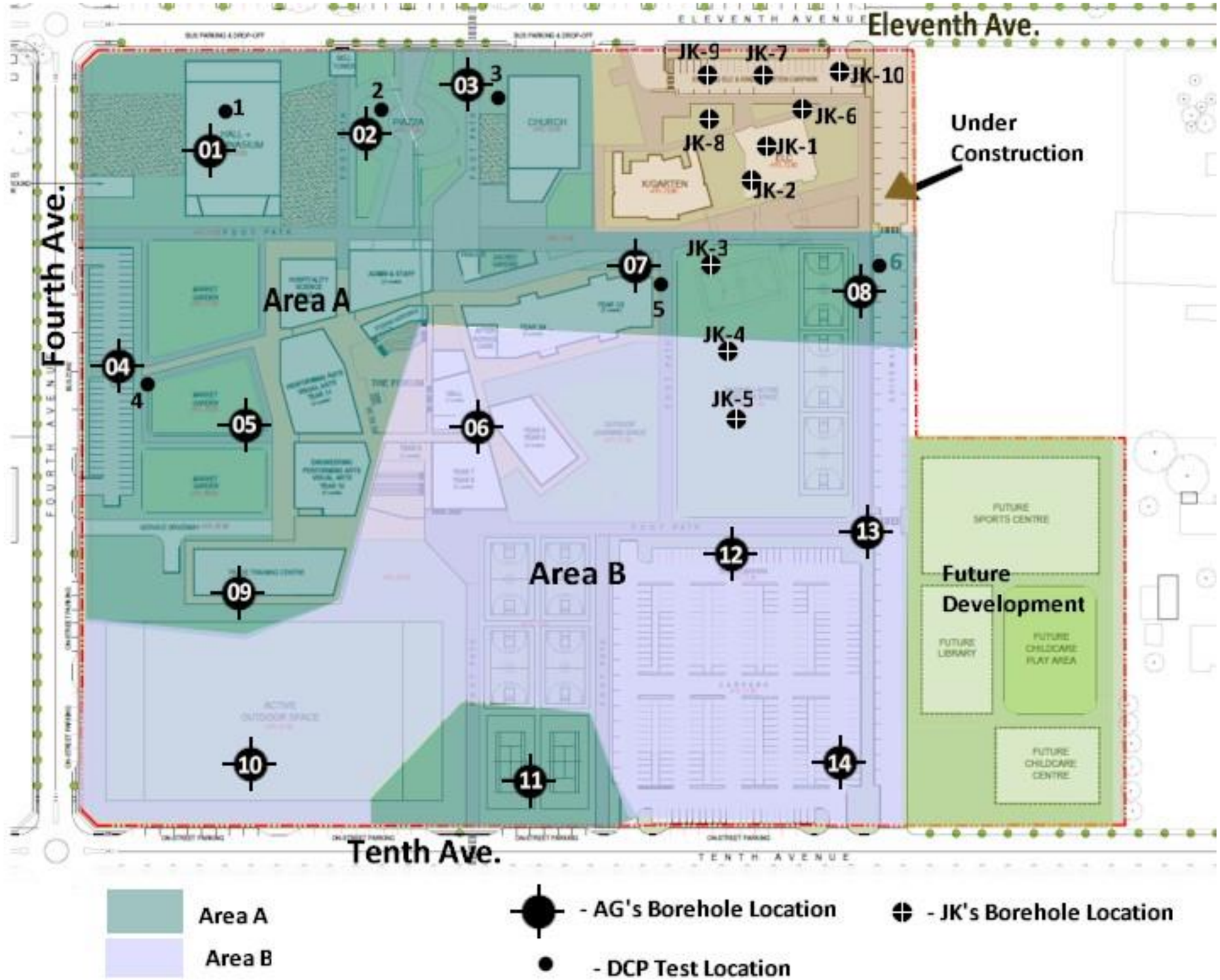
Photo 2 – AG's Site Investigation - Looking the east

APPENDIX B
Drawing: 6930-GR-1-A
Drawing: 6930-GR-1-B



- AG's Borehole Location
- JK's Borehole Location
- DCP Test Location
- Future Development
- Under Construction

Alliance Geotechnical Pty Ltd ENGINEERING | ENVIRONMENTAL | TESTING 10 Welder Road, Seven Hills, NSW T: 1800 288 188 E: enviro@allgeo.com.au	Project Address: 135-165 Tenth Avenue and 140 - 170 Eleventh Avenue, Austral, NSW 2179	Client: Sydney Catholic Schools	Project Name: St Anthony of Padua Catholic School Austral	Report No: 6930-GR-1-1 Figure Date: 13/04/2018	N	Drawing No: 6930-GR-1-A	Figure Title: Test Location Plan



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APPENDIX C

Borehole Logs (BH1 to BH14)
&
DCP Tests Results

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F: 02 9675 1888
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BH No: BH 01
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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179

Started: 23/3/18
Finished: 23/3/18
Borehole Size: 100mm

Rig Type: Christie Engineering (Rig #) **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Michael **Logged:** MS
RL Surface: 73.0 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					TOPSOIL: Silty clay, low to medium plasticity, dark brown, with organics	Salinity	M		TOPSOIL
					CH	Silty CLAY, high plasticity, red-brown	Salinity	SM	VSt - H	RESIDUAL
		72	1				Plasitic Index			
							Salinity			
					CH	Silty CLAY, high plasticity, grey mottled brown and orange, trace shale inclusions		SM	H	
							Salinity			
						SHALE, grey and brown, extremely weathered, very low strength, thinly laminated, trace iron induration	SPT 11, 225/140mm			BEDROCK, Class V Shale
		71	2							
						SHALE, grey, highly weathered, low strength, thinly laminated				
						Borehole BH 01 terminated at 2.8m				TC Bit Refusal on Class IV Shale
		70	3							
		69	4							
		68	5							
		67	6							

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BH No: BH 02
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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Started: 23/3/18
Finished: 23/3/18
Borehole Size: 100mm
Rig Type: Christie Engineering (Rig #1) **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Michael **Logged:** MS
RL Surface: 72.9 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					TOPSOIL: Silty clay, low to medium plasticity, dark brown, trace fine grained sand, with organics	Salinity	M		TOPSOIL
					CH	Silty CLAY, high plasticity, orange-brown	Salinity	M	VSt	RESIDUAL
		72	1		CH	As above, slightly moist, hard	Salinity	SM	VSt	
							Salinity			
							SPT 8, 225/130mm			
		71	2			SHALE, grey and brown, highly weathered, very low to low strength, thinly laminated				BEDROCK, Class V Shale
						SHALE, grey, highly weathered, low strength, thinly laminated				
		70	3			Borehole BH 02 terminated at 2.7m				TC Bit Refusal on Class IV Shale
		69	4							
		68	5							
		67	6							

BOREHOLE / TEST PIT 6930-BOREHOLE LOGS.GPJ GINT STD AUSTRALIA.GDT 11/4/18

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BH No: BH 03
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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Started: 23/3/18
Project: St Anthony of Padua Catholic School Austral
Finished: 23/3/18
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Borehole Size: 100mm
Rig Type: Christie Engineering (Rig #) **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Michael **Logged:** MS
RL Surface: 72.9 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					FILL: Sandy Gravel, grey, fine to medium crushed rock, well graded, appears well compacted	Salinity	M		FILL
						TOPSOIL: Silty clay, low to medium plasticity, dark brown, with organics		M		TOPSOIL
					CH	Silty CLAY, high plasticity, light brown mottled grey and red		M	VSt	RESIDUAL
							Salinity			
		72	1				Salinity			
					CH	Silty CLAY, high plasticity, grey mottled light brown and orange, trace shale inclusions, trace carbonaceous material		SM	H	
							Salinity			
		71	2				SPT 14, 23, 25/80mm			
						SHALE, brown, extremely weathered, very low strength, thinly laminated				BEDROCK, Class V Shale
		70	3			SHALE, grey, highly weathered, low strength, thinly laminated				
							SPT 20/30mm			
						Borehole BH 03 terminated at 3.1m				TC Bit Refusal on Class IV Shale
		69	4							
		68	5							
		67	6							

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Borehole Log

Client: Sydney Catholic Schools
Started: 23/3/18
Project: St Anthony of Padua Catholic School Austral
Finished: 23/3/18
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Borehole Size: 100mm
Rig Type: Christie Engineering (Rig 7) **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Michael **Logged:** MS
RL Surface: 71.1 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered	71				TOPSOIL: Silty clay, low to medium plasticity, dark brown, with organics	Salinity	M		TOPSOIL
					CH	Silty CLAY, high plasticity, orange-brown	Salinity	SM	H	RESIDUAL
					CH	As above, grey mottled orange-brown, trace shale inclusions	CBR Sample	SM	H	
		70	1				Salinity			
							Salinity			
						SHALE, grey and brown, highly weathered, very low strength, thinly laminated				BEDROCK, Class V Shale
		69	2			Borehole BH 04 terminated at 1.6m				Borehole Terminated
		68	3							
		67	4							
		66	5							
		65	6							

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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179

Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 71.5 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					TOPSOIL: Silty clay, low plasticity, brown, with organics	Salinity	SM		TOPSOIL
					CL	Silty CLAY, low plasticity, light brown to brown, trace fine to medium grained sand		SM	(VSt)	RESIDUAL
		71					Salinity			
			1		CH	As above, with shale inclusions	Salinity	SM	(VSt)	
		70				SHALE, grey and brown, extremely weathered, very low strength, thinly laminated	Salinity SPT 25/50mm			BEDROCK, Class V Shale
			2			SHALE, grey, highly weathered, low strength, thinly laminated				
		69				Borehole BH 05 terminated at 2.4m				TC Bit Refusal on Class IV Shale
			3							
		68								
			4							
		67								
			5							
		66								
			6							

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Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 72.7 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered	72	0			TOPSOIL: Silty clay, low plasticity, brown to dark brown, with organics, with humic matter, trace fine to medium grained sand	Salinity	D		TOPSOIL
					CH	Silty CLAY, medium plasticity, light brown, trace fine to medium grained sand, trace fine subangular to subrounded gravel	Salinity	D	(VSt)	RESIDUAL
			1		CH	As above, with shale inclusions	Salinity	D	(VSt)	
		71					Salinity			
			2				SPT 8, 11, 14 N=25			
		70				SHALE, grey and brown, extremely weathered, very low strength, thinly laminated				BEDROCK, Class V Shale
			3				SPT 25/100mm			
		69								
			4							
		68								
			5			Borehole BH 06 terminated at 4.7m				TC Bit Refusal on Class IV Shale
		67								
			6							

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Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Started: 23/3/18
Finished: 23/3/18
Borehole Size: 100mm
Rig Type: Christie Engineering (Rig #1) **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Michael **Logged:** MS
RL Surface: 72.8 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered	72	0			TOPSOIL: Silty clay, low plasticity, dark brown, with organics	Salinity	M		TOPSOIL
					CH	Silty CLAY, high plasticity, grey mottled orange and light brown	Salinity	M	St	RESIDUAL
			1				Salinity			
							Salinity			
		71			CH	Silty CLAY, medium to high plasticity, light grey mottled red and orange, trace ironstone inclusions, trace carbonaceous material	SPT 6, 8, 17 N=25	SM	VSt	
			2							
		70				SHALE, brown, extremely weathered, very low strength, thinly laminated, with clay seams				BEDROCK, Class V Shale
			3				SPT 23, 25/140mm			
		69								
			4			Borehole BH 07 terminated at 3.8m				TC Bit Refusal on Class IV Shale
		68								
			5							
		67								
			6							

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Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179

Started: 23/3/18
Finished: 23/3/18
Borehole Size: 100mm

Rig Type: Christie Engineering (Rig #) **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Michael **Logged:** MS
RL Surface: 72.5 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					FILL: Sandy Gravel, grey, fine to medium crushed rock, well graded	Salinity	SM		FILL
		72			CH	CLAY, high plasticity, grey mottled red	Salinity	M	St	RESIDUAL
			1				CBR Sample			
							Salinity			
					CI-CH	Silty CLAY, medium to high plasticity, light grey mottled light red, trace ironstone inclusions		SM	VSt - H	
		71					Salinity			
			2			SHALE, brown, extremely weathered, very low strength, thinly laminated				BEDROCK, Class V Shale
						Borehole BH 08 terminated at 2.1m				Borehole Terminated
		70								
			3							
		69								
			4							
		68								
			5							
		67								
			6							

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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179

Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 68.8 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					TOPSOIL: Silty CLAY, low plasticity, dark brown, with organics	Salinity	D		TOPSOIL
		68	1		CL	Silty CLAY, low plasticity, light brown mottled brown, with fine to medium grained sand, trace ironstone inclusions	Salinity Salinity Salinity	D	(VSt)	RESIDUAL
		67	2			SHALE, brown, extrmely weathered, very low strength, thinly laminated	SPT 25/100mm			BEDROCK, Class V Shale
		66	3			Borehole BH 09 terminated at 2.3m				TC Bit Refusal on Class IV Shale
		65	4							
		64	5							
		63	6							

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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 66.8 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered	66	1			TOPSOIL: Silty CLAY, low plasticity, dark brown, with fine to medium grained sand, trace fine to medium subangular to subrounded gravel, with organics	Salinity	D		TOPSOIL
					CH	Silty CLAY, high plasticity, red-brown mottled grey, trace fine to medium grained sand	Salinity	D	St	RESIDUAL
		65	2				Salinity			
							Salinity			
							SPT 1, 3, 7 N=10			
		64	3		CH	Silty CLAY, high plasticity, grey mottled brown, trace ironstone inclusions		D	(St - VSt)	
							SPT 3, 11, 20 N=31			
		63	4			SHALE, brown and grey, extremely weathered, very low strength, thinly laminated				BEDROCK, Class V Shale
							SPT 25/50mm			
		62	5			Borehole BH 10 terminated at 4.6m				TC Bit Refusal on Class IV Shale
		61	6							

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BH No: BH 11
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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 69.8 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					Topsoil: Silty Clay, low to medium plasticity, brown to dark brown, trace fine to medium grained sand, with organics	Salinity	M		TOPSOIL
					Cl	Silty CLAY, medium plasticity, brown to light brown mottled grey, trace fine to medium grained sand	Salinity	SM	(VSt)	RESIDUAL
		69								
			1				Salinity			
					Cl	As above, brown mottled grey		SM	(VSt)	
							Salinity			
		68				SHALE, brown and grey, extremely weathered, very low strength, thinly laminated	SPT 2, 4, 21 N=25			BEDROCK, Class V Shale
			2							
						Borehole BH 11 terminated at 2.2m				TC Bit Refusal on Class IV Shale
		67								
			3							
		66								
			4							
		65								
			5							
		64								
			6							

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Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179

Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 73.2 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered	73				Topsoil: Silty Clay, medium to high plasticity, brown to orange-brown, with organics	Salinity	D		TOPSOIL
					CI-CH	Silty CLAY, medium to high plasticity, brown to orange-brown mottled grey and light red, trace fine to medium grained sand		SM	(VSt)	RESIDUAL
							Salinity			
			1				Salinity			
		72					CBR Sample			
							Salinity			
						Borehole BH 12 terminated at 1.5m				Borehole Terminated
		71	2							
			3							
		70								
			4							
		69								
			5							
		68								
			6							
		67								

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BH No: BH 13
Sheet: 1 of 1
Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Project: St Anthony of Padua Catholic School Austral
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Started: 23/3/18
Finished: 23/3/18
Borehole Size: 110mm

Rig Type: Hanjin D&B D8 **Hole Location:** Refer Drawing: 6930-GR-1-A **Driller:** Brett **Logged:** DJ
RL Surface: 75.0 **Contractor:** BG Drilling **Bearing:** --- **Checked:** LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					TOPSOIL: Silty Clay, low to medium plasticity, brown to dark brown, with organics	Salinity	SM		TOPSOIL
					CH	Silty CLAY, high plasticity, red-brown		SM	(St)	RESIDUAL
							Salinity			
		74	1				Salinity			
					CH	Silty CLAY, high plasticity, red brown mottled light red, trace fine to medium subangular gravel		SM	St	
							Salinity			
					CH	As above, with ironstone inclusions	SPT 2, 3, 5 N=8	SM	(St)	
		73	2							
					CH	As above, brown to red-brown mottled grey		SM	(VSt)	
		72	3			SHALE, brown and grey, extremely weathered, very low strength, thinly laminated	SPT 16, 16, 20/15mm			BEDROCK, Class V Shale
		71	4							
		70	5							
						SHALE, grey, highly weathered, low strength, thinly laminated				
		69	6							
						Borehole BH 13 terminated at 6m				TC Bit Refusal on Class IV Shale

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BH No: BH 14
Sheet: 1 of 1
Job No: 6930

Borehole Log

Client: Sydney Catholic Schools
Started: 23/3/18
Project: St Anthony of Padua Catholic School Austral
Finished: 23/3/18
Location: 135 - 165 Tenth Ave & 140 - 170 Eleventh Ave, Austral NSW 2179
Borehole Size: 110mm
Rig Type: Hanjin D&B D8
Hole Location: Refer Drawing: 6930-GR-1-A
Driller: Brett
Logged: DJ
RL Surface: 75.0
Contractor: BG Drilling
Bearing: ---
Checked: LM

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	No Groundwater Encountered					TOPSOIL: Silty CLAY, low plasticity, brown, with organics	Salinity	D		TOPSOIL
					CI-CH	Silty CLAY, medium to high plasticity, brown to dark brown trace fine to medium grained sand		D	(St)	RESIDUAL
							Salinity			
		74	1				Salinity			
					CI-CH	As above, brown mottled red		D	VSt	
							Salinity			
		73	2				SPT 1, 5, 12 N=17			
		72	3			SHALE, brown and grey, extremely weathered, very low strength, thinly laminated	SPT 25/100mm			BEDROCK, Class V Shale
		71	4							
						Borehole BH 14 terminated at 4.5m				TC Bit Refusal on Class IV Shale
		70	5							
		69	6							

EXPLANATORY NOTES - DRILL & EXCAVATION LOGS

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 excavtion 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

AS	Auger Screwing
AD/V	Auger Drilling with V-Bit
AD/T	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
F	Firm
H	Hard
VH	Very Hard

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

Samples/Tests

D	Disturbed
U	Undisturbed
C	Core Sample
SPT	Standard Penetration Test
N	Result of SPT (*sample taken)
VS	Vane Shear Test
IMP	Borehole Impression Device
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	< 25kPa
S	Soft	25 - 50kPa
F	Firm	50 - 100kPa
St	Stiff	100 - 200kPa
VSt	Very Stiff	200 - 400kPa
H	Hard	≥ 400kPa

Strength figures quoted are the approximate range of Unconfined Compressive Strength for each class.

Density Index. (%) is estimated or is based on SPT results. Approximate N Value correlation is shown in right column.

VL	Very Loose	< 15%	0 - 4
L	Loose	15 - 35%	4 - 10
MD	Medium Dense	35 - 65%	10 - 30
D	Dense	65 - 85%	30 - 50
VD	Very Dense	> 85%	> 50

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

Description	Spacing (mm)
Thinly Laminated	< 6
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-situ 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.

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

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

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
Roughness	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.

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Dynamic Cone Penetrometer Test Report

Client:	Sydney Catholic Schools	Report Number:	6930-GR-1-1
Project Name:	St Anthony of Padua Catholic School Austral	Report Date:	13/04/2018
Project Location:	135-165 Tenth Ave & 140-170 Elevnth Ave, Austral NSW 2179	Date Tested:	23/03/2018
Test Method:	AS 1289 6.3.2		

Test Number	DCP-1	DCP-2	DCP-3	DCP-4
Test Location	Refer Drawing 6740-GR-1-A	Refer Drawing 6740-GR-1-A	Refer Drawing 6740-GR-1-A	Refer Drawing 6740-GR-1-A
R.L (AHD)	70.0	75.0	80.5	89.0
Depth (meters)				
0.00 – 0.15	5	6	8	5
0.15 – 0.30	10	12	15	22
0.30 – 0.45	12	10	8	17
0.45 – 0.60	13	10	7	17
0.60 – 0.75	14	8	7	16

Test Number	DCP-5	DCP-6
Test Location	Refer Drawing 6740-GR-1-A	Refer Drawing 6740-GR-1-A
R.L (AHD)	72.0	75.5
Depth (meters)		
0.00 – 0.15	16	5
0.15 – 0.30	6	5
0.30 – 0.45	6	5
0.45 – 0.60	5	5
0.60 – 0.75	4	5
0.75 – 0.90	6	3
0.90 – 1.05	8	4
1.05 – 1.20	12	5
1.20 – 1.35		7
1.35 – 1.50		15
1.50 – 1.65		>25

APPENDIX D
Laboratory Tests Result

Material Test Report

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Email: paul@allgeo.com.au

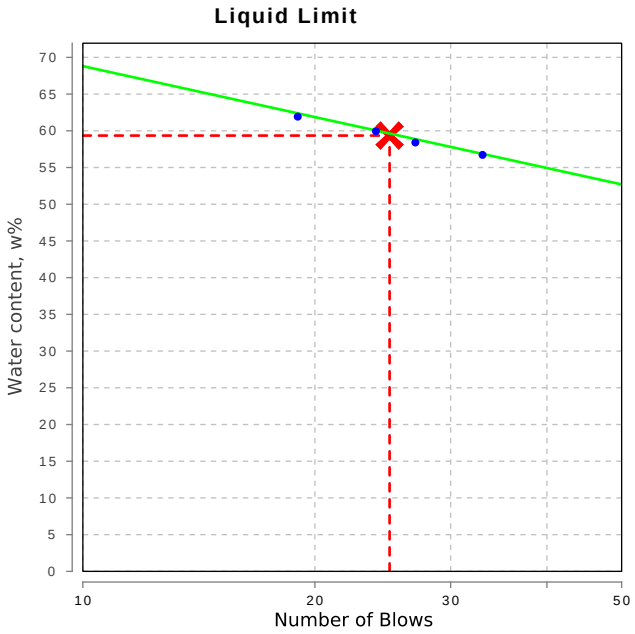
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Paul Haslam
Laboratory Manager
NATA Accredited Laboratory Number: 15100

Report Number: **P18010-1**
Issue Number: 1
Date Issued: 12/04/2018
Client: Sydney Catholic Schools
PO Box 5093, Lyneham ACT 2602
Contact: Erik Innes
Project Number: P18010
Project Name: St Anthony of Padua School (Proposed Buildings)
Project Location: 125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request: 50
Sample Number: 18-50A
Date Sampled: 26/03/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **BH01 (0.5m-1.0m)**
Material: Silty CLAY, high plasticity, red-brown

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	59		
Plastic Limit (%)	13		
Plasticity Index (%)	**46**		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	14.3



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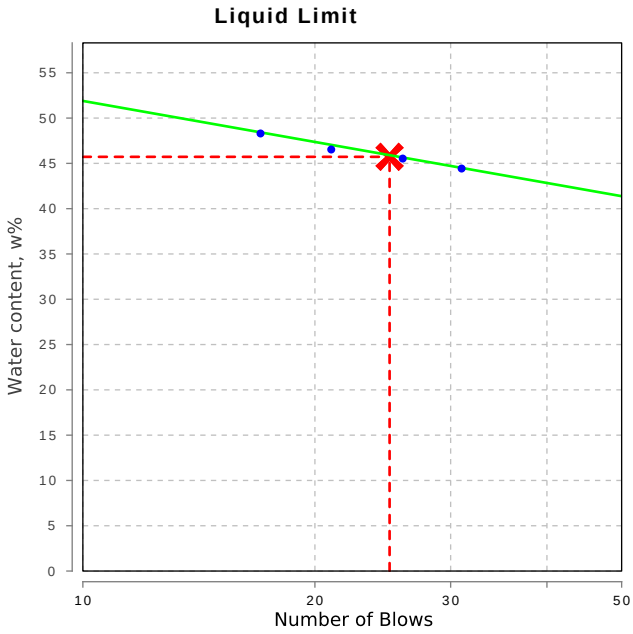
Approved Signatory: Paul Haslam
Laboratory Manager
NATA Accredited Laboratory Number: 15100

Report Number:	**P18010-1**
Issue Number:	1
Date Issued:	12/04/2018
Client:	Sydney Catholic Schools PO Box 5093, Lyneham ACT 2602
Contact:	Erik Innes
Project Number:	P18010
Project Name:	St Anthony of Padua School (Proposed Buildings)
Project Location:	125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request:	50
Sample Number:	18-50B
Date Sampled:	26/03/2018
Sampling Method:	AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location:	**BH06 (1.5m-1.9m)**
Material:	Silty CLAY, medium plasticity, light brown, trace fine to medium grained sand, trace fine subangular to subrounded gravel

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	46		
Plastic Limit (%)	14		
Plasticity Index (%)	**32**		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	13.1



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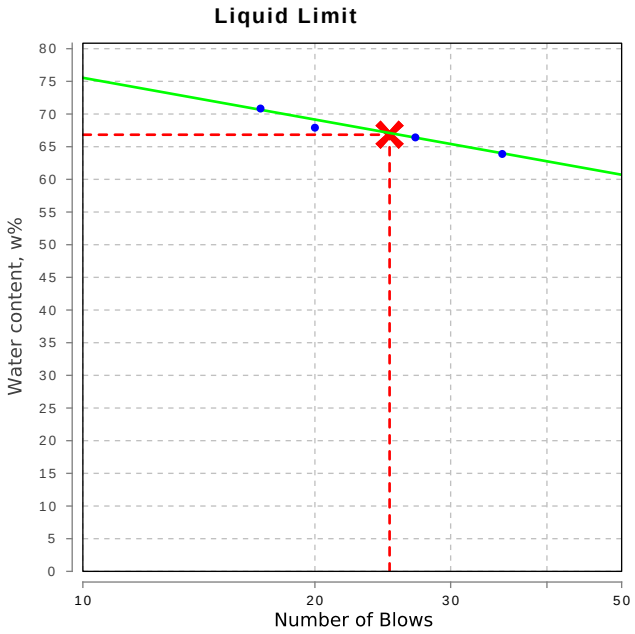
Report Number: **P18010-1**
Issue Number: 1
Date Issued: 12/04/2018
Client: Sydney Catholic Schools
PO Box 5093, Lyneham ACT 2602
Contact: Erik Innes
Project Number: P18010
Project Name: St Anthony of Padua School (Proposed Buildings)
Project Location: 125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request: 50
Sample Number: 18-50C
Date Sampled: 26/03/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **BH13 (0.5m-0.8m)**
Material: Silty CLAY, high plasticity, red-brown

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	67		
Plastic Limit (%)	16		
Plasticity Index (%)	**51**		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	21.0



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NATA Accredited Laboratory Number: 15100

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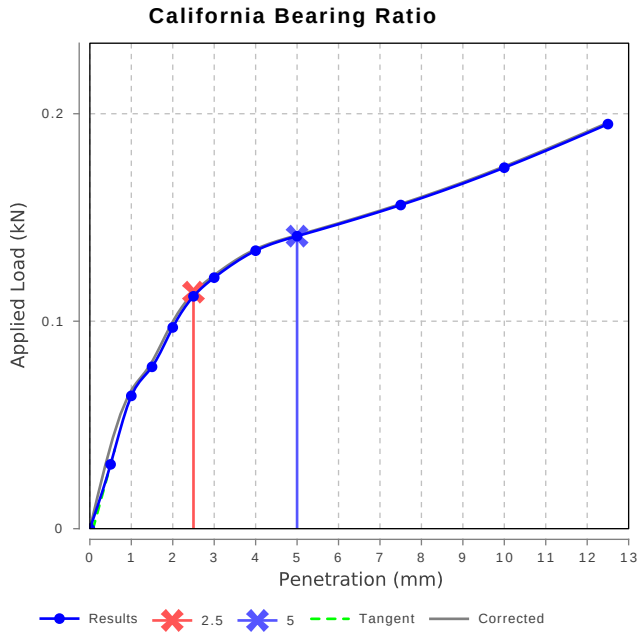
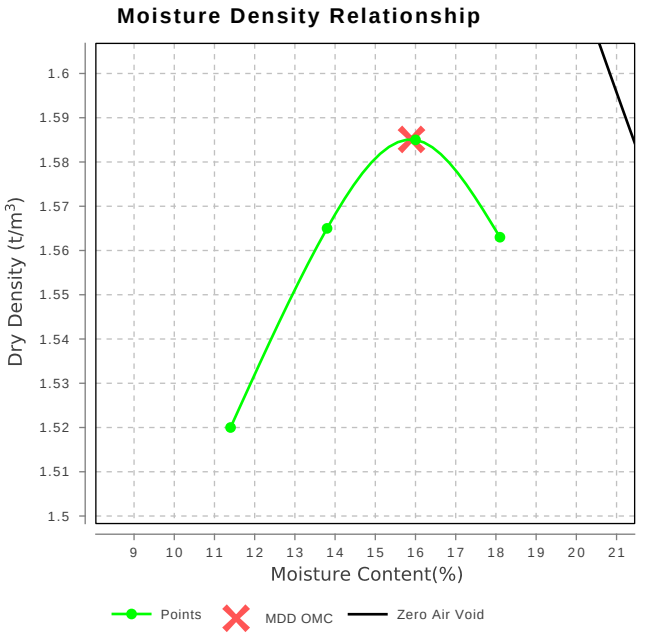
Issue Number: 1
Date Issued: 12/04/2018
Client: Sydney Catholic Schools
PO Box 5093, Lyneham ACT 2602
Contact: Erik Innes
Project Number: P18010
Project Name: St Anthony of Padua School (Proposed Buildings)
Project Location: 125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request: 50
Sample Number: 18-50D
Date Sampled: 26/03/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **BH04 (0.5m-1.0m)**
Material: Silty CLAY, high plasticity, orange-brown

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**1.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	LL Estimate		
Maximum Dry Density (t/m^3)	1.59		
Optimum Moisture Content (%)	16.0		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	102.0		
Moisture Content at Placement (%)	16.2		
Moisture Content Top 30mm (%)	35.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	24.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.59
Optimum Moisture Content (%)	16.0
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	LL Estimate
Curing Hours	48.0





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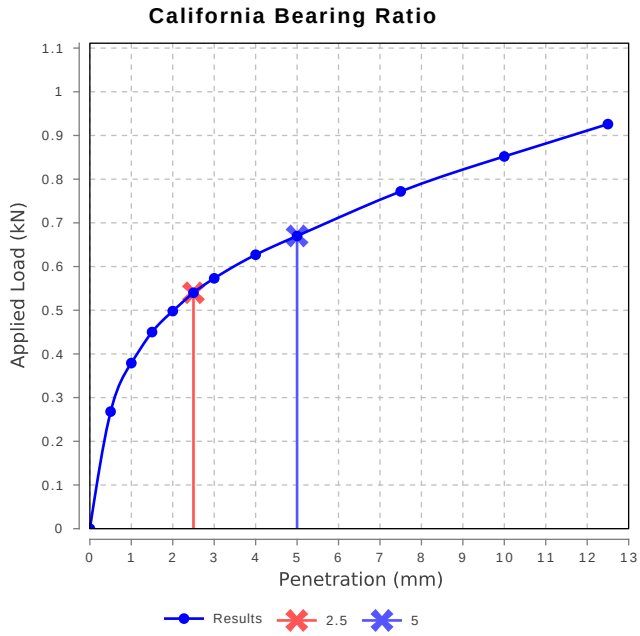
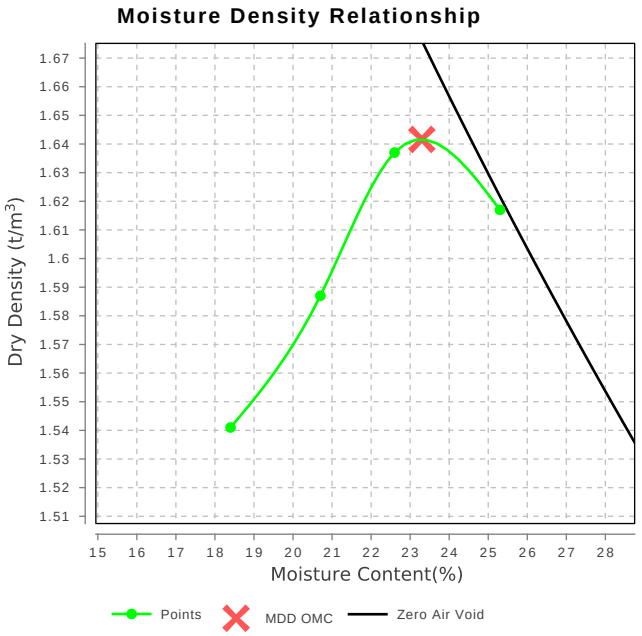
Report Number: **P18010-1**
Issue Number: 1
Date Issued: 12/04/2018
Client: Sydney Catholic Schools
PO Box 5093, Lyneham ACT 2602
Contact: Erik Innes
Project Number: P18010
Project Name: St Anthony of Padua School (Proposed Buildings)
Project Location: 125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request: 50
Sample Number: 18-50E
Date Sampled: 26/03/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **BH08 (0.5m-1.0m)**
Material: CLAY, high plasticity, grey mottled red

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	LL Estimate		
Maximum Dry Density (t/m^3)	1.64		
Optimum Moisture Content (%)	23.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	98.5		
Moisture Content at Placement (%)	23.0		
Moisture Content Top 30mm (%)	25.6		
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		

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.64
Optimum Moisture Content (%)	23.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	LL Estimate
Curing Hours	48.0





Material Test Report

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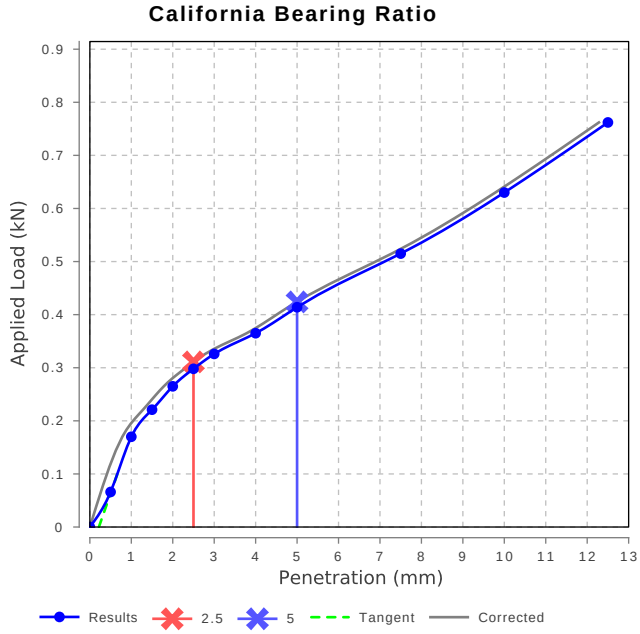
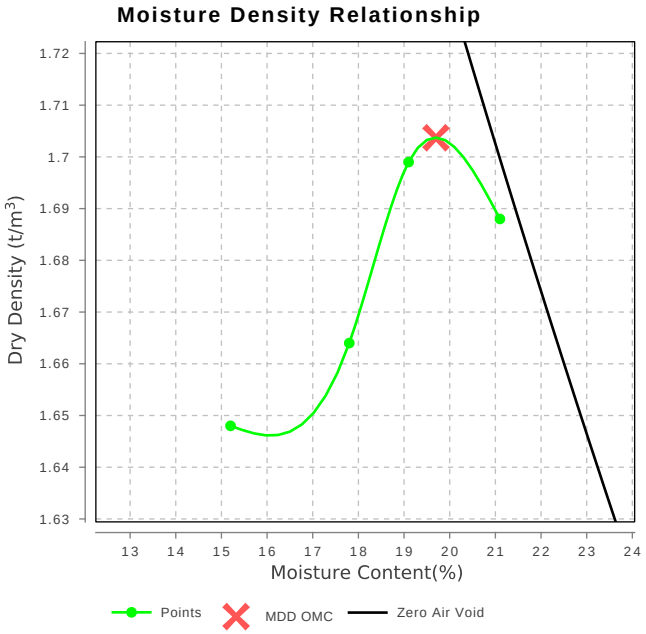
Laboratory Manager
NATA Accredited Laboratory Number: 15100

Report Number: **P18010-1**
Issue Number: 1
Date Issued: 12/04/2018
Client: Sydney Catholic Schools
PO Box 5093, Lyneham ACT 2602
Contact: Erik Innes
Project Number: P18010
Project Name: St Anthony of Padua School (Proposed Buildings)
Project Location: 125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request: 50
Sample Number: 18-50F
Date Sampled: 26/03/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **BH12 (0.8m-1.5m)**
Material: Silty CLAY, medium to high plasticity, brown to orange-brown mottled grey and light red, trace fine to medium grained sand

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	LL Estimate		
Maximum Dry Density (t/m^3)	1.70		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.0		
Moisture Content at Placement (%)	19.9		
Moisture Content Top 30mm (%)	26.1		
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		

Dry Density - Moisture Relationship (AS 1289 5.1.1 & 2.1.1)	
Mould Type	1 LITRE MOULD A
Compaction	Standard
No. Layers	3
No. Blows / Layer	25
Maximum Dry Density (t/m^3)	1.70
Optimum Moisture Content (%)	19.5
Oversize Sieve (mm)	19.0
Oversize Material (%)	0.0
Method used to Determine Plasticity	LL Estimate
Curing Hours	48.0





Material Test Report

Report Number: **P18010-1**
Issue Number: 1
Date Issued: 12/04/2018
Client: Sydney Catholic Schools
PO Box 5093, Lyneham ACT 2602
Contact: Erik Innes
Project Number: P18010
Project Name: St Anthony of Padua School (Proposed Buildings)
Project Location: 125-165 Tenth Avenue & 140-170 Eleventh Avenue - Austral
Work Request: 50

Alliance Geotechnical
ENGINEERING | ENVIRONMENTAL | TESTING
Your On-Site Geotechnical & Environmental Specialists

Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Fax: (02) 9838 8022
Email: paul@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Paul Haslam
Laboratory Manager
NATA Accredited Laboratory Number: 15100

Moisture Content AS 1289 2.1.1			
Sample Number	Sample Location	Moisture Content	Material
18-50A	BH01 (0.5m-1.0m)	14.3 %	Silty CLAY, high plasticity, red-brown
18-50B	BH06 (1.5m-1.9m)	13.1 %	Silty CLAY, medium plasticity, light brown, trace fine to medium grained sand, trace fine subangular to subrounded gravel
18-50C	BH13 (0.5m-0.8m)	21.0 %	Silty CLAY, high plasticity, red-brown

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Craig Cowper	Manager	Huong Crawford
Client	ALLIANCE GEOTECHNICAL PTY LTD	Laboratory	SGS Alexandria Environmental
Address	10 Welder Road Seven Hills NSW 2147	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	0407 989 885	Telephone	+61 2 8594 0400
Facsimile	02 9675 1888	Facsimile	+61 2 8594 0499
Email	c.cowper@allgeo.com.au	Email	au.environmental.sydney@sgs.com
Project	**6930 - Austral**	SGS Reference	**SE177214 R0**
Order Number	**P990**	Date Received	26 Mar 2018
Samples	42	Date Reported	04 Apr 2018

COMMENTS

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

SIGNATORIES

Bennet Lo
Senior Organic Chemist/Metals Chemis

Shane McDermott
Inorganic/Metals Chemist

Parameter	Units	LOR	Sample Number: SE177214.001 Sample Matrix: Soil Sample Date: 23 Mar 2018 Sample Name: BH1-0.5	SE177214.002 Soil 23 Mar 2018 BH1-1.0	SE177214.003 Soil 23 Mar 2018 BH1-1.5	SE177214.004 Soil 23 Mar 2018 BH2-0.5
pH in soil (1:5) Method: AN101 Tested: 27/3/2018						
pH	pH Units	0.1	7.1	6.2	6.4	7.4
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 27/3/2018						
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	110	420	540	65
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 28/3/2018						
Chloride	mg/kg	0.25	42	290	410	25
Sulfate	mg/kg	5	100	400	540	29
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018						
Exchangeable Sodium, Na	mg/kg	2	260	480	570	290
Exchangeable Sodium, Na	meq/100g	0.01	1.2	2.1	2.5	1.3
Exchangeable Sodium Percentage*	%	0.1	6.8	13.0	16.4	8.7
Moisture Content Method: AN002 Tested: 28/3/2018						
% Moisture	%w/w	0.5	12	12	10	12

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.005 Soil 23 Mar 2018 BH2-1.0	SE177214.006 Soil 23 Mar 2018 BH2-1.5	SE177214.007 Soil 23 Mar 2018 BH3-0.5	SE177214.008 Soil 23 Mar 2018 BH3-1.0
pH in soil (1:5) Method: AN101 Tested: 27/3/2018							
pH	pH Units	0.1		6.2	7.0	6.1	6.3
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 27/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		380	240	490	510
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 28/3/2018							
Chloride	mg/kg	0.25		290	240	420	500
Sulfate	mg/kg	5		310	120	270	240
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		530	950	340	500
Exchangeable Sodium, Na	meq/100g	0.01		2.3	4.1	1.5	2.2
Exchangeable Sodium Percentage*	%	0.1		16.4	27.3	9.9	12.4
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		12	7.0	15	15

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.009 Soil 23 Mar 2018 BH3-1.5	SE177214.010 Soil 23 Mar 2018 BH4-0.5	SE177214.011 Soil 23 Mar 2018 BH4-1.0	SE177214.012 Soil 23 Mar 2018 BH4-1.5
pH in soil (1:5) Method: AN101 Tested: 27/3/2018							
pH	pH Units	0.1		6.9	5.5	8.0	7.2
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 27/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		460	530	910	880
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 28/3/2018							
Chloride	mg/kg	0.25		550	610	550	500
Sulfate	mg/kg	5		160	180	610	530
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		440	340	530	630
Exchangeable Sodium, Na	meq/100g	0.01		1.9	1.5	2.3	2.7
Exchangeable Sodium Percentage*	%	0.1		19.3	10.3	10.6	13.1
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		11	13	18	18

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.013 Soil 23 Mar 2018 BH5-0.5	SE177214.014 Soil 23 Mar 2018 BH5-1.0	SE177214.015 Soil 23 Mar 2018 BH5-1.5	SE177214.016 Soil 23 Mar 2018 BH6-0.5
pH in soil (1:5) Method: AN101 Tested: 27/3/2018							
pH	pH Units	0.1		7.2	7.6	7.8	6.3
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 27/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		190	170	180	420
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 28/3/2018							
Chloride	mg/kg	0.25		230	190	210	490
Sulfate	mg/kg	5		43	28	31	130
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		760	720	750	450
Exchangeable Sodium, Na	meq/100g	0.01		3.3	3.1	3.2	2.0
Exchangeable Sodium Percentage*	%	0.1		22.4	22.5	23.2	23.7
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		6.8	6.6	6.0	6.5

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.017 Soil 23 Mar 2018 BH6-1.0	SE177214.018 Soil 23 Mar 2018 BH6-1.5	SE177214.019 Soil 23 Mar 2018 BH7-0.5	SE177214.020 Soil 23 Mar 2018 BH7-1.0
pH in soil (1:5) Method: AN101 Tested: 27/3/2018							
pH	pH Units	0.1		6.3	6.4	5.9	5.8
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 27/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		370	390	280	640
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 28/3/2018							
Chloride	mg/kg	0.25		430	430	210	710
Sulfate	mg/kg	5		130	170	260	370
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		460	400	430	770
Exchangeable Sodium, Na	meq/100g	0.01		2.0	1.7	1.9	3.3
Exchangeable Sodium Percentage*	%	0.1		23.6	21.6	11.0	17.9
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		6.7	5.7	14	17

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.021 Soil 23 Mar 2018 BH7-1.5	SE177214.022 Soil 23 Mar 2018 BH8-0.5	SE177214.023 Soil 23 Mar 2018 BH8-1.0	SE177214.024 Soil 23 Mar 2018 BH8-1.5
pH in soil (1:5) Method: AN101 Tested: 28/3/2018							
pH	pH Units	0.1		5.7	6.8	5.6	7.0
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 28/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		770	440	510	590
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 29/3/2018							
Chloride	mg/kg	0.25		870	290	460	380
Sulfate	mg/kg	5		340	330	300	480
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		790	380	730	490
Exchangeable Sodium, Na	meq/100g	0.01		3.4	1.7	3.2	2.1
Exchangeable Sodium Percentage*	%	0.1		19.6	9.9	17.7	12.8
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		17	21	18	19

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name SE177214.025 Soil 23 Mar 2018 BH9-0.5	SE177214.026 Soil 23 Mar 2018 BH9-1.0	SE177214.027 Soil 23 Mar 2018 BH9-1.5	SE177214.028 Soil 23 Mar 2018 BH10-0.5
pH in soil (1:5) Method: AN101 Tested: 28/3/2018						
pH	pH Units	0.1	7.8	8.3	8.3	5.6
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 28/3/2018						
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	130	150	250	750
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 29/3/2018						
Chloride	mg/kg	0.25	140	170	310	820
Sulfate	mg/kg	5	23	17	30	220
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018						
Exchangeable Sodium, Na	mg/kg	2	640	720	920	600
Exchangeable Sodium, Na	meq/100g	0.01	2.8	3.1	4.0	2.6
Exchangeable Sodium Percentage*	%	0.1	22.3	22.9	22.9	19.3
Moisture Content Method: AN002 Tested: 28/3/2018						
% Moisture	%w/w	0.5	6.0	6.4	8.1	14

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.029 Soil 23 Mar 2018 BH10-1.0	SE177214.030 Soil 23 Mar 2018 BH10-1.5	SE177214.031 Soil 23 Mar 2018 BH11-0.5	SE177214.032 Soil 23 Mar 2018 BH11-1.0
pH in soil (1:5) Method: AN101 Tested: 28/3/2018							
pH	pH Units	0.1		5.6	5.7	5.9	5.8
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 28/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		930	1100	910	1300
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 29/3/2018							
Chloride	mg/kg	0.25		1100	1500	1300	1800
Sulfate	mg/kg	5		300	450	67	120
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		780	700	410	620
Exchangeable Sodium, Na	meq/100g	0.01		3.4	3.0	1.8	2.7
Exchangeable Sodium Percentage*	%	0.1		23.3	23.0	12.1	15.1
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		13	12	13	16

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.033 Soil 23 Mar 2018 BH11-1.5	SE177214.034 Soil 23 Mar 2018 BH12-0.5	SE177214.035 Soil 23 Mar 2018 BH12-1.0	SE177214.036 Soil 23 Mar 2018 BH12-1.5
pH in soil (1:5) Method: AN101 Tested: 28/3/2018							
pH	pH Units	0.1		6.1	6.0	5.2	5.1
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 28/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		1100	77	660	720
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 29/3/2018							
Chloride	mg/kg	0.25		1600	31	680	2100
Sulfate	mg/kg	5		83	87	400	1100
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		680	200	320	450
Exchangeable Sodium, Na	meq/100g	0.01		2.9	0.89	1.4	2.0
Exchangeable Sodium Percentage*	%	0.1		18.7	8.3	11.6	14.9
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		11	11	14	13

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE177214.037 Soil 23 Mar 2018 BH13-0.5	SE177214.038 Soil 23 Mar 2018 BH13-1.0	SE177214.039 Soil 23 Mar 2018 BH13-1.5	SE177214.040 Soil 23 Mar 2018 BH14-0.5
pH in soil (1:5) Method: AN101 Tested: 28/3/2018							
pH	pH Units	0.1		5.4	5.3	5.6	7.3
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 28/3/2018							
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1		360	430	530	190
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 29/3/2018							
Chloride	mg/kg	0.25		270	400	520	6.0
Sulfate	mg/kg	5		260	250	360	290
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018							
Exchangeable Sodium, Na	mg/kg	2		1200	1400	1100	83
Exchangeable Sodium, Na	meq/100g	0.01		5.0	6.0	4.6	0.36
Exchangeable Sodium Percentage*	%	0.1		22.0	23.9	24.5	1.9
Moisture Content Method: AN002 Tested: 28/3/2018							
% Moisture	%w/w	0.5		17	18	16	9.7

Parameter	Units	LOR	Sample Number: SE177214.041 Sample Matrix: Soil Sample Date: 23 Mar 2018 Sample Name: BH14-1.0	Sample Number: SE177214.042 Sample Matrix: Soil Sample Date: 23 Mar 2018 Sample Name: BH14-1.5
pH in soil (1:5) Method: AN101 Tested: 28/3/2018				
pH	pH Units	0.1	**7.3**	**7.0**
Conductivity and TDS by Calculation - Soil Method: AN106 Tested: 28/3/2018				
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**170**	**240**
Soluble Anions (1:5) in Soil by Ion Chromatography Method: AN245 Tested: 29/3/2018				
Chloride	mg/kg	0.25	**4.0**	**7.9**
Sulfate	mg/kg	5	**270**	**470**
Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) Method: AN122 Tested: 28/3/2018				
Exchangeable Sodium, Na	mg/kg	2	**96**	**140**
Exchangeable Sodium, Na	meq/100g	0.01	**0.42**	**0.63**
Exchangeable Sodium Percentage*	%	0.1	**2.4**	**3.8**
Moisture Content Method: AN002 Tested: 28/3/2018				
% Moisture	%w/w	0.5	**10**	**10**

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

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery
Conductivity of Extract (1:5 dry sample basis)	LB144429	µS/cm	1	1 - 19%	102%
	LB144493	µS/cm	1	2 - 4%	105%

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	LB144555	mg/kg	2		115%
	LB144556	mg/kg	2		115%
Exchangeable Sodium, Na	LB144555	meq/100g	0.01	<0.01	NA
	LB144556	meq/100g	0.01	<0.01	NA
Exchangeable Sodium Percentage*	LB144555	%	0.1		NA
	LB144556	%	0.1		NA

Moisture Content Method: ME-(AU)-[ENV]AN002

Parameter	QC Reference	Units	LOR	DUP %RPD
% Moisture	LB144542	%w/w	0.5	0 - 3%

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

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery
pH	LB144429	pH Units	0.1	1 - 2%	101%
	LB144493	pH Units	0.1	1%	101%

Soluble Anions (1:5) in Soil by Ion Chromatography Method: ME-(AU)-[ENV]AN245

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Chloride	LB144534	mg/kg	0.25	<0.25	5 - 20%	98%
	LB144600	mg/kg	0.25	<0.25	2 - 13%	98%
Sulfate	LB144534	mg/kg	5	<5.0	6 - 37%	96%
	LB144600	mg/kg	5	<5.0	0 - 6%	96%

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.
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 refernced to Rayment and Lyons, 2011, sections 15D3 and 15N1.-
AN245	Anions by Ion Chromatography: A water sample 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

Samples 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 criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/ Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf