Douglas Partners
Geotechnics / Environment / Groundwater

Report on
Geotechnical Investigation

Meriden Centre of Music and Drama
13 Margaret Street, Strathfield

Prepared for
Meriden School

Project 86568.00
May 2019

Integrated Practical Solutions

Document History

Document details

Project No.	86568.00	Document No.	R.001.Rev1
Document title	Report on Geotechnical Investigation Meriden Centre of Music and Drama		
Site address	13 Margaret Street, Strathfield		
Report prepared for	Meriden School		
File name	86568.00.R.001.Rev1		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Shahin Falahati	Scott Easton	16 November 2018
Revision 1	Shahin Falahati	Scott Easton	31 May 2019

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Richard Arkell, Meriden School
Revision 1	1	0	Richard Arkell, Meriden School

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		31 May 2019
Reviewer		31 May 2019

ISO 9001 Quality Management

FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Table of Contents

Page

Appendix A:	About This Report
Appendix B:	Drawings
Appendix C:	Field Work Results
Appendix D	Laboratory Test Results

Report on Geotechnical Investigation
Meriden Centre of Music and Drama
13 Margaret Street, Strathfield

1. Introduction

This report presents the results of a geotechnical investigation undertaken for the proposed Centre of Music and Drama at Meriden School, located at 13 Margaret Street, Strathfield (the site). The investigation was commissioned in an email dated 26 September 2018 by Richard Arkell of Meriden School and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal SYD180989.P.001.Rev1 dated 24 September 2018.

The investigation was carried out to provide information on the subsurface conditions for design and planning purposes.

The investigation included the drilling of five rock cored boreholes, excavation of five test pits, and the installation of one groundwater monitoring well. Details of the field and laboratory testing are given in the report, together with comments on design and construction issues.

DP has also prepared a Preliminary Site (Contamination) Investigation (PSI) report for the site (reference 86568.00.R.002, dated 13 November 2018). This Geotechnical Investigation report should be read in conjunction with the PSI.

1.1 Proposed Development

It is understood that the development of the site will include the demolition of an existing structure near the front of the school and the construction of a three-storey music and drama building over a stepped two level basement. Based on the supplied architectural drawings it is understood that:

- The outer shoring wall of the proposed building is to be constructed with a setback of about 1.6 m and 1.2 m from the existing school buildings to the north and east, respectively; and
- The lower basement level will have a finished floor level of Reduced Level (RL) 12.4 m Australian Height Datum (AHD) and RL 14.6 m AHD in the approximate northern and southern half of the development footprint, respectively.

Given the sloping nature of the site, the stepped lower basement level is expected to extend to depths of about:

- 5.8 m in the approximate northern half of the basement footprint or a bulk excavation level of about RL 12.2 m AHD.
- 4.3 m in the approximate southern half of the basement footprint or a bulk excavation level of about RL 14.4 m AHD; and

Bulk excavation for proposed new structures outside of the basement footprint is expected to extend to a depth of up to 1 m for minor levelling works and proposed footings, service trenches, etc. The approximate basement extent is shown on Drawing 1 in Appendix B.

2. Site Description

The location of the new building is a roughly rectangular-shaped area of about 920 m^2, with surface levels observed to be gradually dipping gently to the north from RL 18.8 m AHD to RL 17.1 m AHD. At the time of DP's presence on site a single storey brick building surrounded by grass covered areas, young trees and pavements occupied the site.

Based on a preliminary inspection, both the external brickwork of the existing building and the existing pavements at the site appeared to be in a relatively good condition.

The site is situated within an area developed for a variety of uses. A summary of the current land uses adjacent to the location of the proposed building at the time of DP's presence on site is provided in Table 1.

Table 1: Summary of Adjacent Land Use

Direction Relative to the Site	Land Use Description
North	Two-storey building referred to as the 'Wallis Building' by the school.
East	Two-storey building referred to as the 'Hope Building' by the school.
South	Margaret Street followed by single and two storey buildings with on-ground parking.
West	Decoratively paved area followed by a single-storey brick building with on-ground parking owned by the school.

3. Regional Geology

The Geological Survey of NSW 1:100,000 Series Sheet 9130 for Sydney indicates that the site is underlain by Ashfield Shale which typically comprises black to dark grey shale and laminite (interlaminated siltstones and sandstones).

The results of the field work for the present investigation were consistent with the published geological mapping.

4. Field Work Methods

The field work was carried out over four days (3, 4, 5 and 8 October 2018), and comprised:

- On-site electronic scanning for buried services at proposed borehole locations;
- Drilling of five boreholes (BH101 to BH105) using a bob-cat mounted drilling rig. The boreholes were drilled into the weathered rock to depths of between 2.6 m to 2.8 m using solid flight augers.

The boreholes were then continued to a termination depth of about 8 m using NMLC diamond core drilling equipment to obtain continuous core samples of the bedrock;

- Standard penetration tests (SPTs) at regular depth intervals within the soil profile;
- Disturbed soil samples collected from the augers;
- Excavation of five test pits (TP106, TP107, TP108A, TP108B and TP109) using hand equipment to expose the footings of the existing building to the north and east of the proposed building. The test pits were excavated to depths of about 1 m;
- An undisturbed U_{50} sample was collected at the base of two of the test pits;
- Completion of a 1.2 m deep Dynamic Cone Penetrometer (DCP) test at the surface of the test pits (prior to excavation) and another at the base of the test pits (following excavation) to give a total DCP test depth of about 1.5 m;
- Collection of a California Bearing Ratio (CBR) sample at the location of BH105;
- Installation of a groundwater monitoring well in BH103 to allow for the measurement of groundwater levels; and
- A rising head permeability test within the well in BH103. The water column in the well was removed and then the rise in the water level (i.e. recharge) was measured at regular time intervals.

All boreholes and test pits were backfilled with drilling spoil upon completion and re-instated with brick pavers where necessary. The locations of the boreholes and test pits are shown on Drawing 1 in Appendix B. The test locations were measured from existing site features and levels were estimated using the supplied survey plan. Easting and northings provided on the borehole logs have been obtained from NSW government online mapping.

5. Field Work Results

The detailed borehole and test pit logs and rock core photographs are included in Appendix C, together with notes defining classification methods and terms used to describe the soils and rocks. Discussion on the test pit footing exposures is given in Section 8.8.1.

5.1 Boreholes and Test Pits

Based on the results of the site investigation, the sequence of subsurface materials encountered at the site, in increasing depth order, is summarised in Table 2. Discussion on the selection of the 'Units' and associated rock classification is provided in Section 7.

Table 2: Summary of the Subsurface Ground Profile

Unit	Material	Depth Range to Top of Unit (m)	RL Range to Top of Unit (m AHD)	Thickness (m)	General Description
1	Filling	0	18.7 to 17.0	0.2 to 1.2	Typically sand and silty sand filling at the borehole locations with inclusions of road base, ceramic, tiles and gravel. At the test pit locations, layers of road base gravel, asphalt and silty clay filling with varying proportions of brick, concrete, ceramic and slag fragments, was also observed.
2	Residual Soil	0.2 to 1.2	18.5 to 15.8	0.8 to 2.1	Medium to high plasticity, stiff to hard residual clays and silty clays.
3	Class V Laminite	1.2 to 2.6	16.7 to 14.4	0.2 to 1.8	Extremely low to very low strength laminite comprising interlaminated siltstone and sandstone.
4	Class IV Laminite	2.6 to 2.8	16.2 to 15.3	1.2 to 1.6	Low to medium strength laminite with decomposed seams up to a total 150 mm thickness.
5	Class III / II Laminite	2.6 to 4.2	14.7 to 14.1	3.8 to 5.5	Medium to high strength laminite.

5.2 Groundwater and Permeability Test

Groundwater was not observed during auger drilling of the boreholes. Groundwater seepage was observed in TP106 and TP108B at a depth of 0.1 m and 0.8 m, respectively. However, it is noted that it was raining during our presence on site and it is likely that the observed seepage was due to rainwater infiltration through the surrounding garden bed at the surface of TP106 and the surrounding brick pavers at the surface of TP108B.

The essential use of water as a drilling fluid during the coring of boreholes BH101 to BH105 precluded any further groundwater observations. On completion of drilling, BH103 (the well) was purged dry of drilling fluids using a bailer. A summary of the measured groundwater level in the monitoring well installed in BH103 is provided in Table 3.

Table 3: Summary of Groundwater Measurements

Borehole ID	Surface RL (m AHD)	Groundwater Depth (m)	Groundwater RL (m AHD)	Date	Comments
BH103 (well)	18.1	3.4	14.7	8 October 2018	Measured five days after being purged dry on 3 October 2018

A rising head permeability test was carried out in BH103 on 8 October 2018 using a twister pump to remove water from within the well and then measuring the rise in the water level at regular time intervals. The results of the permeability test indicated the laminite bedrock to have a permeability of about 3.2×10^{-7} m/sec with the detailed results included in Appendix C.

It should be noted that groundwater levels are transient and that fluctuations may occur in response to climatic and seasonal conditions.

6. Laboratory Testing

Laboratory testing was carried out on eight (seven soil and one groundwater) samples to determine:

- Soil and groundwater aggressivity for exposure classification of buried concrete and steel elements;
- Atterberg Limits;
- Shrink / Swell; and
- California bearing ratio (CBR).

The results of the laboratory testing are presented in Table 4 and Table 5. The detailed laboratory test reports are given in Appendix D.

Table 4: Summary of Geotechnical Laboratory Test Results

BH / TP ID	Depth (m)	Material	Atterberg Limits (%)				Shrink / Swell Index Iss (%)	CBR (%)	MDD (t/m^3)	OMC (%)
			LL	PL	PI	LS				
BH102	0.9-1.0	Clay	47	17	30	13	-	-	-	-
BH105	0.4-0.8	Clay	-	-	-	-	-	3.5	1.51	27.5
TP106	0.8-1.1	Clay	-	-	-	-	3.6	-	-	-
TP109	0.9-1.0	Clay	-	-	-	-	2.4	-	-	-

Note: MC = Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage, CBR = California Bearing Ratio, MDD = Maximum Dry Density, OMC = Optimum Moisture Content

The above results indicate that the residual clays are typically of moderately to high plasticity and are likely to exhibit a moderate to high propensity for shrink-swell movements with change in moisture content (i.e. reactive).

Table 5: Summary of Chemical Laboratory Test Results

Borehole ID	Depth (m)	Conductivity (µS/cm)	pH	Cl (PPM)	SO_4 (PPM)
BH101	1.9	300	5.6	150	260
BH102	1.0	160	6.0	58	140
BH103	0.5	160	6.5	35	110
BH103	Groundwater	3,800	7.4	810	240

Notes: Cl = Chloride ion concentration, SO_4 = Sulphate ion concentration, PPM = Parts Per Million

The point load test results on rock cores were tested in-house, with the results shown on the borehole logs in Appendix C.

7. Geotechnical Model

For design purposes, the observed subsurface profile during the investigation has been grouped into five geotechnical units. Two geotechnical cross sections (Section A-A' and Section B-B') showing the interpreted subsurface profile between the borehole locations are shown on Drawing 2 and 3 in Appendix B, respectively.

The interpreted depth and RLs at the top of the various units at each test location is shown in Table 6. Reference should be made to the borehole logs for more detailed information and descriptions of the soil and rock profile.

It is expected that the regional groundwater table in the area would be relatively deep and within the underlying rock. Perched seepage flows will, however, occur along the soil and rock interface and may also occur within fractured zones and joints in the rock. Seepage flows are likely to increase following periods of extended wet weather.

Table 6: Summary of Geotechnical Model

Unit	Material	Depth [m] Reduced Level (m AHD) to Top of Each Unit									
		BH101	BH102	BH103	BH104	BH105	TP106	TP107	TP108A	TPA108B	TP109
1	Filling	[0.0] (17.0)	[0.0] (17.1)	[0.0] (18.1)	[0.0] (18.7)	[0.0] (18.3)	[0.0] (17.2)	[0.0] (17.2)	[0.0] (18.0)	[0.0] (18.0)	[0.0] (18.7)
2	Residual Soil	[1.2] (15.8)	[0.2] (16.9)	[0.6] (17.5)	[0.3] 18.5)	[0.3] (18.1)	[0.7] (16.5)	[0.3] (16.9)	[0.6] (17.4)	[0.5] (17.5)	[0.6] (18.1)
3	Class V Laminite	[2.6] (14.4)	[2.3] (14.8)	[2.5] (15.6)	[2.2] (16.5)	[2.0] (16.3)	N.O (2)	[1.2] (3) (16.0) (3)	[1.5] (3) (16.5) (3)	[1.3] (3) (16.7) (3)	N.O (2)
4	Class IV Laminite	N.E	N.E	[2.8] (15.3)	[2.6] (16.2)	[2.6] (15.7)	N.E	N.E	N.E	N.E	N.E
5	Class III / II Laminite	[2.8] (14.2)	[2.6] (14.5)	[4.0] (14.1)	[4.0] (14.7)	[4.2] (14.1)	N.E	N.E	N.E	N.E	N.E

Notes: (1) N.E = Not Encountered
(2) N.O = Not Observed at DCP termination depth of about 1.2 m below existing surface level
(3) Depth / RL to top Class V Laminite inferred from DCP refusal depth

8. Comments

8.1 Dilapidation Surveys

Dilapidation surveys should be carried out on adjacent / existing buildings, pavements and infrastructure that may be affected by the excavation works. The dilapidation surveys should be undertaken before the commencement of any excavation work in order to document any existing defects so that claims for damage due to construction related activities can be accurately assessed.

8.2 Excavation Conditions

Based on the borehole logs the proposed bulk excavation works are anticipated to extend through all Units (soil and rock) outlined in Table 7. The excavatability of the materials that will be encountered during the bulk excavation works is summarised in Table 7. The detailed excavation for footings, services and side walls within low strength or stronger rock will generally require the use of a rotary rock saw or grinder, or hydraulic rock hammers.

Table 7: Summary of Soil and Rock Excavatability

<table>
<tr><th>Unit</th><th>Material</th><th>Material Strength</th><th>Excavatability</th></tr>
<tr><td>1</td><td>Filling</td><td>Sandy / Clayey Filling</td><td rowspan="3">Excavated using buckets of conventional earthmoving equipment, particularly if fitted with ‘rock teeth’.</td></tr>
<tr><td>2</td><td>Residual Soil</td><td>Stiff to Hard</td></tr>
<tr><td>3</td><td>Class V Laminite</td><td>Extremely Low to Very Low Strength Laminite</td></tr>
<tr><td>4</td><td>Class IV Laminite</td><td>Low to Medium Strength Laminite</td><td rowspan="2">Hard ripping using a large ‘bulldozer’ (such as a D9 or larger plant), or excavators fitted with either ripping tynes or rock hammers. Rock hammers or saws / grinders are generally required for effective excavation of slightly fractured and unbroken rock.</td></tr>
<tr><td>5</td><td>Class III / II Laminite</td><td>Medium to High Strength Laminite.</td></tr>
</table>

8.3 Vibrations

During excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. The level of acceptable vibration is dependent on various factors including the type of structure (e.g. reinforced concrete or brick structures etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the structure and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s vector sum peak particle velocity (VSPPV). This is generally much lower than the vibration levels required to cause structural damage to buildings. The Australian Standard AS2670.2-1990 “Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)” indicates an acceptable day time limit of 8 mm/s VSPPV for human comfort.

Based on the experience of DP and with reference to AS2670, it is suggested that a maximum VSPPV of 8 mm/s (applicable at the foundation level of existing buildings) be adopted for this site for both architectural and human comfort considerations.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of rock excavation. The trial may indicate that smaller or different types of excavation equipment should be used for bulk (or detailed) excavation purposes.

8.4 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014). This includes filling and natural materials that may be removed from the site. Reference should be made to the preliminary in-situ waste classification provided in the PSI report for the site (reference 86568.00.R.002, dated 13 November 2018).

8.5 Excavation Support

Vertical excavations within the soil and weathered/ jointed rock profile (i.e. all five units as outlined in Table 6) will require both temporary and permanent lateral support during and after excavation.

8.5.1 Batter Slopes

Suggested temporary and permanent batter slopes for unsupported excavations up to a maximum height of 4 m are shown in Table 8. If surcharge loads are applied near the crest of the slope then further specific geotechnical review and probably flatter batters or stabilisation using rock bolts or soil nails may be required. Batters are not recommended near existing buildings (e.g. near the existing buildings north and east of the proposed building) or services.

Table 8: Recommended Batter Slopes for Exposed Material

Unit	Material	Excavation Height (m)	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
1	Filling	<4 m	1.5 : 1	2.5 : 1**
2	Residual Soil	<4 m	1 : 1	2 : 1**
3	Class V Laminite	<4 m	0.75 : 1	1 : 1*
4	Class IV Laminite	<4 m	0.75 : 1	1 : 1*
5	Class III / II Laminite	<4 m	0.75 : 1	1 : 1*

Note: * Subject to jointing assessment by experienced Geotechnical Engineer/Engineering Geologist

** Permanent batters in soil may need to be reduced to 3H: 1V to facilitate maintenance of grassed slopes, if required

8.5.2 Retaining Walls

Where batter slopes cannot be used, shoring walls will be required to support Unit 1, 2, 3, 4 and 5 materials as outlined in Table 6. Anchored soldier pile walls are often used to provide temporary retaining support to soils and weathered rock. The soldier piles are usually spaced at approximately 2 m to 2.5 m centres, however, more closely spaced piles may be required to reduce wall movements, or prevent collapse of infill materials, particularly where pavements, structures or services are located in close proximity to the excavation.

Careful attention will need to be given to the design of excavation support on the northern and eastern side of the proposed building that is to have a setback of about 1.6 m and 1.2 m from the adjacent existing buildings, respectively. Along these boundaries, the proposed retaining wall will need to provide adequate support to the existing footings and will need to include more closely spaced piles and/ or construction of shotcrete panels in shallower lifts (say 1.5 m), subject to review during construction by a geotechnical engineer, in order to limit lateral movement (as a result of basement excavations) to tolerable levels. Reference should be made to the footing exposure drawings (Drawings 4 to 9) provided in Appendix B. Further discussion regarding the bearing capacity of the exposed footings is provided in Section 8.8.1.

Cantilevered pile walls should not be used where there are adjacent structures within a distance equal to the height of the excavation from the shoring wall. This is due to their (i.e. cantilevered shoring walls) greater propensity for outward rotation and the consequently higher risk of disturbing such adjacent structures.

It is suggested that preliminary design of cantilevered shoring systems or shoring with one row of anchors/ propping be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 9. ‘Active’ earth pressure coefficient (K_a) values may be used where some wall movement is acceptable, and ‘at rest’ earth pressure (K_o) values should be used where the wall movement needs to be reduced (i.e. adjacent to existing structures or utilities).

Table 9: Recommended Design Parameters for Shoring Systems

Unit	Material	Unit Weight (kN/m^3)	Earth Pressure Coefficient		Effective Cohesion c’ (kPa)	Effective Friction Angle (Degrees)
			Active (K_a)	At Rest (K_o)		
1	Filling	20	0.4	0.6	2	25
2	Residual Soil	20	0.3	0.45	5	25
3	Class V Laminite	24	0.3	0.45	10	28
4	Class IV Laminite	24	0.2	0.3	20	28
5	Class III / II Laminite	24	0.2	0.3	30	30

The design for lateral earth pressures where multiple rows of anchors or propping (i.e. two rows) may be based on a trapezoidal earth pressure distribution. The following earth pressure magnitudes are considered appropriate, where H is the height of soil and rock to be retained, in metres:

- 4H kPa, where some lateral movement is allowed; and
- 6H kPa, where lateral movements need to be reduced (e.g. next to buildings and services).

In each case the maximum pressure generally acts over the central 60% of the wall height, reducing to zero at the top and base of the wall.

The design of the shoring should allow for all surcharge loads, including building footings, inclined slopes behind the wall, traffic, site sheds, and construction related activities.

If a more accurate assessment of predicated ground movements at nearby buildings/ infrastructure as a result of the proposed excavations is required then numerical modelling (using commercially available software such as Plaxis 2D or FLAC 2D) of the proposed excavation may be required.

Shoring walls should also be designed for full hydrostatic pressures unless drainage of the ground behind impermeable walls can be provided. Drainage could comprise 150 mm wide strip drains pinned to the face at 1 m to 2 m centres behind shotcrete in-fill panels. The base of the strip drains should extend out from the shoring wall to allow any seepage to flow into a perimeter toe drain which is connected to the stormwater drainage system.

8.5.3 Passive Resistance

Passive resistance for piles founded in rock below the base of the bulk excavation (including allowance for services and/or footings) may be based on the ultimate passive restraint values provided in Table 10. This ultimate value represents the pressure mobilised at high displacements and therefore it will be necessary to incorporate a factor of safety of at least 3 to limit wall movement. The top 0.5 m of the socket should be ignored due to possible disturbance and over-excavation.

Table 10: Recommended Passive Resistance Values

Unit	Foundation Stratum	Maximum Allowable Passive Pressure (kPa)	Maximum Ultimate Passive Pressure (kPa)
3	Class V Laminite	130*	400*
4	Class IV Laminite	200*	600*
5	Class III / II Laminite	1,300*	4,000*

Note: * subject to geotechnical inspection

8.5.4 Ground Anchors

The design of temporary and permanent ground anchors/rock bolts for the support of excavations and/or shoring systems may be carried out on the basis of the maximum bond stresses given in Table 11.

Table 11: Recommended Bond Stresses for Rock Anchor Design

Unit	Material Description	Maximum Allowable Bond Stress (kPa)	Maximum Ultimate Bond Stress (kPa)
3	Class V Laminite	35	70
4	Class IV Laminite	75	150
5	Class III / II Laminite	500	1,000

The parameters given in Table 11 assume that the drilled holes are clean and adequately flushed. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the shoring, and "lift-off" tests should be carried out to confirm the anchor capacities. Trial anchors should be used to confirm bond stress values. It is suggested that ground anchors should be proof loaded to 125% of the design working load and locked-off at no higher than 80% of the working load.

8.6 Excavation Induced Ground Movement

Precise survey and/ or inclinometer monitoring of excavation faces and nearby buildings/ structures (particularly on the northern and eastern side of the proposed building that is to have a setback of about 1.6 m and 1.2 m from the adjacent existing buildings, respectively) should be carried out to assess vertical and horizontal movements during the excavation. The survey and/ or inclinometer monitoring should commence prior to excavation to provide a baseline and should continue every 1.5 m drop of the excavation. If deflections show an increase in the rate of movement or exceed the predicted movements, then the structural engineer and geotechnical engineer should be contacted for immediate review.

8.7 Groundwater

It is expected that perched groundwater seepage will occur along the top of the soil and rock interface and through joints and along bedding planes within the rock exposed in the basement floor and walls, particularly after wet weather.

During construction and in the long term, it is anticipated that seepage into the excavation could be controlled by perimeter and subfloor drainage connected to a sump-and-pump system. On this basis, a drained basement may be considered for this site. Generally, water collected from dewatering operations should be suitable for disposal by pumping to stormwater drains subject to confirmation testing of groundwater quality and approval from the Council.

It is possible that seepage into the basement may give rise to precipitation of red brown iron oxide residue from the oxidisation of soluble iron likely to be present within the groundwater and therefore perimeter and subfloor drains should be designed for easy access to allow for inspection, maintenance and periodic cleaning.

8.8 Foundations

The following material is expected to be exposed following bulk excavation work:

- Unit 1 fill and/ or Unit 2 residual soil outside of the basement footprint;
- Unit 5 rock in the northern half of basement footprint; and
- Unit 4 rock and possibly some Unit 5 rock in the approximate southern half of the basement footprint.

It is recommended that all footings for the structures be uniformly founded on rock with similar strength in order to provide uniform support of the proposed structures and to reduce the potential for differential settlements. Footings for any adjacent structures (i.e. within the zone of influence of the basement excavation and along the line where the excavation is stepped) should preferably be founded deep enough so that the retaining walls are not surcharged.

Where rock is close to design level, shallow pad or strip footings founded in rock could be used. Alternatively, piles founded (i.e. socketed) in stronger rock could be used to reach rock and/ or to achieve higher capacities.

Bored piles could be used on this site however some allowance should be made for removal of water, particularly for deeper piles. Driven piles are not recommended due to the proximity of residents and school occupants who may be disturbed by the noise and vibrations.

Footings may be designed using the values given in Table 12. For bored piles, if required, shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the shaft adhesion values for compression in Table 12.

Table 12: Recommended Design Parameters for Foundation Design

Unit	Foundation Stratum	Maximum Allowable Pressure (Serviceability)		Maximum Ultimate Pressure (Ultimate)		Young's Modulus, E (MPa)
		End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	
2	Residual Soil Stiff to Very Stiff Clay or Stronger	150	-	450	-	25
3	Class V Laminite	700	70	3,000	100	70
4	Class IV Laminite	1,000	100	4,000	200	100
5	Class III / II Laminite	3,500	350	30,000	600	700

Foundations proportioned on the basis of the allowable bearing pressure in Table 12 would be expected to experience total settlements of less than 1% of the footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value.

Footings designed using ultimate values and Limit State Design will need to consider serviceability which usually governs the design in this case. For pile design, a basic geotechnical strength reduction factor, Φ_{gb}, of about 0.56 (or possibly higher) calculated from Table 4.3.2 (A, B, and C) of AS2159-2009: Piling Design and Installation, is considered feasible. However, the structural engineer will need to make their own assessment with the final (Φ_{gb}) number being dependent on the design and installation method (and associated risk rating) adopted by the structural engineer. A Φ_{gb} of 0.4 is required if pile load testing is not carried out.

8.8.1 Existing Footings of the Heritage Listed Building

As previously mentioned, DP excavated five test pits adjacent to the existing buildings to the north and east of the proposed building. Reference should be made to the footing exposure drawings (Drawings 5 to 9) provided in Appendix B. A summary of the observations made during the footing exposures along with the anticipated allowable bearing capacity of the existing footings is provided in Table 13 below.

It should be noted that DP has not assessed the structural capacity of the existing footings. If these existing footings are required to carry any additional loading then the structural engineer would need to assess the load carrying capacity of the existing footings and associated settlements and differential settlements as a result of the additional loads. DP can assist with this if required.

Table 13: Summary of Footing Exposures

Test Pit ID	Inferred Footing Type	Depth to Base of Footing Below Surface (m)	Apparent Footing Condition	Material Exposed Below the Base of Footing	Allowable Bearing Capacity of Existing Footing (kPa)
TP106	Strip Footing	0.65	No visual signs of damage observed	FILLING: Crushed Sandstone, over CLAY: Very Stiff to Hard	200
TP107	Pad Footing	0.86	No visual signs of damage observed	CLAY: Very Stiff to Hard	200
TP108A	Strip Footing	0.79	No visual signs of damage observed	FILLING: Sandy Gravel, over CLAY: Stiff	100

Test Pit ID	Inferred Footing Type	Depth to Base of Footing Below Surface (m)	Apparent Footing Condition	Material Exposed Below the Base of Footing	Allowable Bearing Capacity of Existing Footing (kPa)
TP108B	Pad Footing	0.78	No visual signs of damage observed	FILLING: Sandy Gravel, over CLAY: Stiff to Very Stiff	150
TP109	Strip Footing	0.97	No visual signs of damage observed	CLAY: Hard	200

The footings exposed in TP106, TP108A and TP108B appeared to comprise a concrete footing founded on a layer of sandy gravel or crushed sandstone filling about 40 mm to 70 mm thick. It is possible that this filling may be a weak concrete, or possibly it is placed to improve the foundation and reduce shrink swell movements. Further investigation of this area could be carried out to verify the material at the base of the footing if required.

8.8.2 Site Classification

The laboratory tests on the residual soils indicate that the clays tested at the site are of moderate to high plasticity and have a high potential for shrink / swell movements with changes in moisture content.

If the proposed structures outside of the basement footprint were to be constructed over clayey filling thicker than 0.4 m, then the site would be classified as Class P when assessed in accordance with AS 2870 – 2011 Residential slabs and footings. However, where the filling is stripped during the bulk excavation then the site is classified as Class H1.

It is noted that abnormal moisture conditions could also exist due to existing trees and also after removal of trees, resulting in a more severe Class H2 or P site classification. Reference should be also be made to AS2870 for design, construction, performance criteria and maintenance precautions.

If existing trees are to be removed or if the site is to be filled with reactive clays (e.g. excavated from elsewhere on-site), the effect of the readjustment in soil moisture in the underlying clays should be carefully assessed. Should any large trees require removal, it is recommended they be removed well in advance of construction to allow for readjustment of the moisture content of the highly reactive clay subsoil. Removal of any large trees should also include the removal of the tree stump and roots.

8.9 Seismic Design

In accordance with the Earthquake Loading Standard, AS1170.4, 2007, the site has a hazard factor (z) of 0.08 and a site sub-soil class of shallow soil (C_e).

8.10 Soil and Groundwater Aggressivity

In accordance with AS2159-2009, the results of the chemical laboratory testing indicate that the:

- Soils are non-aggressive to buried concrete and non-aggressive to buried steel; and
- Groundwater is non-aggressive to buried concrete and moderately aggressive to buried steel.

8.11 Subgrade Preparation and Engineering Filling

Site preparation will be required prior to construction of ground slabs and proposed pavements/ driveways. Earthworks recommendations provided in this report should be complemented by reference to AS 3798 – 2007 Guidelines on earthworks for commercial and residential developments.

The following methodology is suggested for subgrade preparation of pavements and on-grade slabs and for raising of site levels using engineered filling:

- Strip the filling down to the surface of the residual soils. This material can either be removed from site or retained for landscaping or re-use as engineered filling.
- Proof rolling of the exposed (clay) subgrade should be carried out prior to placement of any filling or the construction of slabs. Proof rolling should comprise six passes of a smooth drum roller (say at least 10 tonne). The final pass should be carried out under the observation of a geotechnical engineer to identify any soft or saturated zones. Any such zones should be over-excavated to a maximum depth of 600 mm and replaced with compacted durable granular material.
- As the site is underlain by moderate to highly reactive clay, it is important to ensure that the clay soils do not become desiccated during earthworks. If this occurs, the clay subgrade must be watered gradually and rolled until the cracks disappear. If desiccation were to occur the soils may up after being covered by buildings and/ or floor slabs with consequent swelling and possible damage.
- If any filling is required to raise surface levels, it should be placed in layers not greater than 200 mm loose thickness and compacted to between 98% to 100% of Standard dry density, with moisture content within ±2% of the optimum moisture content.
- The filling, natural residual soil and rock on the site is suitable for reuse as engineered filling provided it has a maximum particle size of 100 mm. Reuse should also consider the contamination status and is subject to approval by an environmental consultant.

8.12 Pavements

The bulk soil sample that was tested returned a CBR value of 3.5%. Upon inspection of the bulk sample, it was noted that the sample contained some ironstone gravels, which can have the effect of artificially increasing the CBR value.

It is expected that the subgrade for any new pavements at the site will generally comprise of stiff to very stiff high plasticity clay material, for which a preliminary CBR value of 3% is suggested for pavement design purposes.

The subgrade formation level should be adequately moisture conditioned to be within ±2% of the optimum moisture content and compacted to 100% Standard dry density prior to placement of new pavements.

9. Further Geotechnical Input

Below is a summary of the recommended additional works that should be carried out:

Pre-Construction

- Dilapidation surveys;
- Monitoring of groundwater levels within the installed well in BH103;

During Construction

- Waste Classification of all material to be excavated and transported off site;
- Shoring pile inspections and anchor installation; and
- Footing and pile inspections during construction.

It is recommended that a meeting be held after the initial design has been completed to confirm that these recommendations have been interpreted correctly.

10. Conclusion

This report has discussed various geotechnical aspects of the proposed development and has outlined appropriate construction methods, monitoring requirements, and design parameters. Similar basements have been constructed in Sydney without significant impacts to surrounding properties. It is considered that the basement could be designed and constructed without significant adverse impacts to surrounding properties.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at the Meriden School, located at Margaret Street, Strathfield in accordance with DP's proposal SYD180989 dated 24 September 2018 and acceptance received from Meriden School dated 26 September 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Meriden School for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.
This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

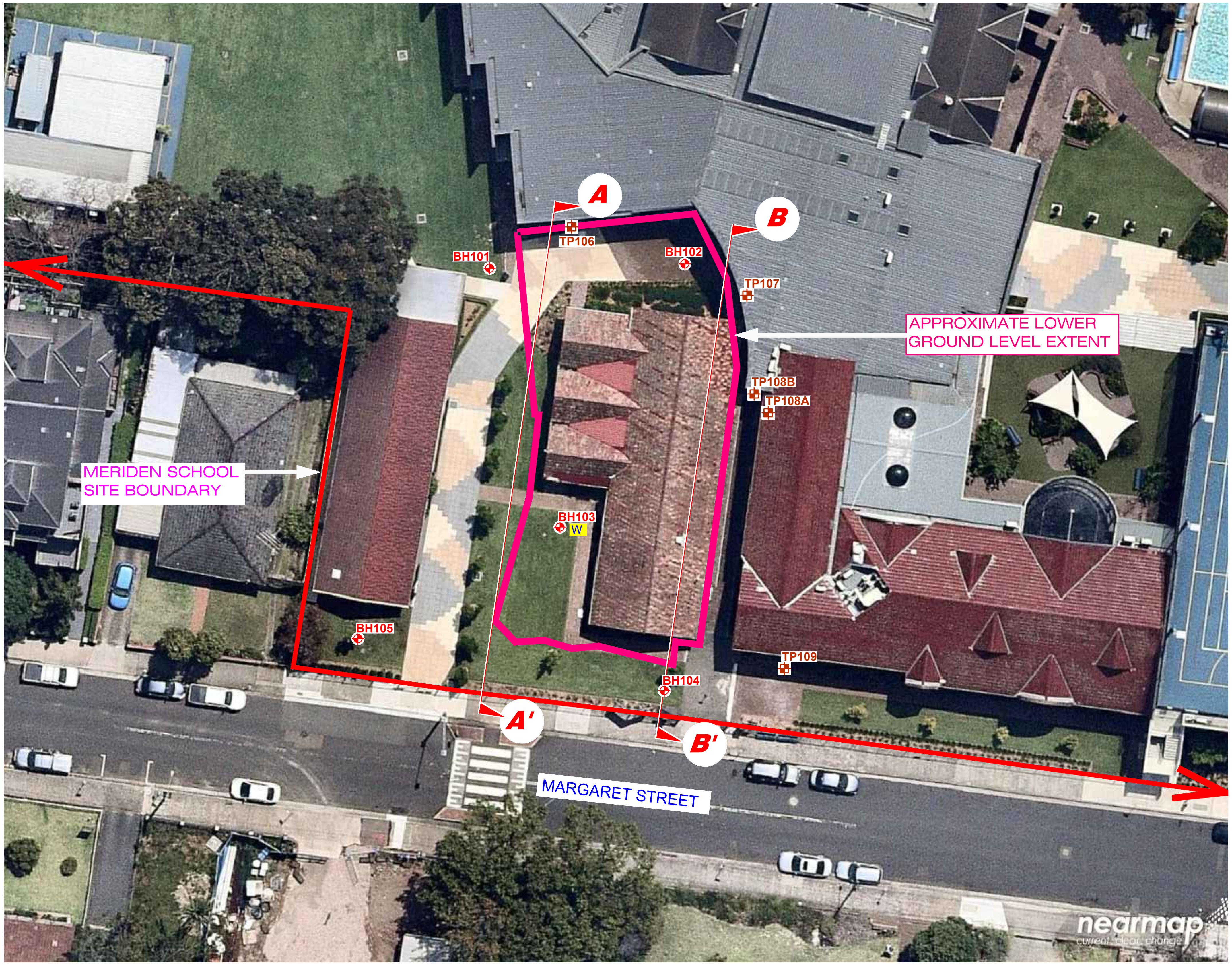
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

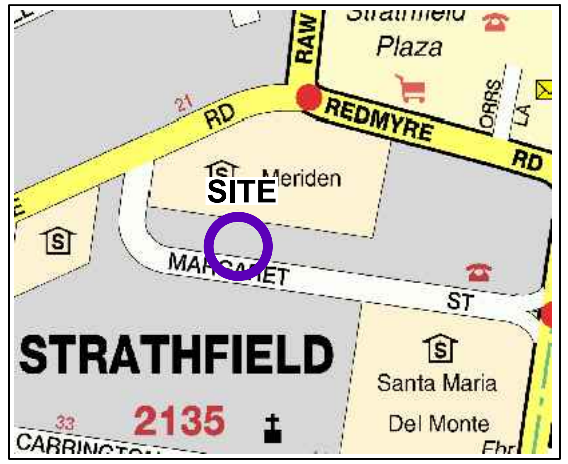
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings





Locality Plan

NOTE:
1: Base image from Nearmap.com (Dated 23.10.2018)
2: Test locations are approximate only and are shown with reference to existing features.

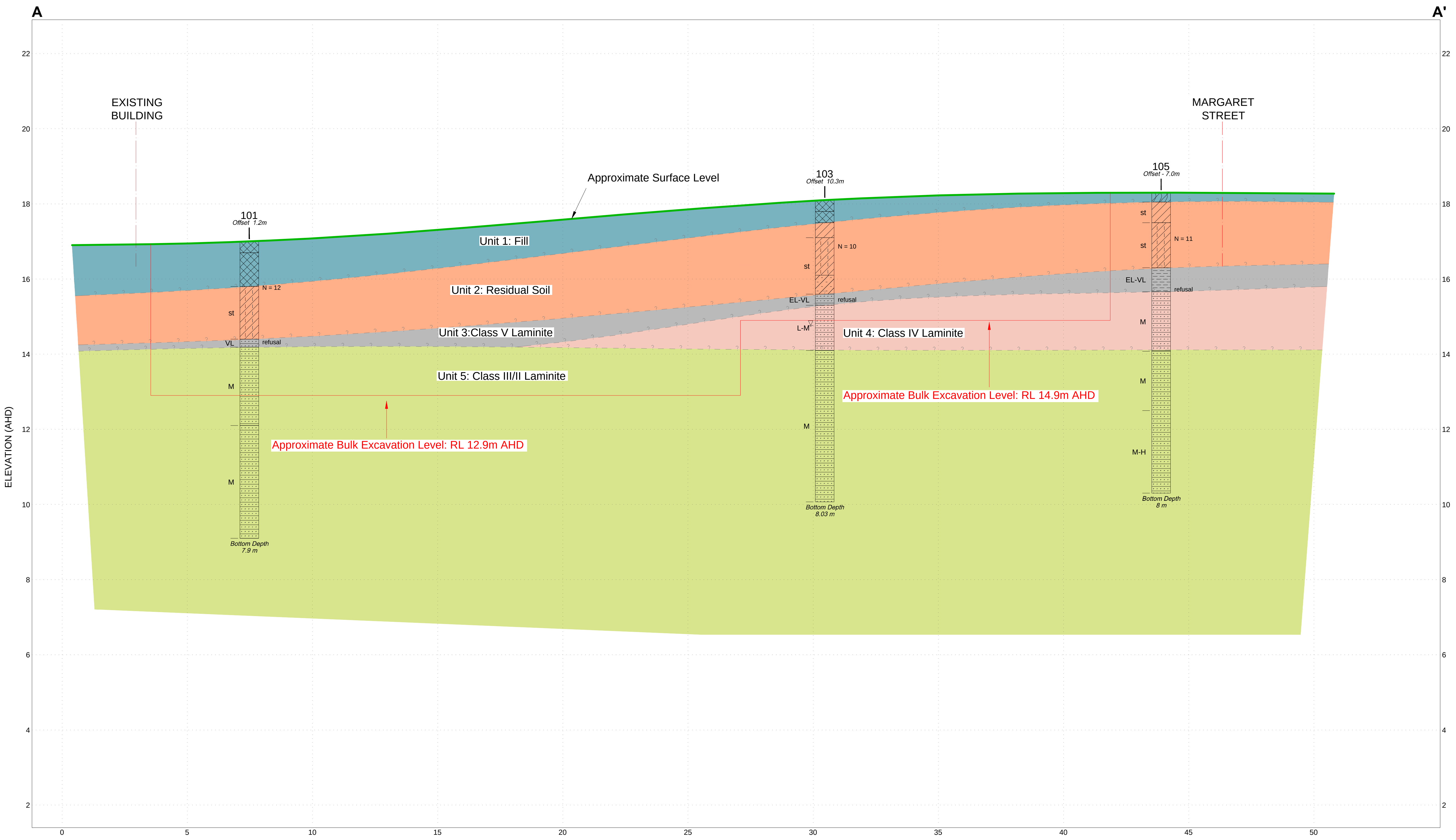
0 2 4 6 8 10 15 20 30 40m
1:400 @ A3

LEGEND

- Test pit location
- Borehole location
- W Groundwater well
- A A' Geotechnical Cross Section A-A'

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Meriden School		TITLE: **Site Plan**	PROJECT No: 86568.00
OFFICE: Sydney	DRAWN BY: PSCH	**Meriden Centre of Music and Drama**	DRAWING No: 1
SCALE: 1:400 @ A3	DATE: 7.11.2018	**13 Margaret Street, STRATHFIELD**	REVISION: 0



LEGEND

- Filling
- Silty Clay
- Laminite
- Clay
- Shaly Clay
- Topsoil
- Shale

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
- EL - Extremely low
- VL - Very low
- L - Low
- M - Medium
- H - High

SOIL STRENGTH/CONSISTENCY
- f - Firm
- st - Stiff
- vst - Very stiff
- h - Hard
- l - Loose
- md - Medium dense
- d - Dense
- vd - Very dense

TESTS / OTHER
- N - Standard penetration test value
- Water level
- Inferred Geology

0 3

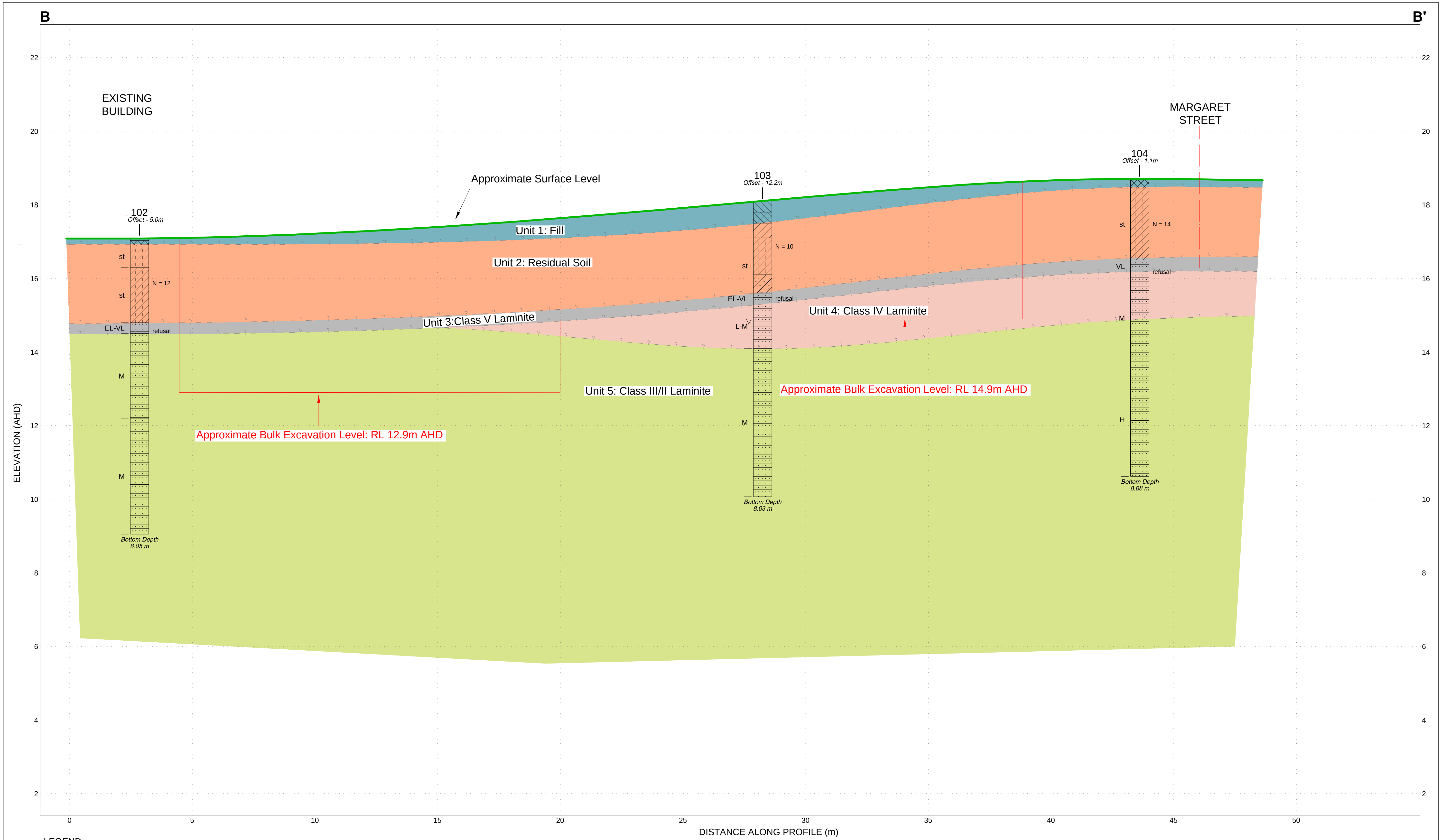
Horizontal Scale (metres)

Vertical Exaggeration = 1.5

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Meriden School		TITLE: Cross-section A-A' Mediden Centre of Music and Drama 13 Margaret Street, Strathfield
OFFICE: Sydney	DRAWN BY: JDB	
SCALE: 1:150 (H) 1:100 (V) @ A3	DATE: 09.11.2018	

PROJECT No: 86568.00
DRAWING No: 2
REVISION: 0



LEGEND

- Bricks
- Filling
- Silty Clay
- Laminite
- Clay
- Shaly Clay

NOTE:

1. Subsurface conditions are accurate at borehole locations. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only. Should be read in conjunction with detailed logs.

ROCK STRENGTH
- EL - Extremely low
- VL - Very low
- L - Low
- M - Medium
- H - High

SOIL STRENGTH/CONSISTENCY
- f - Firm
- st - Stiff
- vst - Very stiff
- h - Hard
- l - Loose
- md - Medium dense
- d - Dense
- vd - Very dense

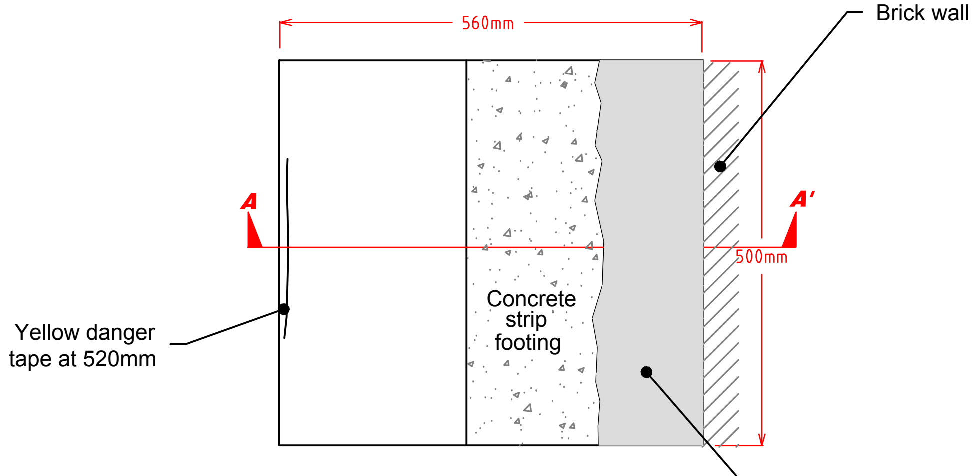
TESTS / OTHER
- N - Standard penetration test value
- Water level
- Inferred Geology

0 3
Horizontal Scale (metres)

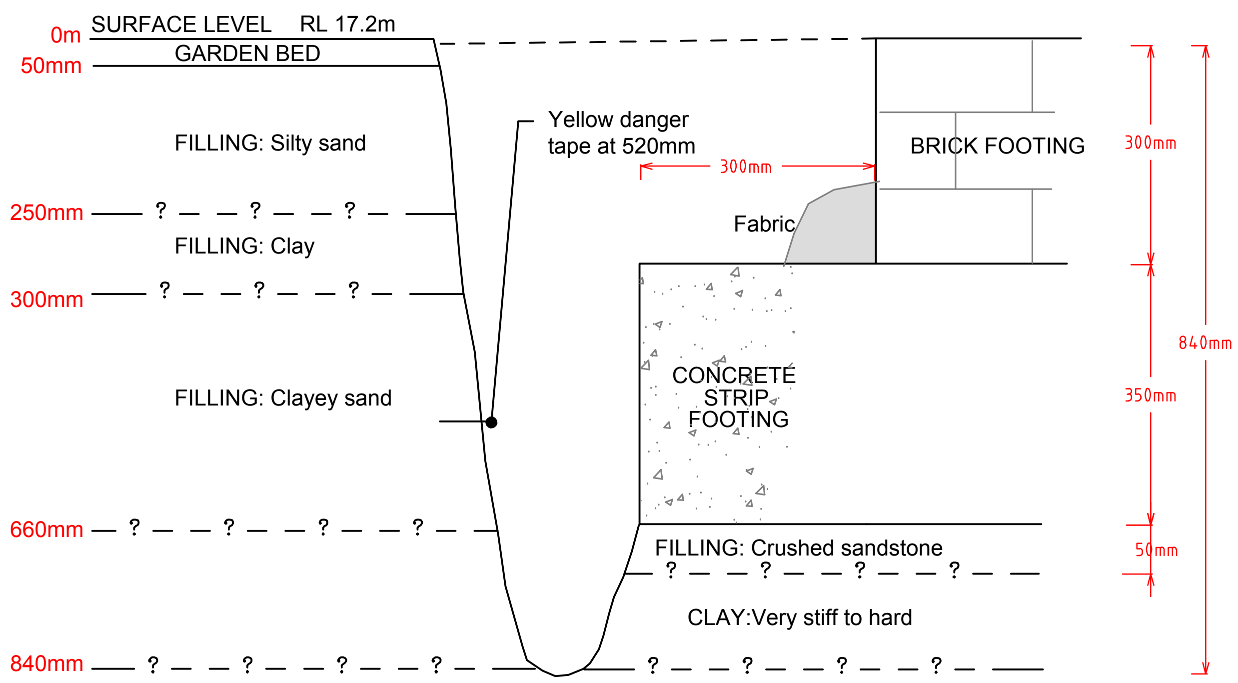
Vertical Exaggeration = 1.5

Douglas Partners
Geotechnics | Environment | Groundwater

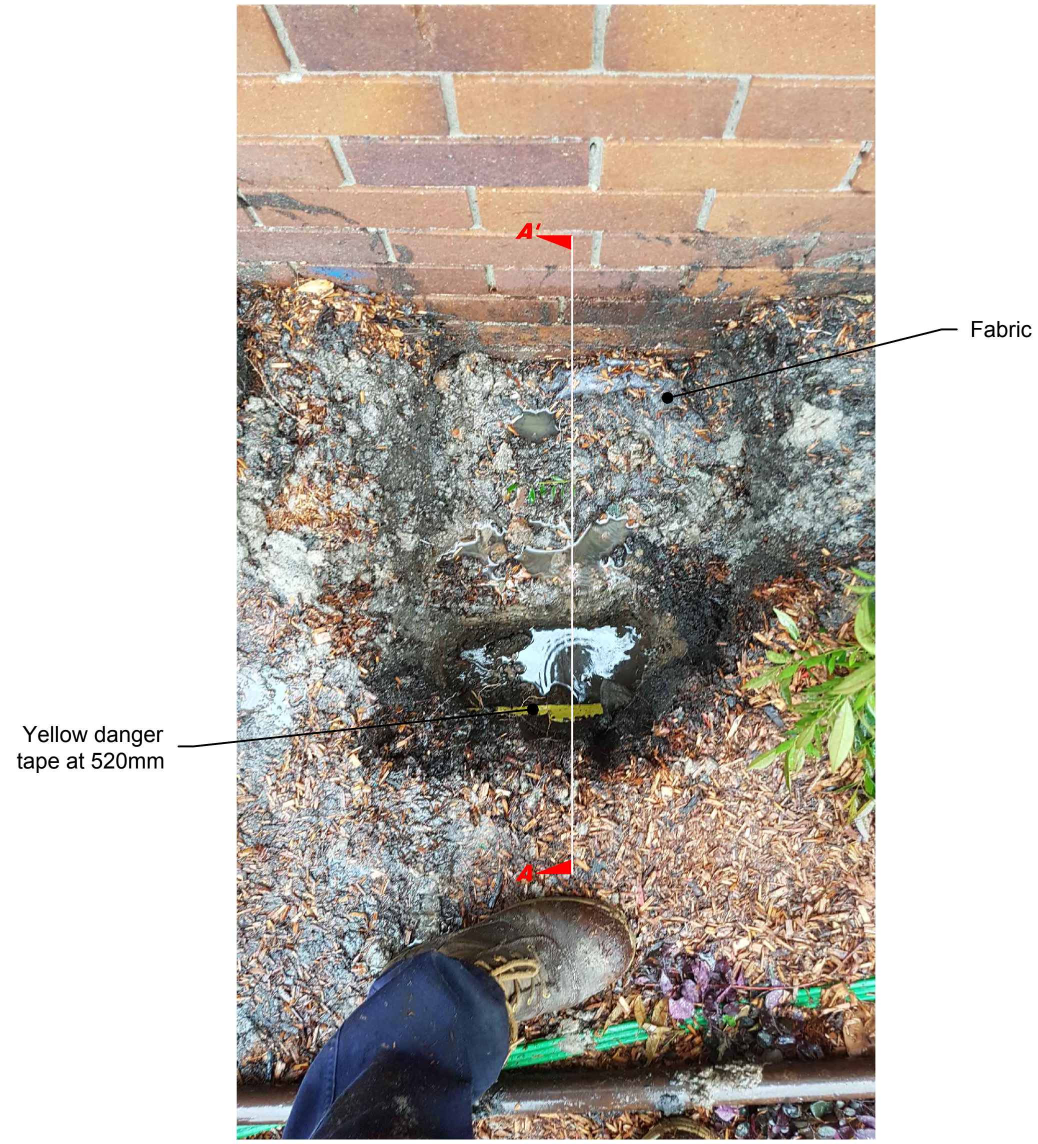
CLIENT: Meriden School		TITLE: Cross-section B-B'	PROJECT No: 86568.00
OFFICE: Sydney	DRAWN BY: JDB	Mediden Centre of Music and Drama	DRAWING No: 3
SCALE: 1:150 (H) 1:100 (V) @ A3	DATE: 09.11.2018	13 Margaret Street, Strathfield	REVISION: 0



PLAN



SECTION A-A'



Douglas Partners Geotechnics | Environment | Groundwater

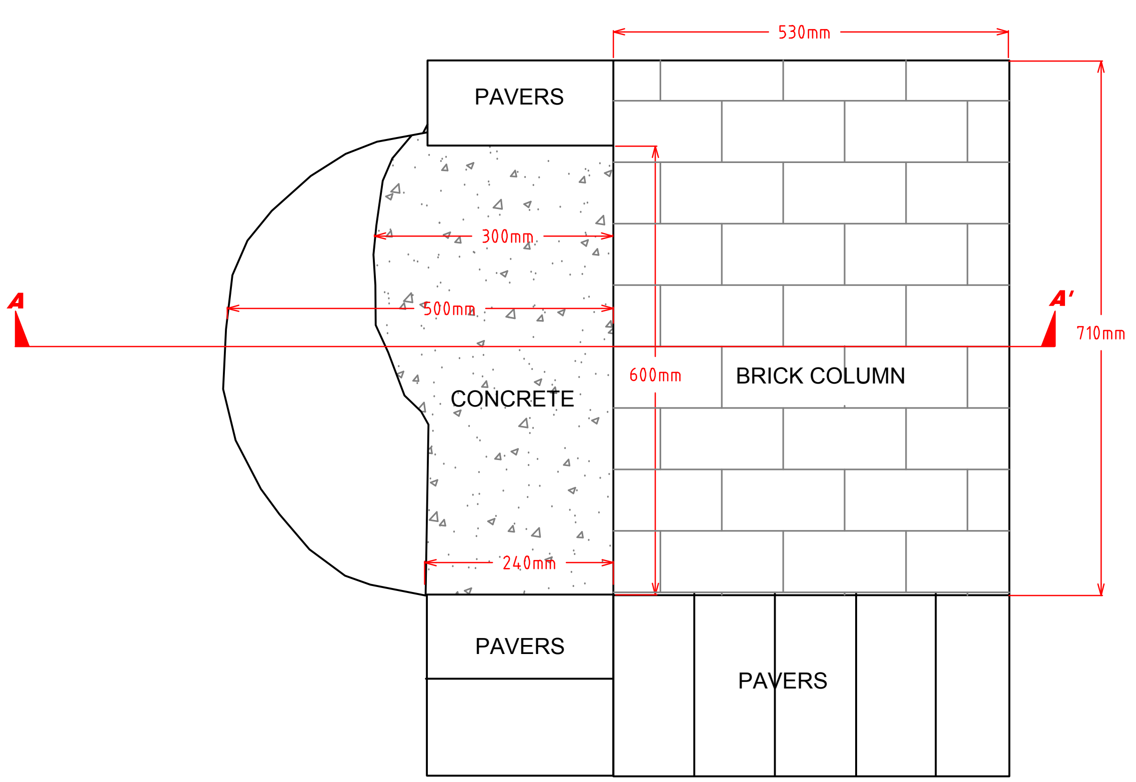
CLIENT: Meriden School
OFFICE: Sydney | DRAWN BY: PSCH
SCALE: 1:100 @ A3 | DATE: 7.11.2018

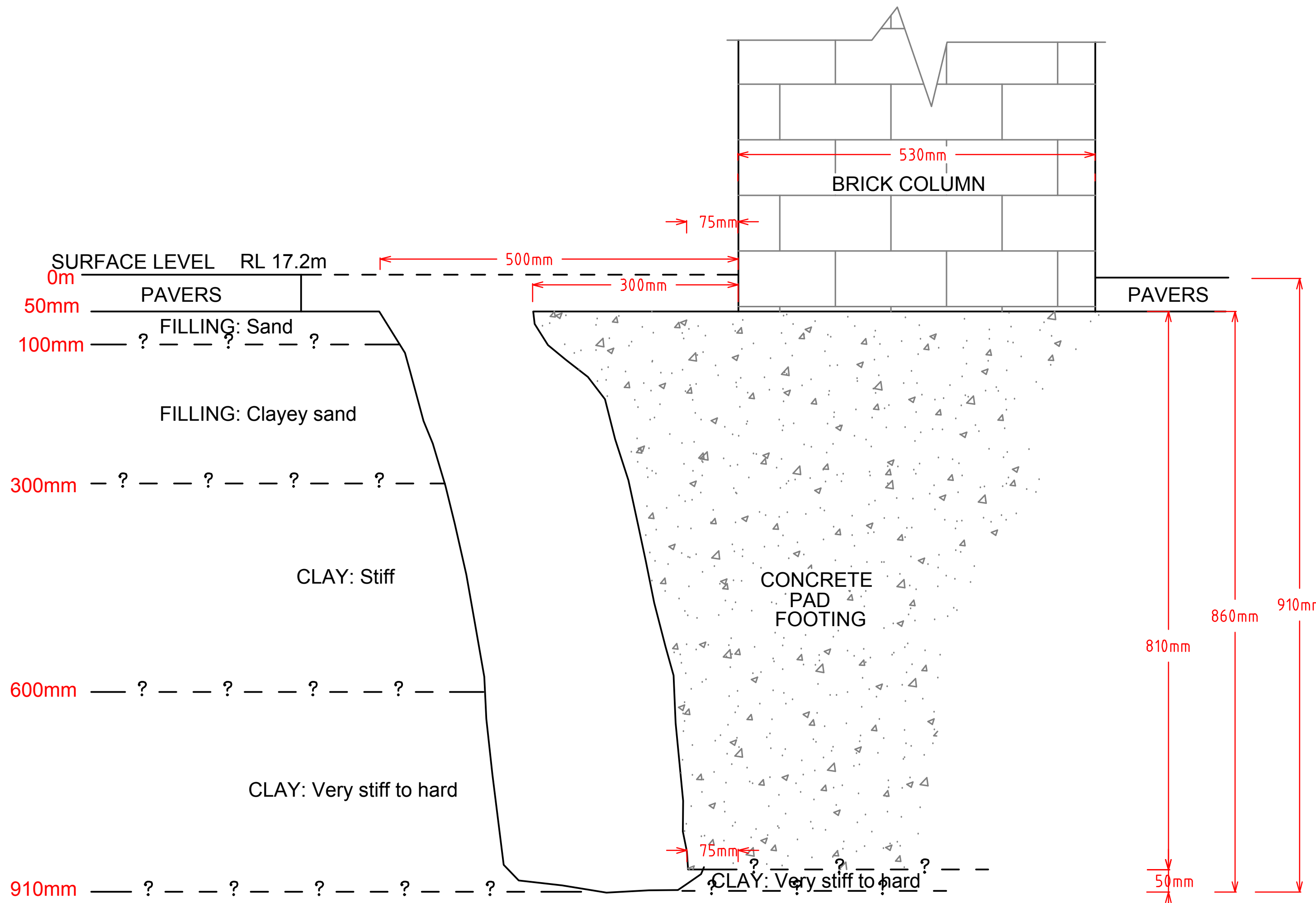
TITLE: **Test Pit 106 Details**
Meriden Centre of Music and Drama
13 Margaret Street, STRATHFIELD

N

PROJECT No: 86568.00
DRAWING No: 4
REVISION: 0

PLAN





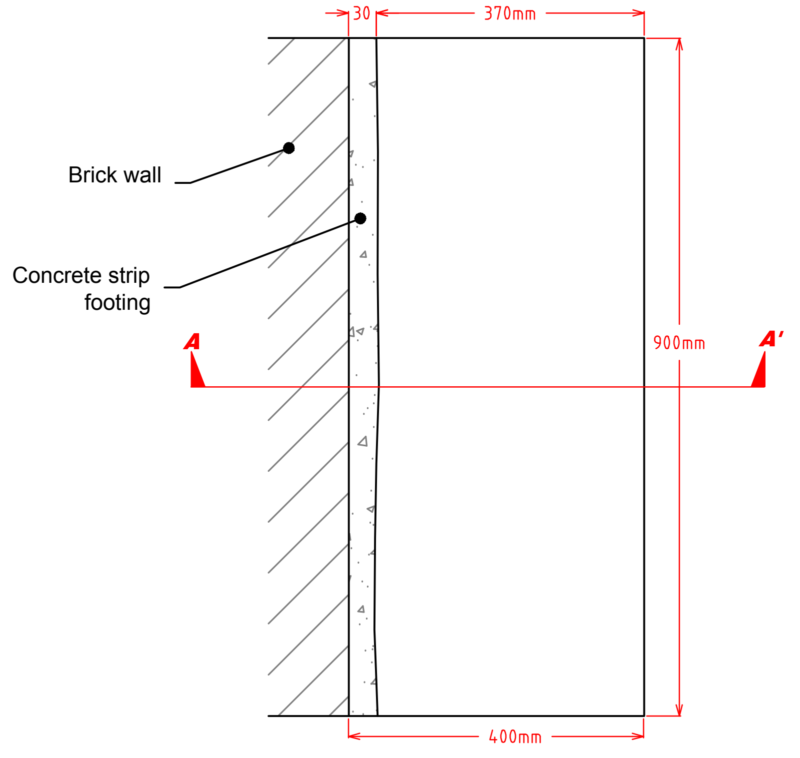
SECTION A-A'

Douglas Partners
Geotechnics / Environment / Groundwater

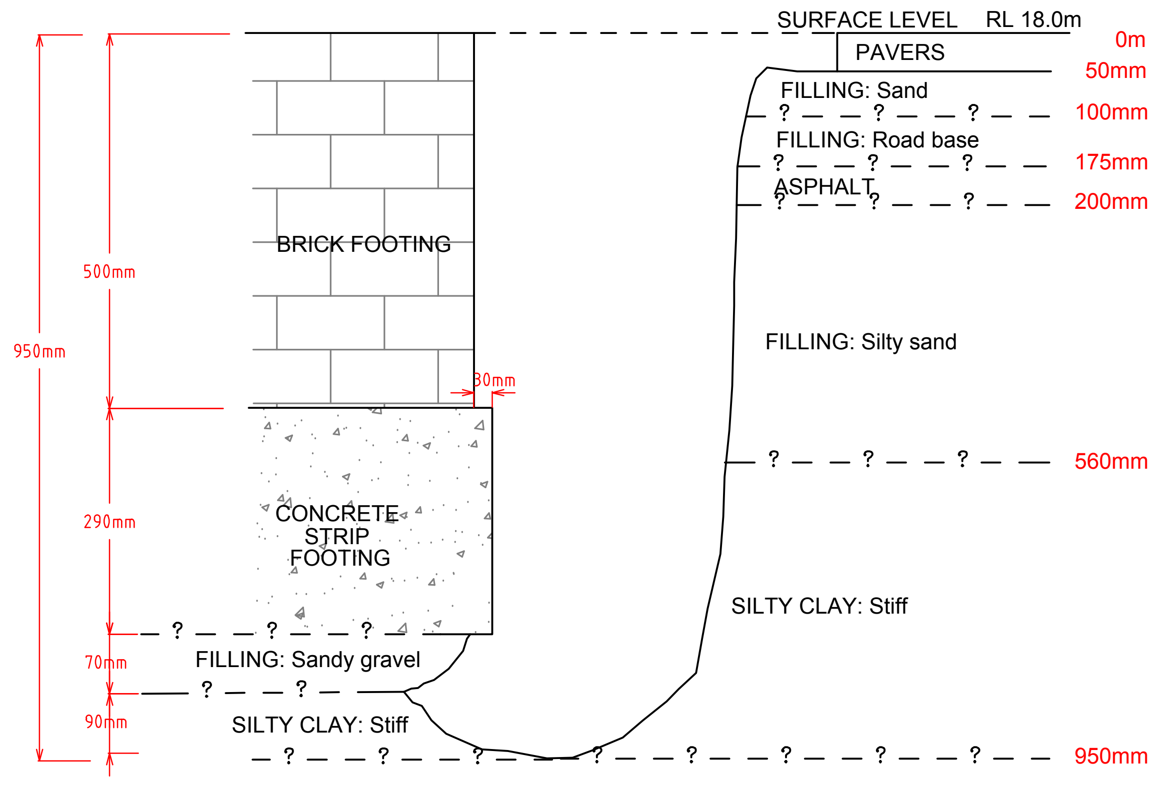
CLIENT: Meriden School		TITLE:	**Test Pit 107 Details**
OFFICE: Sydney	DRAWN BY: PSCH		**Meriden Centre of Music and Drama**
SCALE: 1:100 @ A3	DATE: 8.11.2018		**13 Margaret Street, STRATHFIELD**

N

PROJECT No:	86568.00
DRAWING No:	5
REVISION:	0



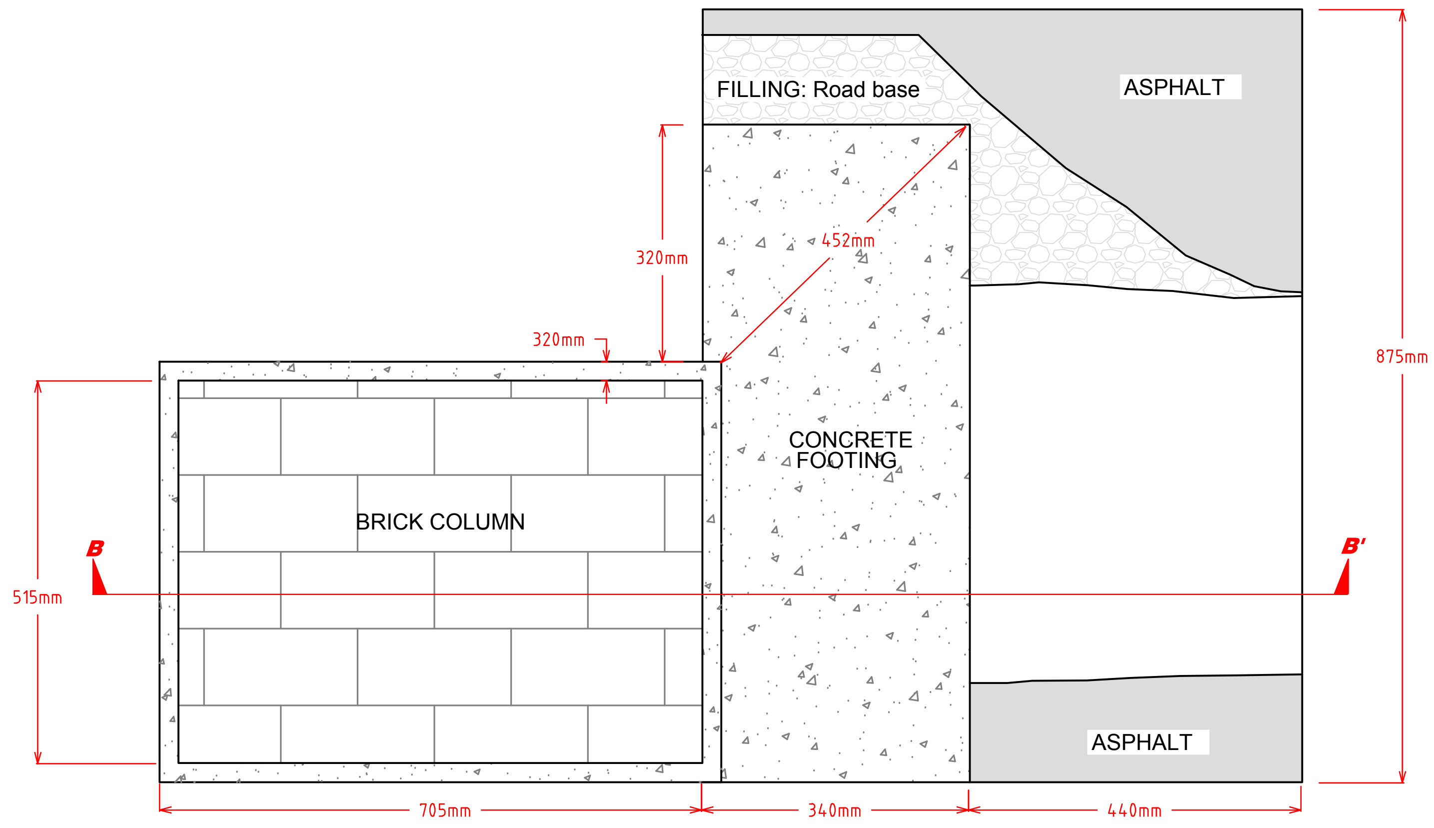
PLAN



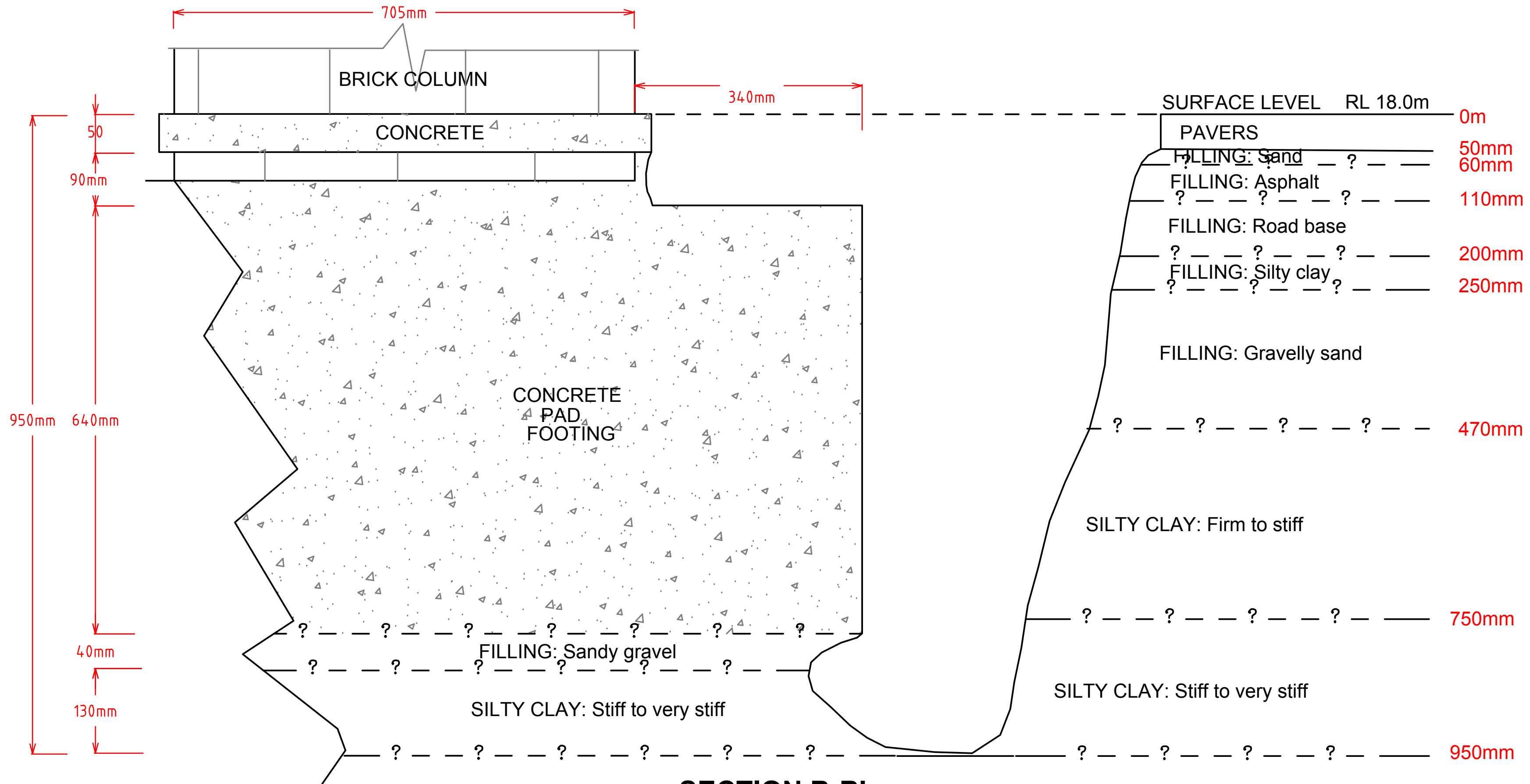
SECTION A-A'

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Meriden School		TITLE: **Test Pit 108A Details** **Meriden Centre of Music and Drama** **13 Margaret Street, STRATHFIELD**	PROJECT No: 86568.00
OFFICE: Sydney	DRAWN BY: PSCH		DRAWING No: 6
SCALE: 1:100 @ A3	DATE: 8.11.2018		REVISION: 0



PLAN



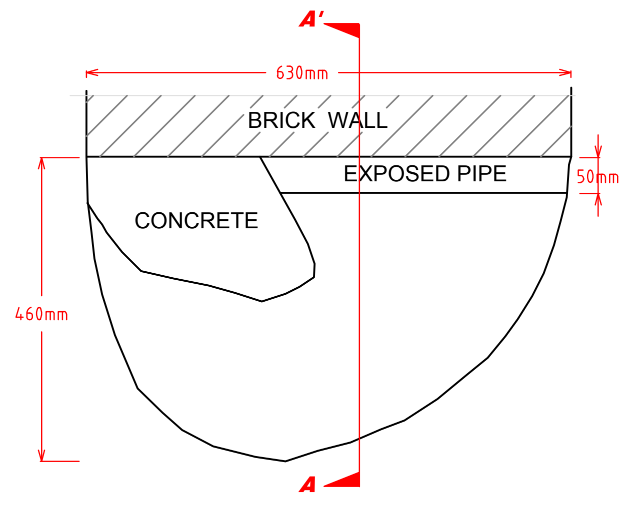
SECTION B-B'

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Meriden School	
	OFFICE: Sydney	DRAWN BY: PSCH
	SCALE: 1:100 @ A3	DATE: 8.11.2018

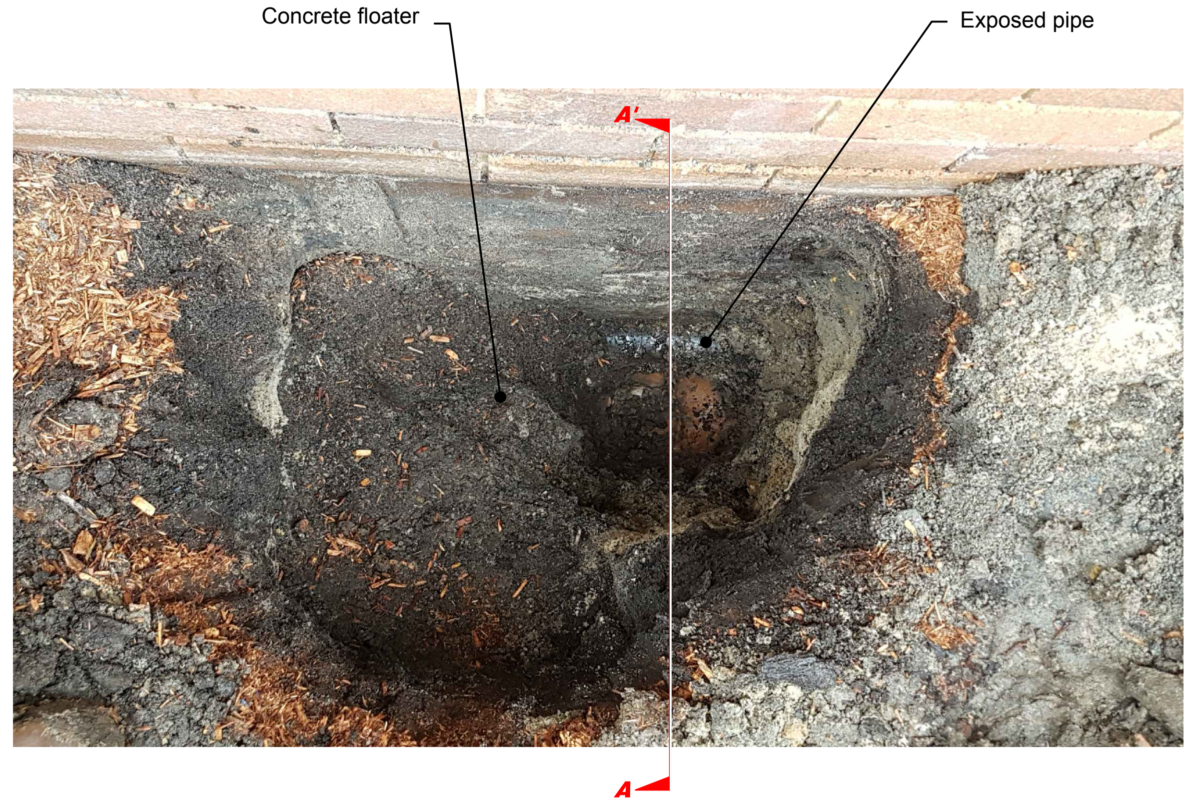
TITLE: **Test Pit 108B Details**
Meriden Centre of Music and Drama
13 Margaret Street, STRATHFIELD

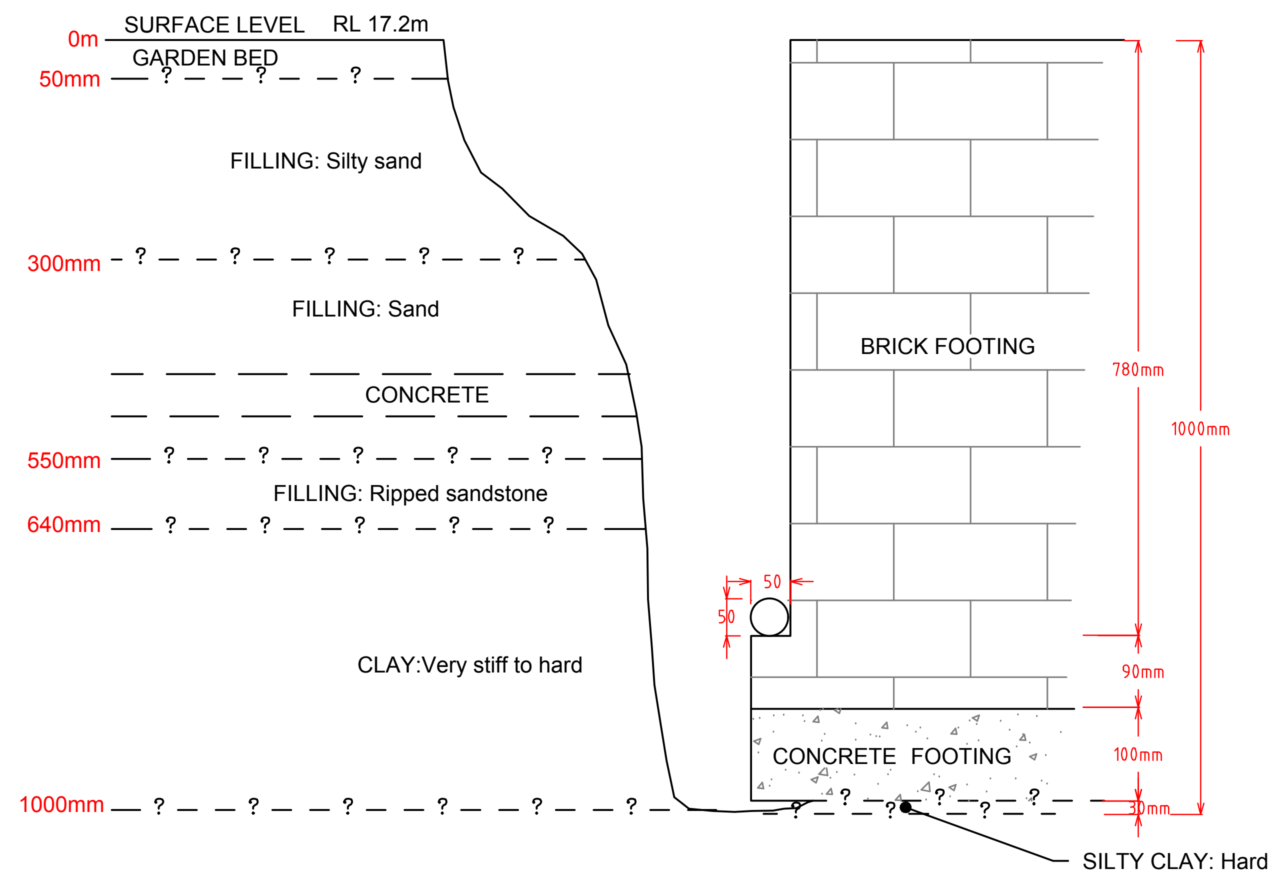
N

PROJECT No:	86568.00
DRAWING No:	7
REVISION:	0



PLAN





SECTION A-A'

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Meriden School		TITLE: **Test Pit 109 Details** **Meriden Centre of Music and Drama** **13 Margaret Street, STRATHFIELD**
	OFFICE: Sydney	DRAWN BY: PSCH	
	SCALE: 1:100 @ A3	DATE: 8.11.2018	

N	PROJECT No:	86568.00	
	DRAWING No:	8	
	REVISION:	0	

Appendix C

Field Work Results

Sampling

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

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

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin
It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Descriptions

Douglas Partners

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

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

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

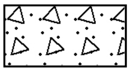
Symbols & Abbreviations

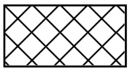
Graphic Symbols for Soil and Rock

General

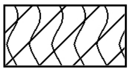
 Asphalt

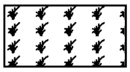
 Road base

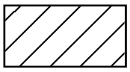
 Concrete

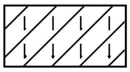
 Filling

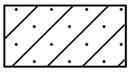
Soils

 Topsoil

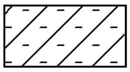
 Peat

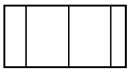
 Clay

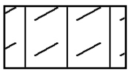
 Silty clay

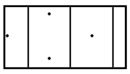
 Sandy clay

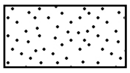
 Gravelly clay

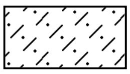
 Shaly clay

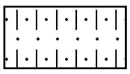
 Silt

 Clayey silt

 Sandy silt

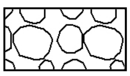
 Sand

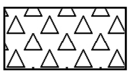
 Clayey sand

 Silty sand

 Gravel

 Sandy gravel

 Cobbles, boulders

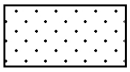
 Talus

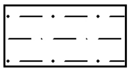
Sedimentary Rocks

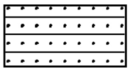
 Boulder conglomerate

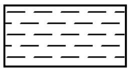
 Conglomerate

 Conglomeratic sandstone

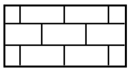
 Sandstone

 Siltstone

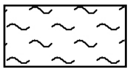
 Laminite

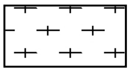
 Mudstone, claystone, shale

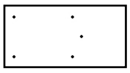
 Coal

 Limestone

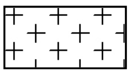
Metamorphic Rocks

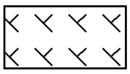
 Slate, phyllite, schist

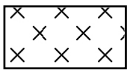
 Gneiss

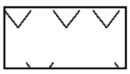
 Quartzite

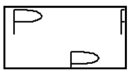
Igneous Rocks

 Granite

 Dolerite, basalt, andesite

 Dacite, epidote

 Tuff, breccia

 Porphyry

BOREHOLE LOG

CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 17.0 AHD
EASTING: 323488
NORTHING: 6250175
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 86568.00
DATE: 4/10/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0–0.3	FILLING: dark grey, fine to coarse sand filling (topsoil) with some silt and roadbase gravel, moist.		A/E			
0.3–1.2	FILLING: apparently compacted, light yellow-brown, fine to medium sand filling, moist 0.6m: geofabric inclusion 0.7m: slightly silty with some roadbase gravel, ironstone flakes and ceramic inclusions, moist		A/E* A/E S			3,5,7 N = 12
1.2–2.6	SILTY CLAY: stiff, light grey mottled red-brown silty clay, with some ironstone inclusions (10-30mm) MC>PL, damp to moist	Unless otherwise stated rock is fractured along rough planar bedding with ironstaining and clay 1-5mm, dipping 0°-5°	A/E S			8,15/70 refusal
2.6–2.81	LAMINITE: very low strength, light grey-brown laminite	2.78-2.80m: Cs, 20mm				
2.81–4.9	LAMINITE: medium strength, moderately then slightly weathered, fractured and slightly fractured, grey-brown laminite with approximately 25% fine sandstone laminations and some clay bands	3.18m: J 85°&70°, st, ro, cly 1mm 3.23-3.25m: Cs 20mm 3.25m: J 45°, un, ro, cly 3.4m: J 70°&80°, st, ro, fe 3.77-3.80m: Cs 30mm 3.8m: J 70°, un, ro, cln	C	100	75	PL(A) = 0.4 PL(A) = 0.4
			C	100	97	PL(A) = 0.4
4.9–7.9	LAMINITE: medium strength, fresh, unbroken, pale grey and grey laminite with approximately 20% fine sandstone laminations					PL(A) = 0.6
			C	100	100	PL(A) = 0.7
			C	100	100	PL(A) = 0.6
7.9	Bore discontinued at 7.9m					

RIG: Bobcat **DRILLER:** JE **LOGGED:** LS/SI **CASING:** HW to 2.7m

TYPE OF BORING: Solid flight auger (TC-bit) to 2.68m, NMLC-coring to 7.9m

WATER OBSERVATIONS: No free gorundwater observed whilst augering

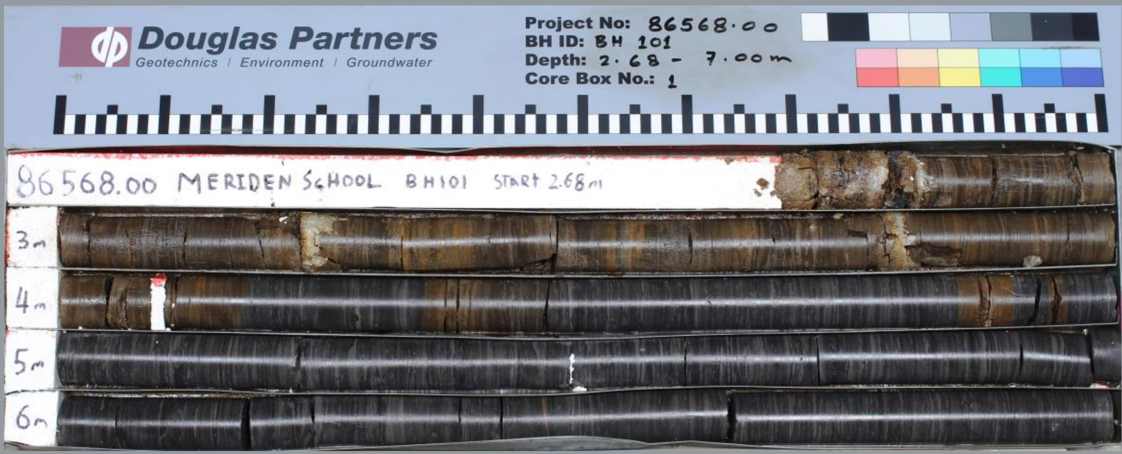
REMARKS: Backfilled with drilling spoil; *BD3/041018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 101 PROJECT: STRATHFIELD OCTOBER 2018



2.68 – 7.00m

BORE: 101 PROJECT: STRATHFIELD OCTOBER 2018

7.00 – 7.90m

BOREHOLE LOG

CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 17.1 AHD
EASTING: 323505
NORTHING: 6250175
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 86568.00
DATE: 3/10/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.07	BRICK PAVEMENT		A/E			
0.2	FILLING: light yellow-brown, medium to coarse sand filling with a trace of silt, moist 0.15m: tile inclusion 0.18-0.2m: roadbase gravel		A/E*			
0.8	SILTY CLAY: stiff, red-brown silty, MC>PL, moist		A			
	SILTY CLAY: stiff, light grey mottled red-brown, with some ironstone gravel (3-25mm), MC>PL, damp to moist, (extremely weathered shale)		S			5,4,8 N = 12
2.3	LAMINITE: extremely low to very low strength, grey-brown laminite and some clay bands	Unless otherwise stated rock is fractured along rough planar bedding with 2mm clay and iron staining, dipping 0°-5°	S			9/40 refusal Bouncing
2.6	LAMINITE: medium strength, moderately to slightly then slightly weathered, fractured and slightly fractured, grey-brown laminite with approximately 20% fine sandstone laminations	2.73-2.83m: J 85°-90°, un, he 2.95-3.00m: fg 3.5m: B 0°, cly 5mm 3.56-3.58m: Ds 20mm 3.58m: J 85°, un, ro, ti 3.69-3.72m: Ds 30mm 3.82m: B 0°, fe	C	100	90	PL(A) = 0.4 PL(A) = 0.8
		4.74m: J 45°, pl, ro, cln	C	100	88	PL(A) = 0.8
4.9	LAMINITE: medium strength, fresh, unbroken, pale grey and grey laminite with approximately 25% fine sandstone laminations		C	100	100	PL(A) = 0.7 PL(A) = 0.7 PL(A) = 0.8 PL(A) = 0.8
8.05	Bore discontinued at 8.05m					

RIG: Bobcat **DRILLER:** JE **LOGGED:** LS/SI **CASING:** HW to 2.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 2.5m, NMLC-coring to 8.05m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Backfilled with drilling spoil; *BD2/031018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 102 PROJECT: STRATHFIELD OCTOBER 2018

2.60 – 7.00m

BORE: 102 PROJECT: STRATHFIELD OCTOBER 2018

7.00 – 8.05m

BOREHOLE LOG

CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.1 AHD
EASTING: 323494
NORTHING: 6250151
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 86568.00
DATE: 3/10/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Water	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.0–0.3	FILLING: dark grey, fine to coarse sand filling (topsoil)			A/E			
0.3–0.6	FILLING: dark grey, silty, fine sand filling, slightly clayey with some rootlets and fine to medium igneous gravel.			A/E			
0.6–1.0				A/E			
1.0	CLAY: orange-brown, clay with traces of ironstone gravel			S/E			1,4,6 N = 10
	SILTY CLAY: stiff, light grey-brown silty clay with dark gray carbonaceous material 1.5m: with medium to coarse ironstone gravel			A/E*			
2.0	SHALY CLAY: pale grey, shaly clay with some fine to coarse ironstone gravels		Unless otherwise stated rock is fractured along rough planar bedding with ironstaining and clay veneer, dipping 0°-10°	A			
2.5	LAMINITE: extremely low to very low strength, pale grey shale with some ironstone bands			S			10,25/130 refusal Bouncing
2.8	LAMINITE: low to medium strength, highly weathered, fractured to slightly fractured brown and grey laminite with 10-20% sandstone laminations and some extremely low strength bands	08-10-18	2.80-3.18m: J, sv, un, sm, cly inf 5-10mm 2.87m: B10°, un, ti, cly co 3.16m: Cs, 30mm 3.25-3.61m: J(x2), sv, pl, sm, cly inf 2-4mm 3.33m: Ds, 30mm 3.57m: Cs, 40mm 3.62m: J80°, pl, ro, fe stn	C	100	13	PL(A) = 0.4
4.0	LAMINITE: medium strength, slightly weathered then fresh, slightly fractured to unbroken dark grey-brown then dark grey laminite with approximately 30% sandstone laminations		4.1m: B0°, pl, cly inf 4mm 4.13m: J80°, pl, ti 4.6-4.75m: B(x3), 10-20°, pl, ro, fe stn 4.85m: B5°, un, cly co, 2mm 5.31m: B20°, pl, ro, cln	C	100	88	PL(A) = 0.5
			6.73m: J50°, pl, fe stn, ti	C	100	100	PL(A) = 0.6 PL(A) = 0.6
			7.43-7.7m: J45-90°, un, cly 0-2mm, ti	C	100	100	PL(A) = 0.9
8.03	Bore discontinued at 8.03m						

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Rotary washbore (Blade bit) to 2.8m, NMLC-coring to 8.03m.
WATER OBSERVATIONS: No free groundwater observed whilst augering. Dipped at 11:00 am 8/10/2018, water level at 3.36m.
REMARKS: *BD1/031018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 103 PROJECT: STRATHFIELD OCTOBER 2018

2.80 – 7.00m

BORE: 103 PROJECT: STRATHFIELD OCTOBER 2018

7.00 – 8.03m

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

Permeability Testing - Falling Head Test Report

Client:	Meriden School	Project No:	86555.00
Project:	Meriden Centre for Music and Drama	Test date:	2-Oct-18
Location:	13 Margaret Street, Strathfield	Tested by:	JAP

Test Location

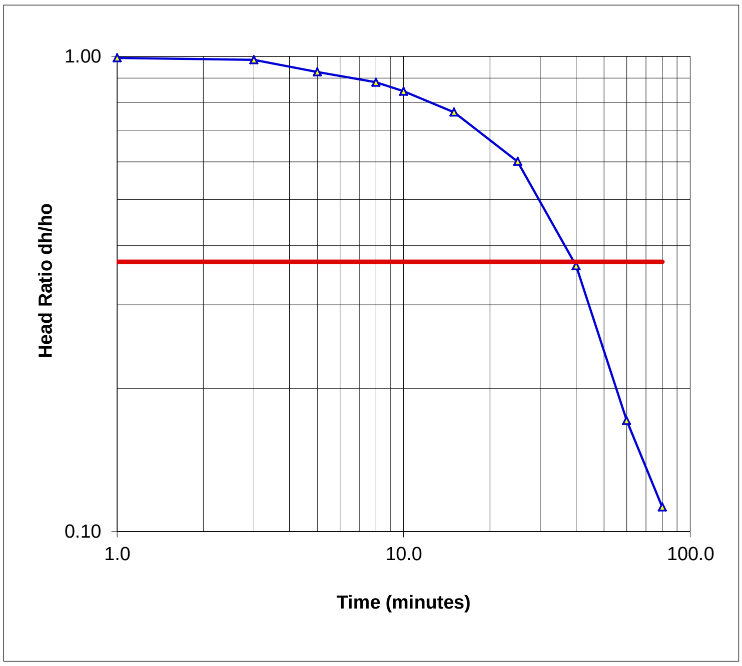
Description:	BH103 groundwater well	**Test No.**	BH103	
Material type:	Clays over laminite	Easting:	323475	m
		Northing	6250140	m
		Surface Level:	18.3	m AHD

Details of Well Installation

Well casing diameter (2r)	76	mm	Depth to water before test	3.36	m
Well screen diameter (2R)	76	mm	Depth to water at start of test	7.8	m
Length of well screen (Le)	4.5	m			

Test Results

Time (sec)	Depth (m)	Change in Head: dH (m)	dH/Ho
0	7.8		
1.0	7.77	4.41	0.993
3.0	7.73	4.37	0.984
5.0	7.48	4.12	0.928
8.0	7.28	3.92	0.883
10.0	7.11	3.75	0.845
15.0	6.75	3.39	0.764
25.0	6.03	2.67	0.601
40.0	4.97	1.61	0.363
60.0	4.12	0.76	0.171
80.0	3.86	0.50	0.113



To = 40 Minutes

Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**3.2E-07**	m/sec
	=	**0.115**	cm/hour

BOREHOLE LOG

CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.1 AHD
EASTING: 323494
NORTHING: 6250151
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 86568.00
DATE: 3/10/2018
SHEET 1 OF 1

Depth (m)	Description of Strata
0.0–0.3	FILLING: dark grey, fine to coarse sand filling (topsoil)
0.3–0.6	FILLING: dark grey, silty, fine sand filling, slightly clayey with some rootlets and fine to medium igneous gravel.
0.6–1.0	CLAY: orange-brown, clay with traces of ironstone gravel
1.0–2.0	SILTY CLAY: stiff, light grey-brown silty clay with dark gray carbonaceous material 1.5m: with medium to coarse ironstone gravel
2.0–2.5	SHALY CLAY: pale grey, shaly clay with some fine to coarse ironstone gravels
2.5–2.8	LAMINITE: extremely low to very low strength, pale grey shale with some ironstone bands
2.8–4.0	LAMINITE: low to medium strength, highly weathered, fractured to slightly fractured brown and grey laminite with 10-20% sandstone laminations and some extremely low strength bands
4.0–8.03	LAMINITE: medium strength, slightly weathered then fresh, slightly fractured to unbroken dark grey-brown then dark grey laminite with approximately 30% sandstone laminations
8.03	Bore discontinued at 8.03m

Sampling & In Situ Testing

Type	Depth	Results & Comments
A/E	0.1–0.2	
A/E	0.5–0.6	
A/E	0.9–1.0	
S/E	1.0–1.45	1,4,6 N = 10
A/E*	1.5–1.6	
A	1.8–2.0	
S	2.5–2.78	10,25/130 refusal Bouncing
C	2.8–4.05	
	3.7	PL(A) = 0.4
C	4.05–5.5	
	4.8	PL(A) = 0.5
	5.6	PL(A) = 0.6
C	5.5–7.05	
	6.4	PL(A) = 0.6
C	7.05–8.03	
	7.9	PL(A) = 0.9

Water: 08-10-18

Well Construction Details

- Gatic Cover
- Filling (0.0-2.1m)
- Blank PVC Casing (0.05-2.85m)
- Bentonite Plug (2.0-2.75m)
- Slotted PVC Casing (2.85-7.85m)
- Gravel (2.75-7.85m)
- End Cap
- Hole Collapse

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Rotary washbore (Blade bit) to 2.8m, NMLC-coring to 8.03m.

WATER OBSERVATIONS: No free groundwater observed whilst augering. Dipped at 11:00 am 8/10/2018, water level at 3.36m.

REMARKS: *BD1/031018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.7 AHD
EASTING: 323503
NORTHING: 6250136
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 86568.00
DATE: 5/10/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.01	FILLING: dark grey, fine to medium sand filling with some silt (topsoil)		A/E			
0.25	FILLING: dark grey slightly silty sand filling		A/E*			
	SILTY CLAY: stiff, light grey mottled red-brown silty clay, with some ironstone inclusions (5-10mm), MC>PL, moist		A/E			
			S			4,6,8 N = 14
2.2	LAMINITE: very low strength, highly weathered, pale grey-brown laminite	Unless otherwise stated rock is fractured along rough planar bedding with clay 1-3mm and iron, dipping 0°-5°	S			16/30 refusal Bouncing, no recovery
2.55	LAMINITE: medium strength, moderately then slightly weathered, fractured and slightly fractured, grey-brown laminite with approximately 20% fine sandstone laminations and some clay bands	2.56m: B 0°, cly 10mm 2.78m: B 0°, cly 10mm 2.78-2.80m: Ds 20mm 2.83-2.86m: Cs 30mm 3.14-3.86m: Cs 20mm 3.21-3.23m: Cs 20mm 3.23m: J 40°, pl, cly 1mm 3.51-3.53m: Cs 20mm 3.82m: J 45°, pl, ro, cln 3.92m: B 0°, cly 20mm 4.1m: J 5°&20°, st, ro, cly vn 4.12-4.20m: J 70°, pl, ro, cly vn 4.2m: J 85°, un, ro, cly vn 4.32-4.34m: Ds 10mm 4.43-4.50m: Ds 20mm 4.68m: B 0°, pl, ro, cly 10mm	C C	100 100	66 63	PL(A) = 0.6 PL(A) = 0.5 PL(A) = 0.8
5.0	LAMINITE: high strength, slightly weathered then fresh, slightly fractured and unbroken grey laminite with approximately 20% fine sandstone laminations	6.33m: J 30°, un, ro, fe	C	100	100	PL(A) = 1.1 PL(A) = 1.1 PL(A) = 1.5 PL(A) = 1.1
8.08	Bore discontinued at 8.08m					

RIG: Bobcat **DRILLER:** JE **LOGGED:** LS/SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Rotary washbore (Blade bit) to 2.53m, NMLC-coring to 8.08m.
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Backfilled with drilling spoil; *BD6/051018

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 104 PROJECT: STRATHFIELD OCTOBER 2018

2.53 – 7.00m

BORE: 104 PROJECT: STRATHFIELD OCTOBER 2018

7.0 – 8.08m

BOREHOLE LOG

CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.3 AHD
EASTING: 323475
NORTHING: 6250140
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 86568.00
DATE: 5/10/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.25	TOPSOIL: dark grey, silty, fine sand topsoil with some clay and rootlets, moist.		A/E			
0.8	CLAY: apparently stiff, light brown clay with a trace of fine ironstone gravel and rootlets, damp.		A/E B			Bulk sample taken from 0.4-0.8m
2.0	SILTY CLAY: stiff, grey mottled red-brown, silty clay with some fine to medium ironstone gravel, and a trace of rootlets and carbonaceous material, humid.		A/E* S/E A/E			pp = 200-180 3,4,7 N = 11
2.64	LAMINITE: extremely low strength, light brown shale with some fine to coarse ironstone gravel. 2.50m: becomes brown, very low strength	Unless otherwise stated rock is fractured along rough planar bedding with ironstaining and clay veneer, dipping 0°-10°	S/E			pp >600 25/140 refusal Bouncing
4.22	LAMINITE: medium strength with some extremely low strength bands, highly weathered, fractured to slightly fractured, brown and dark brown laminite with some ironstaining	2.72-2.76m: Cs, 40mm 2.92m: B0°, pl, ro, cly co 4mm 3.06-3.09m: Cs, 30mm 3.09-3.29m: J80°, pl, ro, cln 3.31m: J40°, pl, ro, cly vn 3.55m: J40-60°, cu, sm, cln 3.57m: J(x3), 60-80°, un, sm, cly co 2-6mm 3.70-3.71m: Cs, 10mm 3.77-4.00m: J, sv, un, sm, cln	C	100	75	PL(A) = 0.4
8.0	LAMINITE: medium then medium to high strength, fresh, slightly fractured to unbroken, dark grey laminite with approximately 80% siltstone interbedded with 20% fine grained sandstone.	4.09-4.13m: Ds, fg, 40mm 4.45-4.49m: B(x2), 0°, pl, ro, fe stn	C	100	94	PL(A) = 0.7
		5.46m: B0°, pl, ro, fe stn 6.49-6.56m: B(x3), 0°, pl-un, ro, fe stn	C	100	95	PL(A) = 0.9 PL(A) = 1
		7.86m: B5°, un, ro, quartz flecks	C	100	100	PL(A) = 1
	Bore discontinued at 8.0m					

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Rotary washbore (Blade bit) to 2.64m, NMLC-coring to 8.00m.

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Backfilled with drilling spoil; *BD8/20181005 taken from 0.9-1.0m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: 105 PROJECT: STRATHFIELD OCTOBER 2018

2.64 – 7.00m

BORE: 105 PROJECT: STRATHFIELD OCTOBER 2018

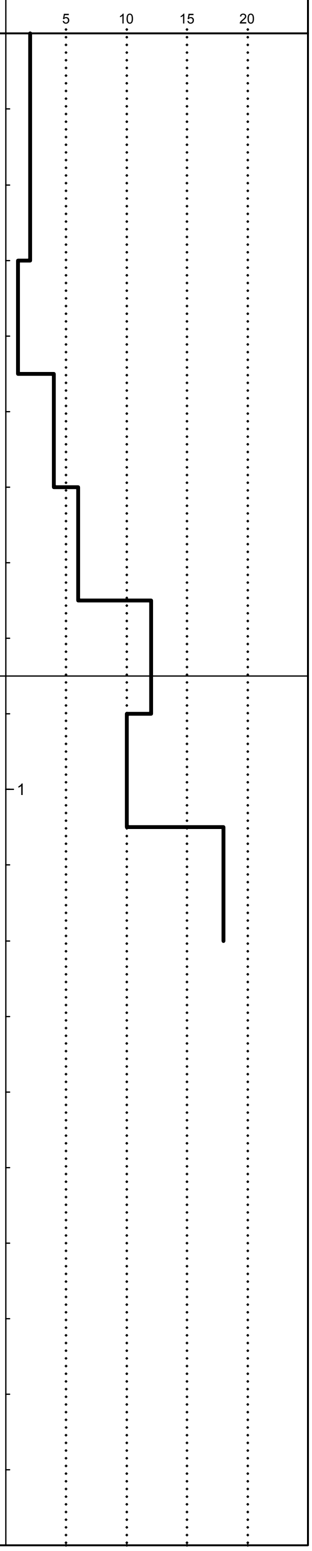
7.00 – 8.00m

TEST PIT LOG

CLIENT:	Meriden School	**SURFACE LEVEL:**	17.2 AHD	**PIT No:**	TP106
PROJECT:	Meriden Centre of Music and Drama	**EASTING:**	323493	**PROJECT No:**	86568.00
LOCATION:	13 Margaret Street, Strathfield	**NORTHING:**	6250178	**DATE:**	5/10/2018
				SHEET	1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
		FILLING: brown, bark filling with some topsoil, moist.					
17	0.05	FILLING: dark grey-brown, silty, fine to medium sand filling with some rootlets and trace brick fragments and rootlets, wet.					
	0.25	FILLING: dark grey-brown, clay filling with some fine igneous gravel, trace brick and concrete fragments, wet	D/E	0.2–0.3			
	0.35	FILLING: pale grey, slightly clayey, fine to medium sand filling with some brick and concrete fragments, wet. 0.50m: yellow danger tape	D/E	0.5–0.6			
	0.66	CLAY: very stiff to hard, grey mottled orange-brown, slightly silty clay with som efine to medium ironstone gravel, medium plasticity, wet.	D/E	0.75–0.84			
16	0.85	Pit discontinued at 0.85m	U_{50}	0.85–1.11			

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **LOGGED:** JDB/SI **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: Water seepage from 0.1m

REMARKS: Backfilled with excavated spoil

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

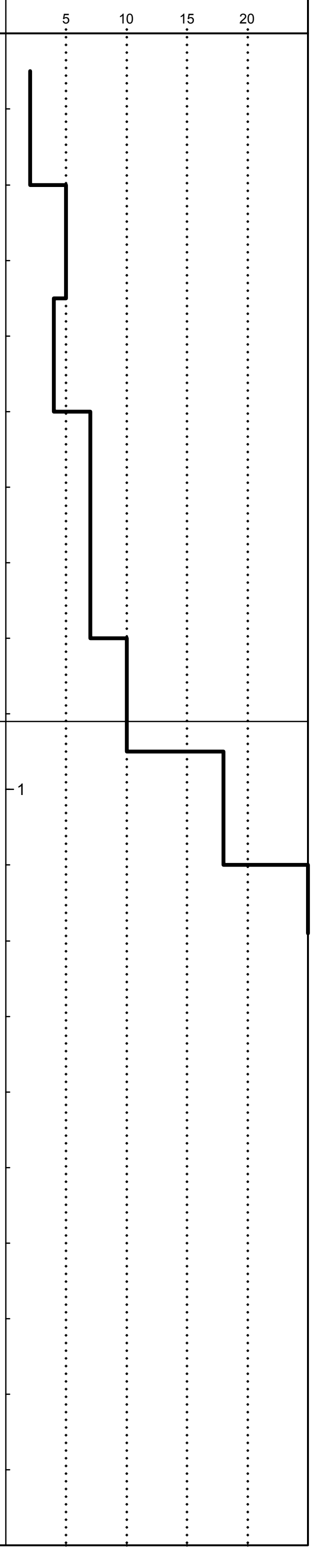
CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 17.2 AHD
EASTING: 323511
NORTHING: 6250172

PIT No: TP107
PROJECT No: 86568.00
DATE: 4/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		BRICK PAVERS					
	0.05	FILLING: light grey-brown, fine to medium sand filling, humid.					
	0.1	FILLING: dark grey-brown, slightly clayey, fine to medium sand filling with some fine igneous gravel and trace brick fragments, moist.	D/E	0.1–0.2			
17	0.3	CLAY: stiff, orange-brown clay with trace fine to medium ironstone gravel, moist.	D/E	0.4–0.5			
	0.6	SILTY CLAY: very stiff to hard, orange-brown mottled grey, silty clay with some fine to medium ironstone gravel and trace of carbonaceous material, moist.	D/E*	0.6–0.7			
	0.91	Pit discontinued at 0.91m					
16	1						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **LOGGED:** JDB/SI **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Backfilled with excavated spoil; *BD5/20181004 taken from 0.6-0.7m

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

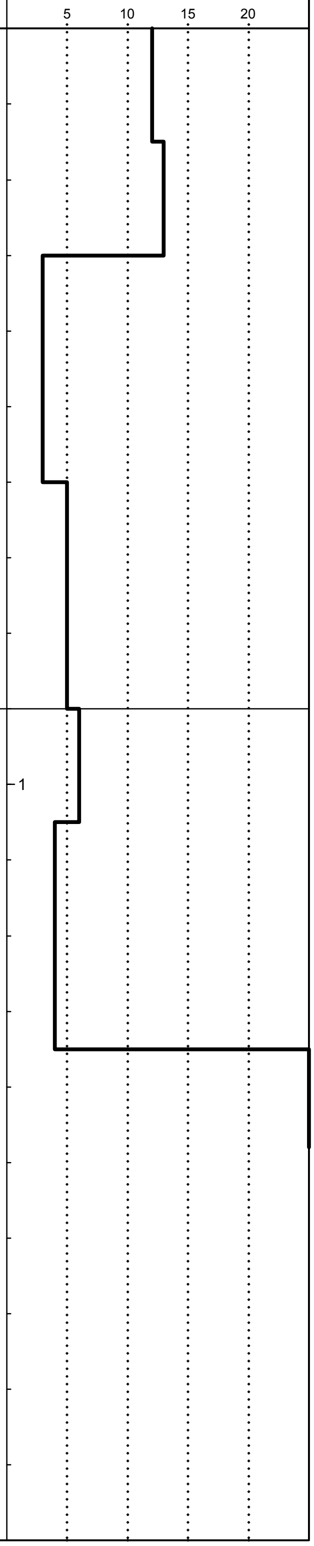
CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.0 AHD
EASTING: 323513
NORTHING: 6250162

PIT No: TP108A
PROJECT No: 86568.00
DATE: 4/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water
18		BRICK PAVERS					
	0.05	FILLING: light yellow-brown, medium sand filling.	D/E	0.05			
	0.1	ROADBASE: apparently compacted, light grey-green, igneous gravel (3-25mm), angular to sub-angular, well graded with some fine to coarse sand, moist.		0.1			
	0.18	ASPHALTIC CONCRETE	E	0.18			
	0.2	FILLING: brown and orange-brown, silty clay filling with some coarse sand, sandstone gravel (4-10mm) with trace ceramic fragments and slag (5-25mm), moist. 0.40m: becomes grey with some fine gravels, low plasticity, MC ~ PL	D/E	0.2			
	0.57	SILTY CLAY: stiff, red-brown, silty clay with trace ironstone gravel, medium to high plasticity, MC ~ PL.	D/E	0.59			
	0.9	Pit discontinued at 0.9m					
17	1						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools **LOGGED:** RB **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: Free groundwater observed at 0.79m

REMARKS: Backfilled with excavated spoil

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

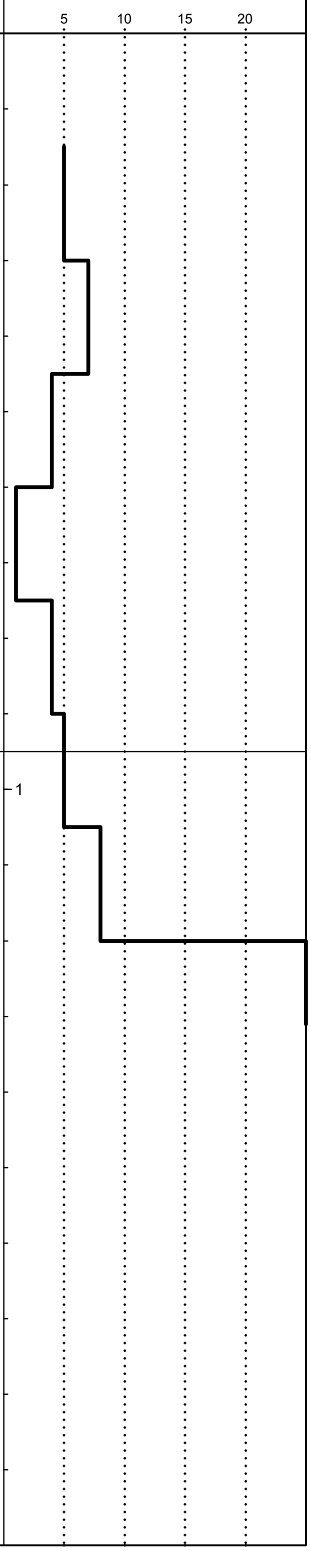
CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.0 AHD
EASTING: 323512
NORTHING: 6250163

PIT No: TP108B
PROJECT No: 86568.00
DATE: 4/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water
18		BRICK PAVERS					
	0.05	FILLING: light yellow-brown, fine to medium sand filling, moist.					
	0.06	ASPHALTIC CONCRETE					
	0.11		D	0.11 – 0.13			
	0.2	ROADBASE: grey, gravelly sand with clay.					
		FILLING: brown and grey, gravelly silty clay filling , medium plasticity, MC ~ PL.					
	0.25	FILLING: grey, gravelly sand filling with some clay and silt, moist.	D/E	0.25 – 0.26			
	0.47	SILTY CLAY: firm to stiff, grey and brown, silty clay with a trace of ironstone gravel, medium to high plasticity, MC ~ PL.	D/E	0.5 – 0.6			
		0.70m; becomes red-brown, MC > PL					
		0.75m: stiff to very stiff	E	0.8 – 0.9		pp = 220	
	0.95	Pit discontinued at 0.95m					
17	1						

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools
LOGGED: RB
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Backfilled with excavated spoil

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

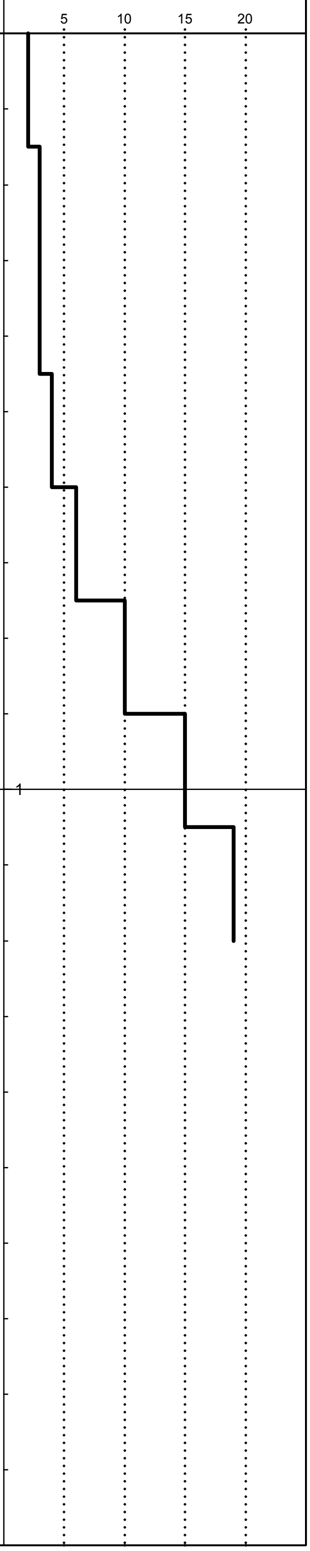
CLIENT: Meriden School
PROJECT: Meriden Centre of Music and Drama
LOCATION: 13 Margaret Street, Strathfield

SURFACE LEVEL: 18.7 AHD
EASTING: 323514
NORTHING: 6250138

PIT No: TP109
PROJECT No: 86568.00
DATE: 4/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
		FILLING: bark and wood chips (garden bed)						
	0.05	FILLING: dark grey, silty, fine sand filling with some organic matter, moist.		D/E	0.1–0.2			
	0.3	FILLING: light grey, fine to medium sand filling with a trace of ripped sandstone boulder and brick fragments, moist. 0.42m: concrete fragment, 60mm thick		D/E*	0.5–0.6			
	0.55	FILLING: pale grey, ripped sandstone and cobble filling, sub-rounded to sub-angular, with some fine sand and trace slate fragments, moist.						
18	0.64	CLAY: very stiff to hard, brown mottled light grey clay, moist.		D/E	0.8–1.0			
	1.0	Pit discontinued at 1.0m		U_{50}	1.0–1.33			
17								

Dynamic Penetrometer Test (blows per 150mm)



RIG: Hand tools
LOGGED: JDB/SI
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Backfilled with excavated spoil; *BD4/20181004 taken from 0.5-0.6m

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
96 Hermitage Road
West Ryde NSW 2114
PO Box 472
West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Results of Dynamic Penetrometer Tests

Client Meriden School | Project No. 86568.00

Project Meriden Centre of Music and Drama | Date 4/10/2018

Location 13 Margaret Street, Strathfield | Page No. 1/1

Test	106 (Top)	106 (Bottom)	107 (top)	107 (Bottom)	108A (Top)	108A (Bottom)	108B (Top)	108B (Bottom)	109 (top)	109 (Bottom)
Depth (m)	Penetration Resistance Blows/150 mm									
0 - 0.15	2		2/100		12				2	
0.15 - 0.30	2		5		13		5		3	
0.30 - 0.45	1		4		3		7		3	
0.45 - 0.60	4		7		3		4		4	
0.60 - 0.75	6		7		5		1		6	
0.75 - 0.90	12	4/50	10	5/60	5		4	1	10	
0.90 - 1.05	10	9	18	22	6	3	5	5	15	6/50
1.05 - 1.20	18	16	25/140	25/100	9	4	8	13	19	16
1.20 - 1.35			R	R		4	13	25/110		
1.35 - 1.50						25/130		R		
1.50 - 1.65						R				
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Flat End Penetrometer ☐

Tested By RB/JDB
Checked By SF

Remarks R = Refusal, 25/140 indicates 25 blows for 140 mm penetration
B = Bouncing

Appendix D

Laboratory Test Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

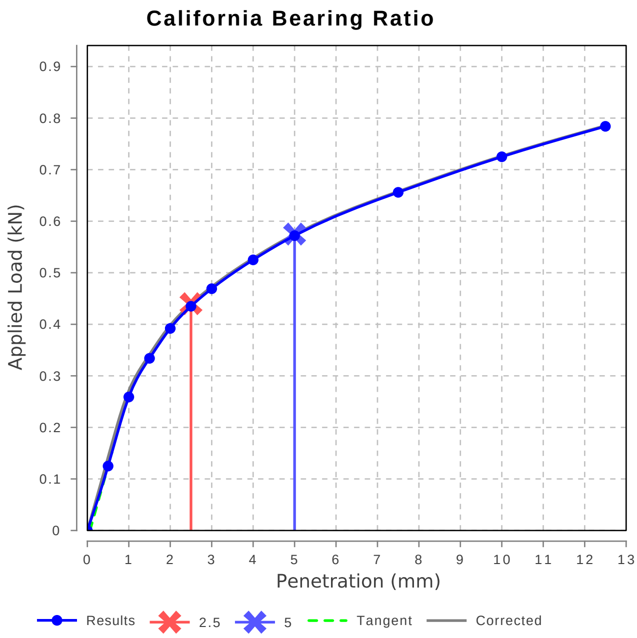
NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Andrew Hutchings
Senior Geotechnician

NATA Accredited Laboratory Number: 828

Report Number: **86568.00-2**
Issue Number: 2 - *This version supersedes all previous issues*
Date Issued: 29/05/2019
Client: Meriden School
10-12 Redmyre Rd, Strathfield NSW 2135
Contact: Richard Arkele
Project Number: 86568.00
Project Name: Meriden Centre of Music & Drama
Project Location: 13 Margaret Street, Strathfield
Work Request: 3797
Sample Number: 18-3797A
Date Sampled: 09/10/2018
Dates Tested: 09/10/2018 - 26/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **105 (0.4 - 0.8m)**
Material: CLAY: light brown clay with trace of fine ironstone gravel

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**3.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.51		
Optimum Moisture Content (%)	27.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.50		
Field Moisture Content (%)	30.7		
Moisture Content at Placement (%)	27.6		
Moisture Content Top 30mm (%)	30.2		
Moisture Content Rest of Sample (%)	28.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	170		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report

Report Number: **86568.00-2**
Issue Number: 2 - *This version supersedes all previous issues*
Date Issued: 29/05/2019
Client: Meriden School
10-12 Redmyre Rd, Strathfield NSW 2135
Contact: Richard Arkele
Project Number: 86568.00
Project Name: Meriden Centre of Music & Drama
Project Location: 13 Margaret Street, Strathfield
Work Request: 3797
Sample Number: 18-3797D
Date Sampled: 09/10/2018
Dates Tested: 09/10/2018 - 11/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **102 (0.9 - 1.0m)**
Material: SILTY CLAY: light grey mottled red-brown silty clay with some ironstone gravel

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
Phone: (02) 9809 0666
Fax: (02) 9809 0666
Email: andrew.hutchings@douglaspartners.com.au

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Andrew Hutchings
Senior Geotechnician

NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	47		
Plastic Limit (%)	17		
Plasticity Index (%)	**30**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.0		
Cracking Crumbling Curling	None		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: tim.white@douglaspartners.com.au

Report Number:	**86568.00-1**
Issue Number:	2 - *This version supersedes all previous issues*
Date Issued:	29/05/2019
Client:	Meriden School 10-12 Redmyre Rd, Strathfield NSW 2135
Contact:	Richard Arkele
Project Number:	86568.00
Project Name:	Meriden Centre of Music & Drama
Project Location:	13 Margaret Street, Strathfield
Work Request:	479
Dates Tested:	11/10/2018 - 11/10/2018

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Tim White
Lab manager

NATA Accredited Laboratory Number: 828

Shrink Swell Index AS 1289 7.1.1 & 2.1.1		
Sample Number	18-479A	18-479B
Sampling Method	Sampled by Others	Sampled by Others
Date Sampled	09/10/2018	09/10/2018
Date Tested	11/10/2018	11/10/2018
Material Source	U50 push tube	U50 push tube
Sample Location	TP 109 (1.00 - 1.33 m)	TP 106 (0.84 m - 1.1 m)
Inert Material Estimate (%)	1	6
Pocket Penetrometer before (kPa)	280	220
Pocket Penetrometer after (kPa)	160	210
Shrinkage Moisture Content (%)	21.5	22.9
Shrinkage (%)	**6.2**	**3.9**
Swell Moisture Content Before (%)	21.4	22.9
Swell Moisture Content After (%)	23.7	23.1
Swell (%)	**0.6**	**0.8**
Shrink Swell Index Iss (%)	**3.6**	**2.4**
Visual Description	SILTY CLAY - light grey mottled red brown silty clay, trace of fine gravel	SILTY CLAY - light grey and red brown silty clay. Some shale gravel throughout
Cracking	Slightly Cracked	Highly Cracked
Crumbling	No	No
Remarks	**	**

Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.
NATA Accreditation does not cover the performance of pocket penetrometer readings.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 202697

Client Details

Client	Douglas Partners Pty Ltd
Attention	Shahin Falahati
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86568.00, Meriden Centre of Music and Drama**
Number of Samples	1 WATER, 3 SOIL
Date samples received	10/10/2018
Date completed instructions received	10/10/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	17/10/2018
Date of Issue	16/10/2018

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Misc Inorg - Soil				
Our Reference		202697-2	202697-3	202697-4
Your Reference	UNITS	BH103_0.5	BH102_1.0	BH101_1.9
Depth		0.5	1.0-1.45	1.9
Date Sampled		03/10/2018	03/10/2018	05/10/2018
Type of sample		SOIL	SOIL	SOIL
Date prepared	-	12/10/2018	12/10/2018	12/10/2018
Date analysed	-	12/10/2018	12/10/2018	12/10/2018
pH 1:5 soil:water	pH Units	6.5	6.0	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	160	160	300
Chloride, Cl 1:5 soil:water	mg/kg	35	58	150
Sulphate, SO4 1:5 soil:water	mg/kg	110	140	260
Resistivity in soil*	ohm m	63	63	33

Miscellaneous Inorganics		
Our Reference		202697-1
Your Reference	UNITS	BH103_W
Depth		-
Date Sampled		08/10/2018
Type of sample		WATER
Date prepared	-	10/10/2018
Date analysed	-	10/10/2018
pH	pH Units	7.4
Electrical Conductivity	µS/cm	3,800
Chloride, Cl	mg/L	810
Sulphate, SO4	mg/L	240
Resistivity	ohm m	2.6

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			11/10/2018	2	12/10/2018	12/10/2018		11/10/2018	[NT]
Date analysed	-			11/10/2018	2	12/10/2018	12/10/2018		11/10/2018	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	2	6.5	6.5	0	102	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	2	160	170	6	103	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	35	37	6	92	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	2	110	130	17	101	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	<1	2	63	58	8	[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			10/10/2018	[NT]	[NT]	[NT]	[NT]	10/10/2018	[NT]
Date analysed	-			10/10/2018	[NT]	[NT]	[NT]	[NT]	10/10/2018	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	86	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	94	[NT]
Resistivity	ohm m	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

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

Quality Control Definitions

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.