Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Multistorey Building
Bankstown City Campus
74 Rickard Rd, Bankstown

Prepared for
Western Sydney University

Project 86462.00
August 2018

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	86462.00	Document No.	R.002
Document title	Report on Geotechnical Investigation Proposed Multistorey Building Bankstown City Campus		
Site address	74 Rickard Road, Bankstown		
Report prepared for	Western Sydney University		
File name	86462.00.R.002.Rev0 Geotechnical Investigation		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Draft 1	Brendan O'Kane	Michael J Thom	8th August 2018
Rev 0	Brendan O'Kane	Michael J Thom	13th August 2018

Distribution of copies

Status	Electronic	Paper	Issued to
Draft 1	1	0	Western Sydney University
Rev 0	1	0	Western Sydney University

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		13th August 2018
Reviewer		13th August 2018

bsi. ISO 9001 Quality Management

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

Report on Geotechnical Investigation
Bankstown City Campus Development
74 Rickard Rd, Bankstown

1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the Western Sydney University's Bankstown City Campus Development at 74 Rickard Road, Bankstown. The study was commissioned by Ms Michelle Lee of Western Sydney University and was undertaken in general accordance with Douglas Partners' proposal SYD180473 dated 21 May 2018.

The aim of this report is to provide information on the subsurface soil and rock profile and groundwater conditions across the site for design and planning purposes. The site extends from the existing Library building on the corner of Rickard and Chapel Roads to the Canterbury Bankstown Council building in the east, and from the northern edge of Paul Keating Park along the southern boundary to Rickard Road in the north. The total site area is approximately 3,300 square metres. At this stage the final details of the development have not been confirmed, but DP understands that the development will probably occupy the entire site and could include up to six basement levels requiring excavation to about 20 m below current site levels.

The investigation comprised the drilling of five rock cored boreholes and seven shallow auger boreholes. Three groundwater monitoring wells were installed to enable field testing of permeability and measurement of groundwater levels. Laboratory testing was carried out on selected soil and rock samples. Details of the field and laboratory work are provided in this report, together with comments relating to design and construction issues.

This report supersedes the previously issued Desktop Geotechnical Study (Ref: 86462.00.R.001.Rev1 dated 12 July 2018), which included a review of previous nearby investigations undertaken by DP in the surrounding area. DP carried out a contamination assessment at the site concurrently with the geotechnical study and the results reported separately (Ref: 86462.00.R.003).

2. Site Description

The location of the site is shown on Figure 1. It is located on the southern side of Rickard Road.

The site is currently used as a council car park and is mostly covered by an asphalt pavement with a limited grassed area on the western side. There are several mature eucalypt trees growing in the landscaped areas.

The site is located in gently undulating terrain where natural surface slopes are estimated to be about 5% towards the south. The surface contours in the area of the site (Figure 2) indicate that the site is located within a slight drainage depression into which surface waters from the north and north-east drain.

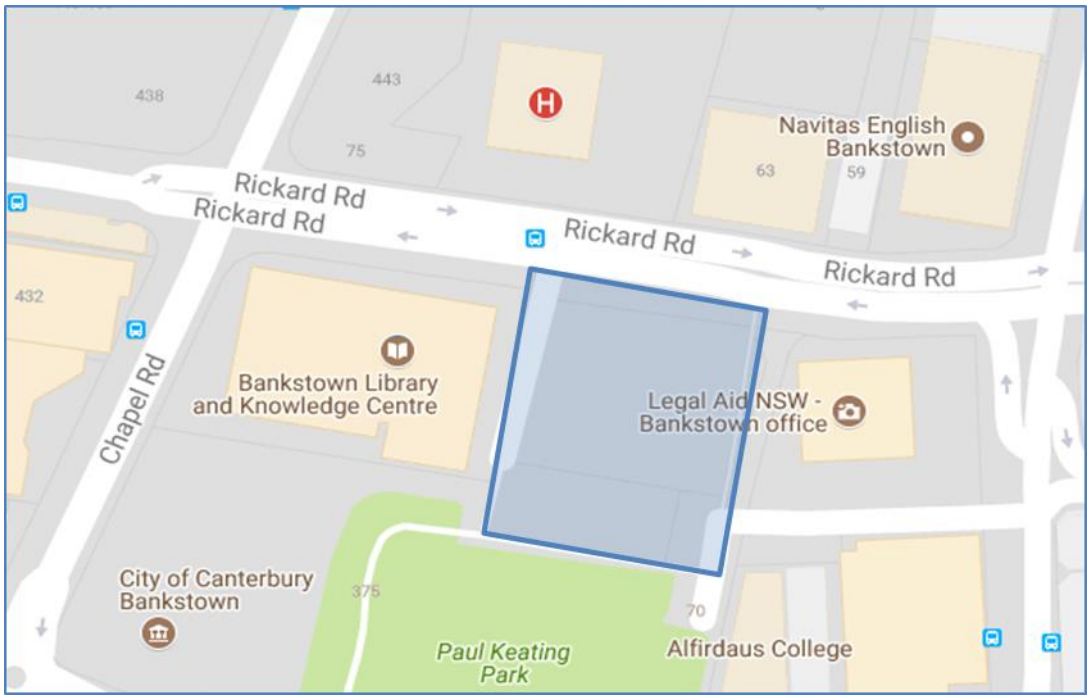


Figure 1: Site Area

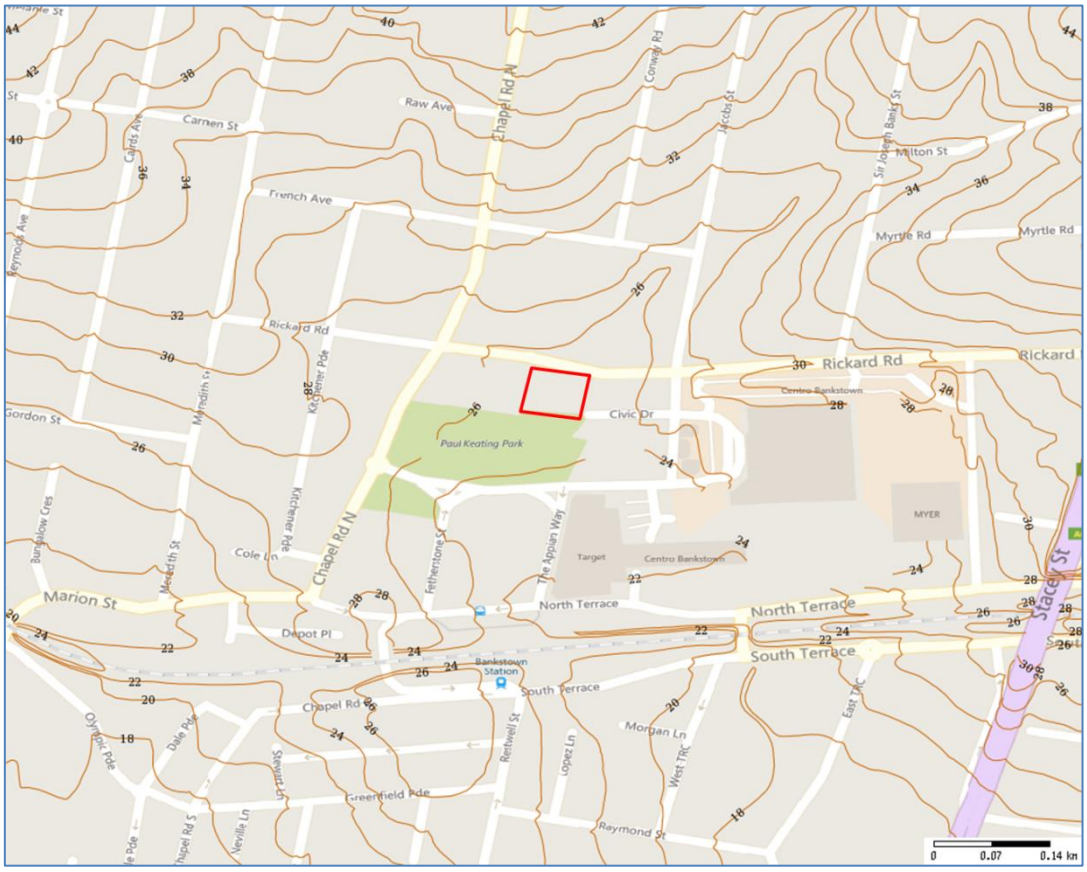


Figure 2: Surface Contours

3. Previous Investigations

DP has previously conducted several geotechnical and contamination investigations in this area. A brief summary of the subsurface conditions encountered during these investigations is given in Table 1.

Table 1: Previous relevant nearby geotechnical investigations

Date	Project No.	Address	Investigation Scope	Summary of closest tests to site
Nov-82	7809	61 Rickard Rd.	4 bores	Filling to 0.3 - 0.4m
				Stiff to very stiff clay to 3m
				Weathered shale to termination depth at 4.8m
				GW at 4m rising to 1.15m after 1 hour
Dec-83	8194	cnr Jacob & Rickard	5 bores	Topsoil & filling to 0.3 - 0.8m
				Clay to about 3m then weathered shale
				MS shale below about 4.5m
				GW at 1.3 - 1.5m
Aug-88	11458	69 Rickard Rd	6 cored bores	Filling to 1.2m max
				Stiff to very stiff clay to 4.5m
				LS - MS shale to 6m
				MS shale below about 6m
				GW not observed while augering
Sep-98	27577	59 Rickard Rd	5 cored bores	0.2 m filling
				Firm to stiff clay to 2.5 - 3m
				LS shale with some ELS bands to 4.5m
				MS shale below 4.5m
				GW at 2.0 - 3.5 m
May-06	43798A	NW cnr Rickard & Chapel	11 auger bores	Filling to 0.3 - 1.0 m away from UST
				Stiff to very stiff silty clay to 4.5 - 5.0 m
				ELS shale below 5m
				GW at 2.5 - 4.0 m
Sep-10	71940	SE cnr Rickard & Chapel (Bankstown City Hall)	1 bore, pile inspections and pile analysis	Filling to 0.7 m
				Silty clay to 3.9 m
				MS siltstone to 6.7m
				HS laminite below 6.7m
				GW not observed while augering to 3.9 m

Date	Project No.	Address	Investigation Scope	Summary of closest tests to site
Nov-17	86077	Bankstown Central Square Development	Deep cored bores	Filling to 0.7m
				Very stiff clay to 1.5 m
				ELS and VLS shale to 4.8m
				LS shale to 6.6 m
				MS shale to 13.5 m with some LS and VLS beds
				VHS sandstone to termination at 17.0 m
				GW not observed while augering to 2.1m

Notes: GW = groundwater, ELS = extremely low strength, VLS = very low strength, LS = low strength, MS = medium strength, HS = high strength, VHS = very high strength

The locations of the previous DP investigations that have been used in this assessment are shown on Figure 3.

Figure 3: Location of other DP projects around the site

4. Regional Geology

The 1:100,000 series geological map for Sydney (Geological Series Sheet 9130) and the accompanying notes indicate that the site is underlain by rocks of the Ashfield Shale formation of the Wianamatta Group. The Ashfield Shale typically comprises siltstones, claystones, fine grained sandstones and finely interlaminated beds of siltstone and sandstone, known locally as laminites.

An extract of the regional geological map is shown on Figure 4 with the dark green shading (Rwa) representing areas of Ashfield Shale. A higher rock unit known as the Bringelly Shale is shown to the north of the site (light green shading Rwb).

Figure 4: Regional Geology

There are no igneous dykes or major faults shown on the geological map in the area of the site.

Reference to the Acid Sulphate Soil (ASS) risk maps for the area published by the Department of Conservation and Land Management suggests that it is very unlikely that there are actual or potential acid sulphate soils occurring in the area of the site.

The Soils Landscapes of the Sydney 1:100,000 sheet indicates that the site straddles a boundary between soils of the Blacktown soil landscape group and soils of the Glenorie soil landscape group (Figure 5). The Blacktown group soils are residual soils derived from weathering of the Wianamatta

Group rocks and typically occur on gently undulating rises. The soil profiles are typically between 1 m and 3 m thick and the soils are moderately reactive and highly plastic, with low soil fertility and poor soil drainage. The Glenorie group soils are erosional soils developed on undulating hills also underlain by Wianamatta Group shales. The soils are typically more than 2 m thick on lower slopes, have a high soil erosion hazard and are moderately reactive.

Figure 5: Soil Landscapes

5. Field Work Methods

The field work for the current investigation included the drilling of five rock cored boreholes (Boreholes BH1 to BH5) and seven shallow augered boreholes (Boreholes BH6 to BH12).

The test locations are shown on Drawing 1 in Appendix B. The boreholes were drilled with a truck mounted drilling rig using spiral flight augers and rotary drilling methods through the soils. The rock cored boreholes were then continued to depths of about 25 m using diamond core drilling equipment to obtain continuous core samples of the bedrock. Standard Penetration Tests (SPTs) were carried out within the boreholes at 1.5 m depth intervals to assess the soil strength and to obtain samples for strata identification.

The boreholes were logged and sampled by an experienced geotechnical engineer. The rock cores recovered from the boreholes were photographed, followed by Point Load Strength Index (Is_{50}) testing on selected samples.

Groundwater monitoring wells were installed in three of the deep boreholes (BH1, BH4 and BH5) to allow for the measurement of groundwater levels and permeability testing. The wells typically comprised Class 18 machine slotted PVC with gravel backfill to about 1 m above the slotted section, a bentonite plug above the gravel section and then grout backfill to the surface. Details of the levels of the installed wells and the screened depths are given in Appendix C.

Standing groundwater levels were measured in the wells after the wells had been installed and developed by removing at least three borehole volumes of water. Rising head permeability tests were also carried out within the wells. In these tests the water within the wells was pumped out and the rate of inflow (recharge) was measured and used to calculate permeability.

The locations and surface levels of each of the boreholes were surveyed using a Differential Global Positioning System (DGPS). The levels and co-ordinates of each of the tests are provided on the detailed logs.

6. Field Work Results

Details of the subsurface conditions encountered are given in the borehole logs in Appendix C, together with colour photographs of the rock core and notes defining classification methods and descriptive terms.

In summary, the ground profile encountered during the current investigation generally comprised:

- Filling – pavement materials were encountered in the carpark test locations and typically comprised of between 50 mm to 150 mm thick asphaltic concrete surface overlying road base of between 100 mm and 400 mm thickness; this was overlain by clayey filling with minor proportions of gravel, to depths ranging from 0.8 m and 2.0 m depth;
- Residual soil – comprising clay or silty clay with minor proportions of ironstone gravel that is of generally stiff to very stiff consistency to depths of between 2.7 m and 3.8 m; overlying
- Bedrock – the upper bedrock layers typically comprising shale or laminite with some interbedded sandstone showed considerable variation between test locations. A generalised profile is summarised below:
    - extremely low and very low strength to depths of between 4.2 m and 6.8 m,
    - variable strength, typically low to medium strength with significant thicknesses of very low and low strength as well as medium and high strength layers
    - medium to high strength siltstone and sandstone with some very high strength layers below depths of between 12.2 m and 14.8 m.

The variation in conditions encountered across the site is illustrated on the interpreted sections on Drawings 2 and 3 in Appendix B.

Free groundwater was not observed in any bore during auger drilling. The use of water as a drilling fluid during washboring of soils and NMLC diamond coring of the bedrock precluded further observation of the groundwater levels during the initial field work. The groundwater levels and in situ permeability measurements obtained from the standpipe monitoring wells installed at Boreholes BH1, BH4 and BH5, following their development, are summarised in Table 22.

In situ permeability testing in the standpipe monitoring wells was carried using the rising or falling head test method, whereby the standing water in each well was first measured then water pumped out of or into the well so as to lower or raise the standing water level in the well, whereupon its depth was again measured to commence the test. The water depth in each well was then measured at regular time intervals as it fell back to the initial groundwater level. The equation of Hvorslev (1949) was then used to estimate the permeability of the subject strata, in this case, the bedrock. Plots of the recovery measured in the permeability tests are presented in Appendix D.

Table 2: Summary of Groundwater Level and Permeability Measurements

Borehole	Ground Surface Level (RL, AHD)	Groundwater Depth (and RL) (m)	Permeability (m/s)
		30 July 2018	
BH1	24.9 m	8.6 (RL 16.3 m)	6.0×10^{-6}
BH4	24.3 m	7.9 (RL 16.4 m)	6.2×10^{-6}
BH5	23.8 m	8.9 (RL 14.9 m)	5.7×10^{-8}

7. Laboratory Testing

The results of the current and previous laboratory testing on selected soil, rock and groundwater samples from test locations in and around are summarised in the following sections and the detailed results sheets for the current test results are given in Appendix E.

7.1 Acid Sulphate Soils

Samples of soil were screened for preliminary signs of actual acid sulphate soil (AASS) and potential acid sulphate soil (PASS). The screening involved the measurement of the pH value of each soil sample after the addition of distilled water (pH_F). Hydrogen Peroxide was then added to oxidise the sample and the pH value (pH_{FOX}) was measured again after at least 1 hour. The results for the pH screening are presented in Table 3.

The Acid Sulphate Soils Management Advisory Committee (ASSMAC) prepared an Acid Sulphate Soil Manual (August 1998) which includes guidelines for assessing AASS and PASS. The current ASS screening and laboratory testing regime has been developed in general accordance with the ASSMAC Acid Sulphate Soil Manual.

Table 3: PASS & AASS Screening Results

Borehole	Depth (m)	Material Description	Screening Tests			
			Natural pH_F	Oxidised pH_{FOX}	Change in pH	Reaction
BH1	2.5-2.95	Clay	6.5	5.8	-0.7	Slight
BH2	2.5-2.95	Clay	8.6	7.2	-1.4	Slight
BH3	1.5-1.6	Clay	8.9	8.5	-0.4	Slight
BH3	2.5-2.95	Clay	6.7	6.4	-0.3	High
BH4	2.4-2.5	Silty Clay	5.4	4.4	-1.0	High
BH5	2.5-2.95	Silty Clay	8.1	7.8	-0.3	Slight
BH6	2.5-2.95	Silty Clay	5.5	4.1	-1.4	Moderate

The screening test results were assessed for the possible presence of AASS or PASS on the basis of the following guidance indicators specified in the ASSMAC Guidelines:

- $pH_F \leq 4$ strongly indicates oxidation has occurred in the past and that AASS are likely to be present; and
- $pH_{FOX} < 3.5$ plus preferably one or more of the following strongly indicates the presence of PASS; a pH_{FOX} reading at least one pH unit below the corresponding pH_F, a strong reaction with peroxide, change in soil colour from grey tones to brown tones, or a release of sulphurous gases.

Following review of the screening results, some samples were selected for laboratory analysis of Suspension Peroxide Oxidation and Combined Acidity and Sulphate (SPOCAS). The results of the analysis for SPOCAS are provided in Table 4 together with action criteria as outlined in Table 4.4 of the ASSMAC guidelines (applicable for fine texture, medium to heavy clays).

Table 4: Results of Laboratory Analysis for SPOCAS

Borehole	Depth (m)	Material Description	pH_{KCl}	pH_{ox}	S_{POS} (%w/w)	TPA (Mol H^+/ tonne)	TSA (Mol H+/ tonne)
BH4	2.4-2.5	Silty Clay	4.3	4.3	0.01	42	16
BH6	2.5-2.95	Silty Clay	4.4	5.2	<0.005	15	<5
Action Criteria* (greater than 1000 tonnes disturbed)			<4	<3.5	0.03	18	18
Action Criteria* (less than 1000 tonnes disturbed)			<4	<3.5	0.1	62	62

Notes: Exceeds Action Criteria

* Action Criteria based on fine texture, medium top heavy clays

7.2 Soil Testing

Typical samples from the bores were tested in the laboratory for particle size distribution, moisture content, compaction properties and California Bearing Ratio. The detailed results are contained in Appendix D and are summarised in Tables 5 and 6 below.

Table 5: Summary of Particle Size Distribution and CBR Tests

Test No.	Depth (m)	% passing nominated sieves			FMC (%)	OMC (%)	SMDD (t/m^3)	CBR (%)
		2.36mm	0.075mm	0.002mm				
BH4	1.5-2.0	97	76	39	18.4	18.5	1.75	5
BH9	0.5-2.0	86	48	25	14.8	14.5	1.91	7
BH10	0.5-1.5	77	52	25	14.7	14.0	1.98	5
BH11	0.5-1.5	90	65	27	12.8	16.5	1.82	4.5

Note: FMC = Field Moisture Content, OMC = Optimum Moisture Content, SMDD = Standard Maximum Dry Density, CBR = California Bearing Ratio

Table 6: Summary of Plasticity Tests

Test No.	Depth (m)	W_L (%)	W_P (%)	PI (%)	LS (%)
BH4	1.5-2.0	44	15	29	13.5
BH9	0.5-2.0	48	15	33	14.5
BH10	0.5-1.5	49	15	34	14.5
BH11	0.5-1.5	37	15	22	12.0

Note: W_L = Liquid Limit, W_P = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage

7.3 Chemical Testing of Groundwater

Samples of groundwater from some of the piezometers were tested for pH, chloride and sulphate concentrations. The results are summarised in Table 7.

Table 7: Summary of Aggressivity Test Results

Test No.	Sample Type	pH	Electrical Conductivity (uS/cm)	Chloride as Cl- (mg/kg)	Sulphate as SO4 (mg/kg)
BH1	Water	7.4	22,000	7,200	540
BH4	Water	7.3	21,000	7,100	640
BH5	Water	7.7	14,000	4,200	590

8. Interpreted Geotechnical Model

The subsurface profile is characterised by

- Filling and residual clays overlying extremely low and very low strength rock to depths between 4.2 m and 6.8 m, below which depth the rock becomes quite variable in strength between test locations, underlain by;
- Generally low to medium strength with significant thicknesses of very low to low and medium to high strength layers then;
- Medium and high to very high strength siltstone and sandstone which extends below depths between 12.2 m and 14.8 m.

From a geological perspective the subsurface profile may be subdivided into three main units, namely Bringelly Shale, Minchinbury Sandstone and Ashfield Shale. These three geological formations form the Wianamatta Group of sedimentary rocks.

Interpreted geotechnical cross-sections are given on Drawings 2 and 3 in Appendix B which illustrates the interpreted subsurface profile beneath the site.

Groundwater depths have been measured within the rock from monitoring wells on the site with depths ranging from 7.9 m to 8.9 m (RL 14.9 m to RL 16.4 m). Depending on how many basement levels are constructed for the building, there is a possibility basements could be below the groundwater level.

9. Proposed Development

It is understood that at this stage of the project the details of the development have not been finalised. During preliminary planning it is noted that the development is likely to comprise a high rise building over a two to three level basement, with the possibility of up to a six level basement, requiring excavation to about 20 m below current surface levels.

10. Comments

10.1 Excavations

10.1.1 Excavatability

Excavation on the site is likely to penetrate through a relatively thin surface filling layer, into stiff and very stiff residual clays and then weathered rock.

Excavation of the filling, soil and extremely low to very low strength rock should be achievable using conventional earthmoving equipment such as tracked excavators. Excavation of low strength rock may require moderate ripping, while medium and high strength rock will be hard and very hard ripping and will probably require rock hammering.

Trafficability on the clay and weathered rock during bulk earthworks will generally require the use of tracked plant and machinery. Trafficability after the bulk excavation is completed may be improved by placement of a layer of compacted crushed concrete or similar, which may subsequently be used as sub-base for the basement floor slab.

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the EPA Waste Classification Guidelines.

10.1.2 Support

It is expected that the excavations on the site will extend to the site boundaries. Vertical excavations within the filling, clays and weathered rock will require both temporary and permanent support. Normally, medium or higher strength rock can stand vertically, however, the rock cores recovered from the bores have numerous fractured zones and joints moderately to steeply dipping (ie. at between 30^{o} to near vertical). These joints, if adversely orientated and 'daylighting' in the face of the excavation can form large wedges of rock that can become unstable. Therefore, shoring will generally be required to the medium and high strength siltstone and sandstone layer encountered between depths of 12.2 m and 14.8 m (dependant on excavation depth).

It is expected that a soldier pile shoring system would be suitable for the site. This system would include anchored soldier piles, drilled at 2 – 3 m spacings to below excavation level, with structural shotcrete panels between the soldiers progressively installed during excavation in lifts of approximately 2 m.

10.1.3 Design

The shoring systems will require lateral restraint to be provided by either ground anchors or internal props. Alternatively top-down construction may be adopted, particularly if anchors cannot be used or if it is necessary to reduce wall movements.

The number of rows of support required to provide lateral restraint to the shoring is dependent on the basement depth.

For a multi-propped wall, the magnitude of lateral earth pressure acting on perimeter shoring walls may be approximated as a uniform rectangular pressure of 6H (kPa), where H is the total height of the retained material in metres.

Additional pressures should be allowed where surcharging occurs either from loadings from traffic and/or other loadings associated with the use of the adjoining properties, or arising from construction plant. Unless positive drainage measures can be incorporated to prevent water pressure build-up behind the wall, the full hydrostatic head should be allowed for in design, allowing for the soil unit weight to reduce to buoyant conditions.

To estimate the passive resistance of the piles, it is suggested that an ultimate passive pressure of 2000 kPa is adopted for rock (low strength or better) over any "toe in" length developed at the base of the piles, from about 1 m below the base level of the excavation, or any service trench or other excavations adjacent to the wall.

In view of the possibility of steeply dipping joints within the medium and high strength rock, it is recommended that the walls and/or temporary ground anchors are also designed to support potential rock wedges. It is normally suggested that all earth and rock retaining walls should be designed to withstand a horizontal force per unit width of $4H^2$ (kN) where H is the total height in metres of the excavation.

10.1.4 Ground Anchors

If temporary ground anchors are used for the support of excavations and/or shoring systems, their design may be carried out on the basis of the maximum bond stresses given in Table 8.

Table 8: Recommended Bond Stresses for Temporary Rock Anchor Design

Material Description	Maximum Allowable Bond Stress (kPa)	Maximum Ultimate Bond Stress (kPa)
Stiff to Very Stiff Clay and Extremely Low and Very Low strength Rock	60 (unless smeared then 20)	100
Low to Medium Strength Rock	200	400
Medium and High Strength Rock	400	800

The parameters given in Table 8 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 bulk excavation, and "lift-off" tests should be carried out to confirm the anchor capacities. 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.

It is anticipated that the building will support the basement excavation over the long term and therefore the ground anchors are expected to be temporary only. The use of permanent anchors, if required, would require careful attention to corrosion protection for which further geotechnical advice should be sought.

It should be noted that permission will be required from adjacent property owners prior to installing bolts/anchors below their land. Due consideration should also be given to buried services and possibly basements on surrounding properties.

The parameters provided in Table 8 could also be used to design vertical anchors. In this case, the cone-pull out failure mechanism should be assessed in the design process.

10.1.5 Excavation Induced Ground Movement

If a relatively large excavation is proposed, there is likely to be some ground movements on the adjacent properties due to stress relief effects. In soils, precedence suggests that well-constructed and propped or anchored walls embedded below the excavation may experience lateral deflections of less than 0.1% to 0.5% of the excavation depth. There may also be some stress relief movements when excavating through the high strength laminite which may currently have high horizontal stresses.

It is recommended that survey monitoring of the shoring walls and adjacent buildings should be carried out in critical areas to measure the vertical and lateral movements. The monitoring should be carried out using precise levelling techniques to 0.5 mm accuracy, with measurements taken on a weekly basis during the basement construction period.

10.1.6 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 building structure, its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the building and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s component peak particle velocity (PPVi). 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 component PPVi for human comfort.

Based on the experience of DP and reference to AS2670, it is suggested that a maximum component PPVi of 8 mm/sec (applicable at the foundation level of existing buildings) be employed at this site to reduce the risk of causing architectural damage to surrounding modern, well-constructed buildings. Separate specific advice should be sought on acceptable vibration levels for any heritage buildings in the area.

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.

10.2 Groundwater and Dewatering

The groundwater level measured within the rock from monitoring wells has been measured at depths between 7.9 m to 8.9 m below ground. Relatively high permeabilities have been recorded in the fractured rock. If the proposed basement level is below the groundwater level it is expected that water flows into unlined excavations could be significant.

While the cheapest option for temporary support of the excavation would be to use soldier piles with shotcrete infill panels, this system has no real capacity to prevent groundwater inflow to the site and there is a risk that there could be large groundwater inflows which would require disposal off site and potentially drawdown of groundwater surrounding the site.

If the basement is to be tanked then watertight, perimeter shoring walls tied into a hydrostatic floor slab would generally be required for the permanent (ie. final) basement structure. During excavation and construction, dewatering, possibly by 'sump-and-pump' methods, will be required inside the cut-off walls. The design groundwater uplift pressure for any hydrostatic slabs should be calculated taking into account the potential groundwater level rises. This uplift resistance may be applied by the weight of the building, friction piles or ground anchors or a combination of these. In normal circumstances the weight of the finished structure (for buildings of more than about four storeys) is used to resist uplift in

the long-term so temporary dewatering needs to continue until the dead load of the structure is sufficient to restrain the structure from upward movement. A tanked basement would generally require the incorporation of a hydrostatic raft slab to resist uplift loads and to support the column/building loads, possibly with locally deepened beams and pads.

10.3 Foundations

Depending on the depth of the excavation the material exposed at the bulk excavation level is likely to be very low strength shale or better. Typical design bearing capacities for the different rock strengths are summarised in Table 9.

Table 9: Typical Design Parameters for Foundation Design

Foundation Stratum	Maximum Allowable Pressure		Maximum Ultimate Pressure	
	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)
Extremely low strength rock	700	70	2,500	100
Very low to low strength rock	1,500	150	5,000	200
Medium strength rock	3,500	350	20,000	1,000
Medium to high strength rock	8,000	800	100,000	2,500

Foundations proportioned on the basis of the allowable bearing pressures in Table 9 would be expected to experience total downward settlements of less than 1% of the footing or pile diameter under the applied compression working load, with differential settlements between adjacent columns expected to be less than half of this value.

All footings/piles should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters. Spoon testing should be carried out in at least one third of the footings which are designed for an allowable end bearing pressure of 3500 kPa or greater. Spoon testing generally involves drilling a 50 mm diameter hole below the base of the footing, to a depth of 1.5 times the footing width, followed by testing to check for the presence of weak/clay bands. If weak seams are detected then footings may need to be taken deeper to reach better foundation material.

10.4 Acid Sulphate Soils

Reference to the Acid Sulphate Soil Risk Map (produced by the Department of Land and Water Conservation) indicates the site is within an area of no known occurrence of acid sulphate soils (ASS). The site however is located within 1 km of an area mapped as disturbed terrain, potentially containing Acid Sulphate Soil (ASS).

Based on the ASS mapping and the laboratory testing it is considered that the soils are unlikely to contain AASS or PASS.

10.5 Seismic Loading

In accordance with AS1170-2007 "Structural Design Actions, Part 4 : Earthquake Actions in Australia" a hazard factor (Z) of 0.08 and a site subsoil Class C_e is considered to be appropriate for the site. The site subsoil Class C_e has been selected on the basis that the depth to rock on the site is relatively shallow but there will be soils acting on the basement walls.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at 74 Rickard Road, Bankstown. This report is provided for the exclusive use of Western Sydney University 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 and/or their agents.

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 scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

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 / environmental / groundwater) 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

About this Report

Douglas Partners

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

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

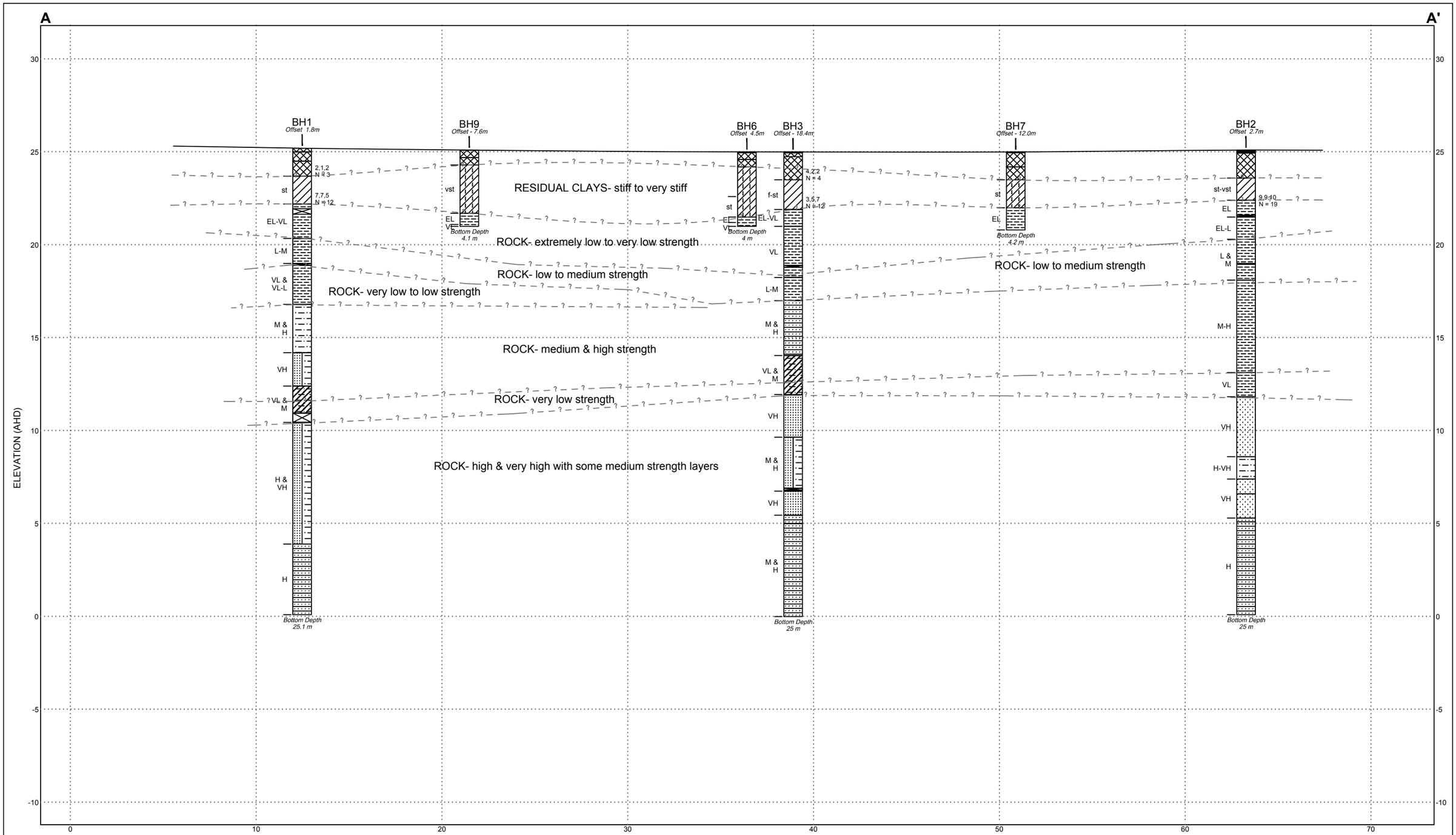
Drawings

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Western Sydney University		
OFFICE:	Sydney	DRAWN BY:	AP
SCALE:	1:400 @ A3	DATE:	08/08/2018

TITLE: **Borehole Locations**
Bankstown City Campus Development
74 Rickard Road, Bankstown

PROJECT No:	86462.00
DRAWING No:	1
REVISION:	5



LEGEND

- Carbonaceous Siltstone
- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Laminite
- Sandstone
- Sandstone fine grained
- Shale
- Siltstone
- Silty 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
VH - Very High

SOIL STRENGTH
f - firm
st - stiff
vst - very stiff

TESTS / OTHER
N - Standard penetration test value
▼ - Water level
PP - Pocket penetrometer test value

Horizontal Scale (metres)
Natural Scale

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Western Sydney University		TITLE: **Interpreted Geotechnical Cross-Section A-A'**
OFFICE: Sydney	DRAWN BY: JDB	**Bankstown City Campus Development**
SCALE: 1:200 (H) 1:200 (V) @ A3	DATE: 06.08.2018	**74 Rickard Rd, Bankstown**

PROJECT No:	86462.00
DRAWING No:	2
REVISION:	0

B

B'

BH4
Offset - 6.5m

BH10
Offset 1.2m

BH3
Offset 14.4m

BH5
Offset - 6.3m

0,1,3
N = 4

3,8,9
N = 17

13,26,B:
refusal

Bottom,Depth.
4.7 m

4,2,2
N = 4

3,5,7
N = 12

4,5,11
N = 16

RESIDUAL CLAYS- stiff to very stiff

ROCK- extremely low to very low strength

ROCK- variable strength

ROCK- high & very high with some medium strength layers

ROCK- low to medium strength

ROCK- medium & high strength

ROCK- very low strength

ROCK- low to medium strength

Bottom Depth
25 m

Bottom Depth
25 m

Bottom Depth
25 m

ELEVATION (AHD)

DISTANCE ALONG PROFILE (m)

LEGEND

- Carbonaceous Siltstone
- Core Loss
- Asphaltic Concrete
- Clay
- Filling
- Laminite
- Sandstone
- Shale
- Siltstone
- Silty Clay
- Topsoil

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
VH - Very High

SOIL STRENGTH
f - firm
st - stiff
vst - very stiff

TESTS / OTHER
N - Standard penetration test value
▼ - Water level
PP - Pocket penetrometer test value

Horizontal Scale (metres)
Natural Scale

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Western Sydney University		TITLE: **Interpreted Geotechnical Cross-Section B-B'**	PROJECT No: 86462.00
OFFICE: Sydney	DRAWN BY: JDB	**Bankstown City Campus Development**	DRAWING No: 3
SCALE: 1:200 (H) 1:200 (V) @ A3	DATE: 06.08.2018	**74 Rickard Rd, Bankstown**	REVISION: 0

Appendix C

Borehole Logs

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 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

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

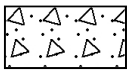
Symbols & Abbreviations

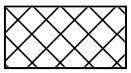
Graphic Symbols for Soil and Rock

General

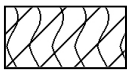

Asphalt

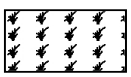

Road base

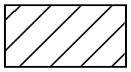

Concrete

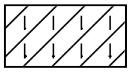

Filling

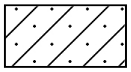
Soils


Topsoil

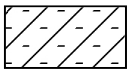

Peat

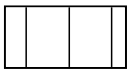

Clay

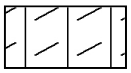

Silty clay

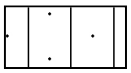

Sandy clay

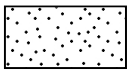

Gravelly clay

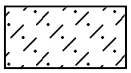

Shaly clay

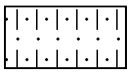

Silt


Clayey silt


Sandy silt

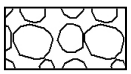

Sand

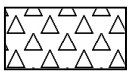

Clayey sand


Silty sand


Gravel

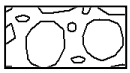

Sandy gravel


Cobbles, boulders

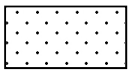

Talus

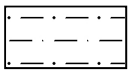
Sedimentary Rocks

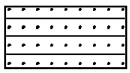

Boulder conglomerate

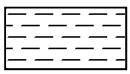

Conglomerate


Conglomeratic sandstone

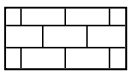

Sandstone


Siltstone

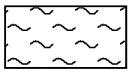

Laminite

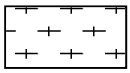

Mudstone, claystone, shale

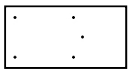

Coal


Limestone

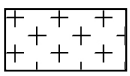
Metamorphic Rocks

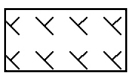

Slate, phyllite, schist

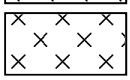

Gneiss

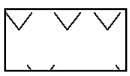

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.9 AHD
EASTING: 318381
NORTHING: 6245551
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86462.00
DATE: 11/7/2018
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
24	0.2	FILLING: dark brown, sand filling (topsoil) with rootlets.							A			
		FILLING: dark brown, slightly gravelly sand filling with ash.							A			
	0.7	FILLING: poorly compacted, light grey-brown, gravelly clay filling, moist							A			
23	1.5	CLAY: stiff, orange-brown and pale grey clay, silty, moist							S			2,1,2 N = 3
		2.5m: some ironstone gravel							A			
22	3.0	SHALE: extremely to very low then very low strength, highly weathered, fractured and slightly fractured, grey brown shale						Unless otherwise stated rock is fractured along planar rough bedding planes dipping at 0°-10°	S			7,7,5 N = 12
	3.55							3.25m: CORE LOSS: 300mm				
21	4							3.78m: J 45°-70°, cu, ro, fe 4.15-4.25m: Cs 4.33-4.35m: Ds				
20	4.85	SHALE: low to medium and medium strength, slightly weathered, slightly fractured grey shale						4.80-4.85m: Ds	C	90	50	PL(A) = 0.1
	5							5.06m: J 70°, pl, sm, fe 5.43-5.60m:J 85°, pl, sm, cln				PL(A) = 0.3
19	6							5.90-6.90m: J 35°&90°, pl, ro, cbs shale				
	6.2	SHALE: very low and very low to low strength, slightly weathered, fragmented to fractured and slightly fractured, pale grey shale 6.7-7.4m: medium strength						6.2m: CORE LOSS: 100mm				PL(A) = 0.1
18	7							7.2m: J 70°, pl, sm, cln 7.50-7.60m: fg	C	97	52	PL(A) = 0.4
17	8							8.06-8.16m: J 85°, pl, sm, cln 8.16-8.30m: fg 8.38m: B 0°, cly co				PL(A) = 0.4
	8.4	8.10-8.35m: carbonaceous shale band SILTSTONE: medium then high strength, fresh, slightly fractured, grey siltstone						8.63m: J 30°, pl, ro, cln 8.73m: J 70°, pl, sm, cln 8.83-8.85m: fg				
16	9							9.05m: J 30°, un, ro, cln 9.22-9.45m: J 70°-85°, st/un, ro, cln				PL(A) = 0.7
15								9.52m: J 45°, pl, ro, cln	C	100	95	

RIG: Scout 2 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Wash bore to 3.25m, NMLC coring to 25.1m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.1m (screen 4.1m to 25.1m, gravel 4.0m to 25.1m, bentonite 3.6m to 4.1m, backfill to GL with flush gatic cover)

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.9 AHD
EASTING: 318381
NORTHING: 6245551
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86462.00
DATE: 11/7/2018
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
		SILTSTONE: medium then high strength, fresh, slightly fractured, grey siltstone *(continued)*						10.42m: J 60°, pl, sm, gravel				PL(A) = 2.9
14	11 11.0	INTERBEDDED SILTSTONE AND SANDSTONE: very high strength, fresh, slightly fractured and unbroken, pale grey fine grained sandstone (30%), interbedded and laminated with grey siltstone (70%)							C	100	95	PL(A) = 3.2
13	12	12.10-12.45m: very low to low strength, carbonaceous shale band						12.07-12.16m: fg				
12	12.8	CARBONACEOUS SHALE: very low and medium strength, highly and slightly weathered, fragmented and fractured, dark grey to black carbonaceous shale						12.8m: B 0°, fe 12.9m: B 0°, cbs co 1mm 13.35-13.55m: fg, cbs band 13.85-14.00m: fg, cbs band 14.00-14.15m: J sv, un, ro, cly 14.15-14.25m: Ds 14.25m: CORE LOSS: 500mm	C	80	60	PL(A) = 3.1 PL(A) = 0.8
11	14											
10	14.75 15	INTERBEDDED SILTSTONE AND SANDSTONE: high and very high strength, fresh, slightly fractured and unbroken, light grey fine grained calcareous sandstone (70%), interbedded with grey siltstone (30%)						14.9m: J 45°, ti	C	100	100	PL(A) = 1.5
9	16											PL(A) = 5.1
8	17							16.56m: B 10°, fg 10mm	C	100	100	PL(A) = 4.8
7	18							17.4m: J 45°, pl, sm, cln				PL(A) = 3.7
6	19								C	100	100	PL(A) = 3.1
5								>>				PL(A) = 2.5

RIG: Scout 2 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Wash bore to 3.25m, NMLC coring to 25.1m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.1m (screen 4.1m to 25.1m, gravel 4.0m to 25.1m, bentonite 3.6m to 4.1m, backfill to GL with flush gatic cover)

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.9 AHD
EASTING: 318381
NORTHING: 6245551
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86462.00
DATE: 11/7/2018
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
4	21	INTERBEDDED SILTSTONE AND SANDSTONE: high and very high strength, fresh, slightly fractured and unbroken, light grey fine grained calcareous sandstone (70%), interbedded with grey siltstone (30%) *(continued)*							C	100	100	PL(A) = 5.3
	21.3	LAMINITE: high strength, fresh, unbroken, pale grey fine grained sandstone (40%) interlaminated with grey siltstone (60%)						21.30-21.35m: fg				PL(A) = 2.6
3	22											PL(A) = 1.7
2	23								C	100	98	
								23.2m: J 45°, pl, ro, cln				PL(A) = 1.8
1	24											
0	25								C	100	100	PL(A) = 1.5
	25.1	Bore discontinued at 25.1m Target depth reached										
-1	26											
-2	27											
-3	28											
-4	29											
-5												

RIG: Scout 2 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Wash bore to 3.25m, NMLC coring to 25.1m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.1m (screen 4.1m to 25.1m, gravel 4.0m to 25.1m, bentonite 3.6m to 4.1m, backfill to GL with flush gatic cover)

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: 1 PROJECT: BANKSTOWN JULY 2018

3.25 – 8.0m

BORE: 1 PROJECT: BANKSTOWN JULY 2018

8.0 – 13.0m

BORE: 1 PROJECT: BANKSTOWN JULY 2018

13.0 – 18.0m

BORE: 1 PROJECT: BANKSTOWN JULY 2018

18.0 – 23.0m

BORE: 1 PROJECT: BANKSTOWN JULY 2018

23.0 – 25.1m

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318431
NORTHING: 6245542
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86462.00
DATE: 19/7/2018
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
24	0.14	ASPHALTIC CONCRETE										
	0.16	CONCRETE										
		FILLING - removed using vacuum excavator truck										
1												
23	1.5	CLAY: stiff to very stiff, orange mottled grey clay, slightly silty and a trace of ironstone gravel, moist.							E*			
2		2.0m: becoming grey mottled red at 2.0m with very low strength shale gravel.							E			
22		2.2m: becoming stiff							E			
	2.7	SHALE: extremely low strength, grey shale.							S			9,9,10 N = 19
3												
21	3.58	SHALE: extremely low then very low strength, extremely then highly weathered, highly fractured, grey-brown shale.						3.5m: CORE LOSS: 80mm 3.60-4.29m: Ds	C	98	76	PL(A) = 0.27
4								4.29m: J 60°, pl,cln 4.39m: J 45°, pl, cln 4.4m: B 0°, pl, cly vn				
20	4.8	SHALE: low and medium strength, slightly weathered, slightly fractured, dark brown shale.						4.62-4.78m: Ds				
5								5.51m: J 65°, pl, cln				PL(A) = 0.65
19												
6												PL(A) = 0.41
	6.14	6.60-7.00m: carbonaceous shale band						6.04m: B 0°, pl, cly 5mm 6.06m: B 0°, pl, cly 5mm 6.11m: CORE LOSS: 30mm 6.64-6.80m: J 85°-60°, st, cln				
18	7.0	SHALE: medium then high strength, fresh, slightly fractured then unbroken, grey shale.										PL(A) = 0.51
7								7.46m: B 0°, pl, cly vn	C	99	97	
17								7.74m: B 0°, pl, cly 3mm				
8								8.21-8.25m: Cs				PL(A) = 2.6
16								8.76m: B 0°, pl, cly 8mm				
9												
15									C	100	94	PL(A) = 1.6

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN/RB/SI **CASING:** HW to 2.5m

TYPE OF BORING: Diatube to 0.16m, Vacuum Truck to 1.5m, Solid flight auger (TC-Bit) to 2.5m, Wash bore to 3.5m, NMLC coring to 25.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: *BD2/20180719 taken from 1.7-1.8m.

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318431
NORTHING: 6245542
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86462.00
DATE: 19/7/2018
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
		SHALE: medium then high strength, fresh, slightly fractured then unbroken, grey shale. *(continued)*						>>				PL(A) = 0.9
11									C	100	94	
												PL(A) = 1.2
12	11.97	SHALE: very low strength, slightly weathered and fresh, fragmented to fractured, dark brown shale with medium strength shale bands.						11.99-12.21: Ds				
								12.45m: B 0°, pl, cly 5mm 12.51-12.56m: fg 12.63-12.78m: Ds 12.87m: B 0°, pl, cly 8mm				PL(A) = 0.59
13	13.27	SANDSTONE: very high strength, fresh, unbroken, light grey fine grained sandstone with some high strength siltstone bands.										PL(A) = 3.6
									C	100	86	
14								14.30-14.31m: Ds				
												PL(A) = 1.2
15												
												PL(A) = 4.4
16												
												PL(A) = 6.4
	16.5	SILTSTONE: high to very high strength, fresh, unbroken dark grey siltstone with medium strength shale and very high fresh sandstone.							C	100	100	
17								16.75m: B 0°, pl, cly 3mm				PL(A) = 0.64
	17.7	SANDSTONE: very high strength, fresh, unbroken, fine grained sandstone with grey siltstone.										PL(A) = 2.6
18												
	18.5	SANDSTONE: very high strength, fresh, slightly fractured, pale grey, fine grained, calcareous sandstone.						18.36-18.43m: fg				
19												PL(A) = 4.1
									C	100	98	
	19.8	LAMINITE: (see next page)										
	20.0											PL(A) = 3.1

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN/RB/SI **CASING:** HW to 2.5m

TYPE OF BORING: Diatube to 0.16m, Vacuum Truck to 1.5m, Solid flight auger (TC-Bit) to 2.5m, Wash bore to 3.5m, NMLC coring to 25.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: *BD2/20180719 taken from 1.7-1.8m.

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318431
NORTHING: 6245542
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86462.00
DATE: 19/7/2018
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		LAMINITE: high strength, fresh, unbroken, pale grey to grey laminite with approxmately 40% fine grained sandstone laminations.							C	100	98	PL(A) = 3.3
	21											
	22								C	100	100	PL(A) = 2.4
	23							23.11-23.19m: J 60°, pl, cln				PL(A) = 1.7
	24								C	100	100	PL(A) = 1.1
	25 25.0	Bore discontinued at 25.0m Limit of Investigation										PL(A) = 1.7
	26											
	27											
	28											
	29											

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN/RB/SI **CASING:** HW to 2.5m

TYPE OF BORING: Diatube to 0.16m, Vacuum Truck to 1.5m, Solid flight auger (TC-Bit) to 2.5m, Wash bore to 3.5m, NMLC coring to 25.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: *BD2/20180719 taken from 1.7-1.8m.

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

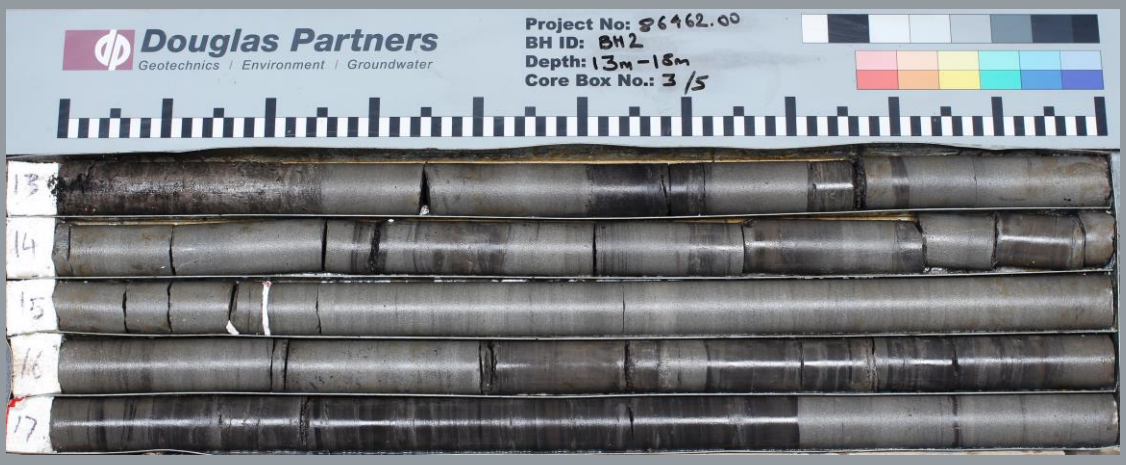
BORE: 2 PROJECT: BANKSTOWN JULY 2018

3.5 – 7.0m

BORE: 2 PROJECT: BANKSTOWN JULY 2018

8.0 – 13.0m

BORE: 2 PROJECT: BANKSTOWN JULY 2018



13.0 – 18.0m

BORE: 2 PROJECT: BANKSTOWN JULY 2018

18.0 – 23.0m

BORE: 2 **PROJECT: BANKSTOWN** **JULY 2018**

23.0 – 25.0m

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318403
NORTHING: 6245526
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86462.00
DATE: 10 - 11/7/2018
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
24.5	0.05	ASPHALTIC CONCRETE										
24.25	0.25	FILLING: roadbase gravel filling.										
		FILLING: dark brown, sand filling with fine to medium igneous gravel and trace of plastic and sandstone gravel.							A			
									S			4,2,2 N = 4
23	1.5	CLAY: firm then stiff, red clay, slightly silty with a trace of ironstone gravel, moist.							A*			
		2.7m: becoming red mottled grey							S			3,5,7 N = 12
21	3.1	SHALE: extremely to very low strength, extremely to highly weathered, pale grey-brown shale.						Unless otherwise stated rock is fractured along planar rough bedding planes dipping at 0°-10°				
								3.8m: J45°, pl, sm, cly 3.9m: J20°, pl, sm, cly				
20	4.0	SHALE: very low strength, highly weathered, fractured and slightly fractured, grey-brown shale.						4.24m: J45°, pl, ro, fe, cly				PL(A) = 0.11
								4.75-4.78m: Cs	C	97	0	
19								5.3m: J60°, pl, ro, fe, fg 50mm 5.50-6.10m; Ds				
18	6.2							6.1m: CORE LOSS: 100mm 6.20-6.70m: B's, 5-10°, he, fe				PL(A) = 0.16
17.75	6.75	SHALE: low to medium strength, slightly weathered, fragmented and slightly fractured, grey to dark grey shale with very low strength carbonaceous shale band from 6.6m.						6.5m: J35°, he, fe 6.9m: J45°, pl, ro, fe 7m: B0°, cly 10mm				PL(A) = 0.35
								7.25-7.35m: fg 7.62-7.70m; fg	C	100	70	
16.5	8.0	LAMINITE: medium and high strength, fresh, slightly fractured, pale grey and grey laminite with approximately 25% fine grained sandstone interlaminated with 75% siltstone.						7.85m: J85°, un, ro, cln 8m: B0°, cly 10mm 8.2m: J80°, pl, sm, cln				PL(A) = 1.8
								8.86m: B5°, cly co 3mm				
15								9.25m: B0°, gravel inclusion	C	100	96	PL(A) = 0.75

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CL/SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid lfight auger (TC-Bit) to 2.5m, Wash bore to 3.55m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: *BD1/20180710 take from 1.5-1.6m. 70% water loss at 14.30m.

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318403
NORTHING: 6245526
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86462.00
DATE: 10 - 11/7/2018
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
14		LAMINITE: medium and high strength, fresh, slightly fractured, pale grey and grey laminite with approximately 25% fine grained sandstone interlaminated with 75% siltstone. *(continued)*						10.23m: J, 45° and 75°, st, ro, cln				PL(A) = 0.78
11	10.95	CARBONACEOUS SHALE: medium then very low strength, fresh then slightly weathered, fractured and slightly fractured, dark grey, carbonaceous shale.						10.95m: J35°, ti 11.10-11.15m: B0°, cbs, cly 5mm	C	100	96	PL(A) = 0.54
13								11.63-11.76m: J85°, pl, ro, cbs band				
12												PL(A) = 1.5
12								12.25-12.35m: cbs band				
13	13.05	SANDSTONE: very high strength, fresh, slightly fractured, pale grey, fine grained, calcareous sandstone with some siltstone bands.						12.75-12.88m: B0°, cbs, cly				PL(A) = 4.8
14								13.92m: B0°, cly 3mm	C	100	88	
10								14.20-14.25m: Cs				PL(A) = 4.6
15								14.7m: B0°, cbs, cly 2mm 15.00-15.25m: J80°, un, ro, cly				
9	15.35	INTERBEDDED SANDSTONE AND SILTSTONE: medium and high strength, fresh, slightly fractured, pale grey, fine grained sandstone (40%) interbedded and laminated with siltstone (60%).										PL(A) = 2.7
16								15.9m: J35°, pl, ro, cln				
8								16.18-16.21m: Ds 16.30m: J, 60-85°, cu, ti				PL(A) = 0.61
17								16.65-16.75m: fg	C	97	91	
7												PL(A) = 2.3
18												
6	18.2 18.25	SANDSTONE: very high strength, fresh, unbroken, fine grained sandstone.						18.05m: B0°, cly 5mm 18.1m: CORE LOSS: 100mm				PL(A) = 5
19									C	100	100	
5	19.55	LAMINITE: (see next page for description)										PL(A) = 2.1
	20.0											

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CL/SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid lfight auger (TC-Bit) to 2.5m, Wash bore to 3.55m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: *BD1/20180710 take from 1.5-1.6m. 70% water loss at 14.30m.

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318403
NORTHING: 6245526
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86462.00
DATE: 10 - 11/7/2018
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		LAMINITE: medium and high strength, fresh, slightly fractured and unbroken, pale grey to grey laminite with approximately 25% fine grained sandstone interlaminated with grey siltstone 75%.							C	100	100	PL(A) = 2.2
	21											PL(A) = 1.3
								21.20-21.25m: sand, possible drilling cuttings				
	22							21.78-28.81m: fg 21.81m: J30°, pl, sm, cln 21.91m: J30°, pl, ro, cly				PL(A) = 0.95
	23							22.55m: J20°, pl, sm, fg 10mm	C	100	94	
								23.25m: J65°, pl, ro, cln				PL(A) = 0.94
	24											
	25 25.0	Bore discontinued at 25.0m Target depth reached							C	100	100	PL(A) = 1.4
	26											
	27											
	28											
	29											

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CL/SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid Ifight auger (TC-Bit) to 2.5m, Wash bore to 3.55m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: *BD1/20180710 take from 1.5-1.6m. 70% water loss at 14.30m.

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: 3 PROJECT: BANKSTOWN JULY 2018

3.55 – 8.0m

BORE: 3 PROJECT: BANKSTOWN JULY 2018

8.0 – 13.0m

BORE: 3 PROJECT: BANKSTOWN JULY 2018

13.0 – 18.0m

BORE: 3 PROJECT: BANKSTOWN JULY 2018

18.0 – 23.0m

BORE: 3 **PROJECT: BANKSTOWN** **JULY 2018**

23.0 – 25.0m

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.3 AHD
EASTING: 318367
NORTHING: 6245510
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86462.00
DATE: 9/7/2018
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
24	0.05	TOPSOIL FILLING: dark grey, silty sand topsoil filling, moist.							A/E			
	0.3	FILLING: poorly compacted, dark brown, silty clay filling with some igneous gravel, 2-20mm, and some medium to coarse sand, moist.										
	0.65	FILLING: poorly compacted, brown mottled grey and orange-brown, silty clay filling with a trace of coarse sand and igneous gravel, 2-5mm, moist. Laminations observed in auger cuttings.							S			0,1,3 N = 4
23	1								E			
									B			
	2.0	FILLING: poorly compacted, grey-brown, silty clay filling, with some shale gravel, 2-5mm, moist to wet. (Possibly natural)										
22	2	SILTY CLAY: stiff to very stiff, grey mottled red-brown and brown, silty clay with some ironstone gravel, 2-5mm, MC > PL, moist.							E			
									S			3,8,9 N = 17
	3	3.50m: becoming shaly clay										
21												
	4								S			13,26,B refusal Bouncing
20	4.3											
	4.43	SHALE: extremely low strength, grey shale.										
		SHALE: very low to low strength, highly weathered, fractuerd and slightly fractured, grey-brown shale.						4.57m: B0°, pl, ro, cly 10mm				PL(A) = 0.1
19	5							5.41-5.70m: J(x6), 30-45°, pl, he, cly 2-5mm	C	100	0	PL(A) = 0.27
	6											
18	6.22	SHALE: very low and low strength, highly and moderately weathered, fractured and slightly fractured, grey shale with some dark grey, medium strength carbonaceous bands.						6.26-6.29m: J(x3), 45-55°, pl, ti, fe, cly 2-3mm 6.62-6.80m: Ds, 180mm				PL(A) = 0.43
	7							7.13m: J30°, pl, ro, cly 1mm 7.23-7.26m: Cz, 30mm 7.34m: J, 0° and 45°, st, ro, fe 7.45m: J40°, pl, ro, fe stn 7.47m: J, 20-30°, un, he, fe 7.54-7.60m: Ds, 60mm 7.67-7.70m: Cz, 30mm 7.89-7.90m: Cs, 10mm 7.9m: J90°, pl, ro, fe 8.10-8.16m: fg 8.37m: B0°, pl, ro, cly 1mm 8.45-8.49m: fg 8.55-8.63m: Sz, 80mm 8.66m: CORE LOSS: 340mm 9.00-9.09m: fg	C	88	21	PL(A) = 0.5
17												
	8											PL(A) = 0.62
16												
	9											
	9.0											
15									C	100	61	PL(A) = 0.66
	10.0											

RIG: Scout 2 **DRILLER:** SS **LOGGED:** LS/SI **CASING:** HW to 4.43m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Wash bore to 4.43m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.0m (screen 6.0m to 25.0m, gravel 5.5m to 25.0m, bentonite 5.0m to 5.5m, backfill to GL with flush gatic cover)

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.3 AHD
EASTING: 318367
NORTHING: 6245510
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86462.00
DATE: 9/7/2018
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
14		SHALE: (continued)						9.23m: B0°, pl, ro, cly 3mm 9.30-9.60m: Ds, 300mm 9.68-9.73m: Ds, 50mm 10.14m: J30°, pl, ro, cly vn 10.20-10.24m: Ds, 40mm 10.40-10.45m: Cs, 50mm 11.20-11.25m: Ds, 50mm				
	10.45	SHALE: low to medium and medium strength, moderately weathered then fresh, fragmented to fractured and slightly fractured, dark grey, carbonaceous shale with some fine grained sandstone laminations.							C	100	61	PL(A) = 0.28 PL(A) = 0.72
11												
13												
12												
12								12.26-12.39m: Ds, 130mm				PL(A) = 0.33
13												
11	13.4	INTERBEDDED SANDSTONE AND SILTSTONE: high and very high strength, fresh, unbroken, pale grey, fine grained, slightly calcareous sandstone (60%) interbedded with grey siltstone (40%).						13.22m: B0°, pl, ro, cly 3mm 13.36-13.38m: Ds, 20mm	C	100	90	PL(A) = 1.6 PL(A) = 7.4
14												
10												
15												PL(A) = 2.1
9												
16												PL(A) = 4.5
8									C	100	100	
17												PL(A) = 1.9
7												
18									C	100	100	PL(A) = 3.8
6												
19									C	100	100	PL(A) = 4.6
5	19.9											

RIG: Scout 2 **DRILLER:** SS **LOGGED:** LS/SI **CASING:** HW to 4.43m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Wash bore to 4.43m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.0m (screen 6.0m to 25.0m, gravel 5.5m to 25.0m, bentonite 5.0m to 5.5m, backfill to GL with flush gatic cover)

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.3 AHD
EASTING: 318367
NORTHING: 6245510
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86462.00
DATE: 9/7/2018
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
4	21	LAMINITE: very high strength and high strength, fresh, unbroken, pale grey, fine grained sandstone (40%) interlaminated with grey siltstone (60%) *(continued)*						>>	C	100	100	PL(A) = 3.7
3	22											PL(A) = 1.6
2	23								C	100	100	PL(A) = 2.1
1	24											PL(A) = 2.1
0	25 25.0	Bore discontinued at 25.0m Target depth reached										PL(A) = 4.8
-1	26											
-2	27											
-3	28											
-4	29											
-5												

RIG: Scout 2 **DRILLER:** SS **LOGGED:** LS/SI **CASING:** HW to 4.43m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.5m, Wash bore to 4.43m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.0m (screen 6.0m to 25.0m, gravel 5.5m to 25.0m, bentonite 5.0m to 5.5m, backfill to GL with flush gatic cover)

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

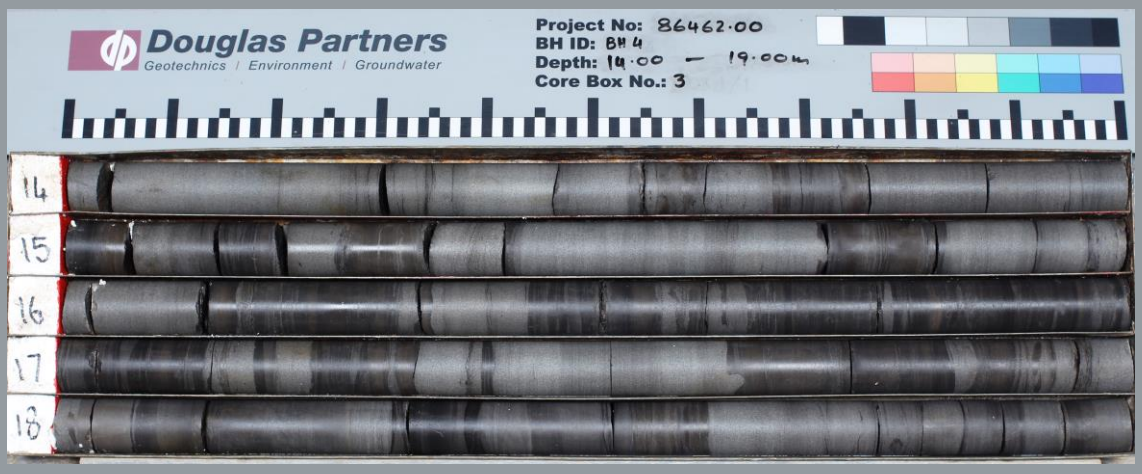
BORE: 4 PROJECT: BANKSTOWN JULY 2018

4.43 – 9.0m

BORE: 4 PROJECT: BANKSTOWN JULY 2018

9.0 – 14.0m

BORE: 4 PROJECT: BANKSTOWN JULY 2018



14.0 – 19.0m

BORE: 4 PROJECT: BANKSTOWN JULY 2018

19.0 – 24.0m

BORE: 4 **PROJECT: BANKSTOWN** **JULY 2018**

24.0 – 25.0m

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 23.8 AHD
EASTING: 318418
NORTHING: 6245503
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86462.00
DATE: 17 - 18/7/2018
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
23	0.05	ASPHALTIC CONCRETE							A			
	0.15	FILLING: grey-brown, gravelly (roadbase), cemented sand filling.							A			
	0.4	FILLING: orange-brown, silty sandy clay filling with some gravel.										
	0.8	FILLING: orange-brown, silty clay filling with trace gravel (possible natural).							A			
22	1	SILTY CLAY: stiff to very stiff, orange-brown, silty clay, MC ~ PL.							A			
		1.2m: becoming mottled grey										
		1.8m: becoming stiff, grey mottled red										
21	2	2.5m: with shale gravel						Unless otherwise stated rock is fractured along rough planar bedding dipping at 0°-10°	A S			4,5,11 N = 16
	3								A			
	3.35	SHALE: very low strength, extremely to highly weathered, fractured and slightly fractured, pale grey-brown shale						3.42-5.00m: fg 3.74-3.77m: Cs				PL(A) = 0.1
20	4							4.06m: B 0°, fg 10mm 4.16-4.20m: fg				
	4.2	SHALE: low strength, slightly weathered, slightly fractured, grey-brown shale										PL(A) = 0.2
19	5								C	97	55	
	5.32							5.16-5.22m: fg 5.22m: CORE LOSS: 100mm				
	5.5	SHALE: medium strength, slightly weathered, slightly fractured, grey shale										PL(A) = 0.6
18	6							5.90-6.25m: J 85°, pl, sm, cln 6.25m: B 0°, cly 5mm 6.35-6.85m: J (x3) 85°, 75°, 45°, st, sm, cln				PL(A) = 0.4
17	7	7.45m: becoming high strength						6.9m: J 60° ti 7.00-7.15m: J 80°, pl, sm, cln 7.27m: J 45° st, sm, cly 7.37m: J 25°, un, ro, cln 7.55m: J 80°, pl, ro, cly 7.7m: J 80°, pl, ro, cly 7.88m: J 45°& 80°, st, ro, cly	C	99	92	PL(A) = 2.2
16	8											
	8.15							8.15m: CORE LOSS: 50mm				
	8.2							8.3m: J 30°, pl, ro, cly 8.53-8.85m: J (x2) 70°, ti	C	100	100	PL(A) = 0.4
15	9							9.03-9.20m: J 45°& 85°, st, ro, cly 9.20-9.27m: Cs				
	9.15	SHALE: very low to low strength, slightly weathered, fractured, pale grey shale with some low strength bands						9.47-9.65m: J sv, un, ro, cly 9.60-10.00m: Ds	C	100	70	
14												

RIG: Scout 2 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.9m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.9m, Wash bore to 3.35m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.0m (screen 6.0m to 25.0m, gravel 5.5m to 25.0m, bentonite 4.9m to 5.5m, backfill to GL with flush gatic cover)

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 23.8 AHD
EASTING: 318418
NORTHING: 6245503
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86462.00
DATE: 17 - 18/7/2018
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
13	10.2	CARBONACEOUS SHALE: low to medium strength, slightly weathered, fragmented to fractured, dark grey coal with some high strength shale bands at 11.3m	EW HW MW SW FS FR		Ex Low Very Low Low Medium High Very High Ex High		0.01 0.05 0.10 0.50 1.00	10.1m: CORE LOSS: 100mm 10.40-10.52m: J sv, pl, sm, cln 10.45-10.82m: fg, coal seam 11.00-11.20m: J 85°& 45°, st, sm, cln 11.40-11.86m: carbonaceous shale	C	86	50	PL(A) = 0.3 PL(A) = 1.3
12	12.12							11.88m: CORE LOSS: 240mm				
11	12.22	SANDSTONE: high to very high strength, slightly weathered, slightly fractured and unbroken, pale grey fine grained, calcareous sandstone with some siltstone bands						12.12m: J 30°, ti 13.65m: B 0°, cly vn 14.85m: B 0°, cly 3mm	C	100	92	PL(A) = 2.8 PL(A) = 4 PL(A) = 1.5
10	15.25	INTERBEDDED SILTSTONE AND SANDSTONE: high to very high strength, fresh, unbroken, pale grey fine grained sandstone interbedded with grey medium strength siltstone						15.25m: J 90°, ti 16.00-16.10m: J 85°, pl, ro, cly 10mm	C	100	100	PL(A) = 0.9 PL(A) = 2.9
9	17.1	SANDSTONE: very high strength, fresh, slightly fractured, grey fine grained sandstone						17.12m: J 20°, pl, sm, cln 17.62-17.65m: Ds				PL(A) = 2.9 PL(A) = 1
8	18.8	SILTSTONE: high strength, fresh, unbroken, pale grey to grey siltstone						19.45m: B 0°, cly vn	C	100	100	PL(A) = 3.6 PL(A) = 1.3

RIG: Scout 2 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.9m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.9m, Wash bore to 3.35m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.0m (screen 6.0m to 25.0m, gravel 5.5m to 25.0m, bentonite 4.9m to 5.5m, backfill to GL with flush gatic cover)

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 23.8 AHD
EASTING: 318418
NORTHING: 6245503
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86462.00
DATE: 17 - 18/7/2018
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SILTSTONE: high strength, fresh, unbroken, pale grey to grey siltstone *(continued)*							C	100	100	PL(A) = 1.1
	20.6	LAMINITE: medium to high strength, fresh, unbroken, pale grey to grey laminite with approximately 25% fine grained sandstone laminations						20.6m: J sv, pl, ro, cln				
									C	100	100	PL(A) = 1.2
												PL(A) = 0.9
												PL(A) = 1.5
									C	100	100	PL(A) = 0.8
	25.0	Bore discontinued at 25.0m Limit of Investigation										

RIG: Scout 2 **DRILLER:** SS **LOGGED:** SI **CASING:** HW to 2.9m

TYPE OF BORING: Solid flight auger (TC-Bit) to 2.9m, Wash bore to 3.35m, NMLC coring to 25.0m.

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS: Standpipe installed to 25.0m (screen 6.0m to 25.0m, gravel 5.5m to 25.0m, bentonite 4.9m to 5.5m, backfill to GL with flush gatic cover)

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: 5 PROJECT: BANKSTOWN JULY 2018

3.35 – 8.0m

BORE: 5 PROJECT: BANKSTOWN JULY 2018

8.0 – 13.0m

BORE: 5 PROJECT: BANKSTOWN JULY 2018

13.0 – 18.0m

BORE: 5 PROJECT: BANKSTOWN JULY 2018

18.0 – 23.0m

BORE: 5 **PROJECT: BANKSTOWN** **JULY 2018**

23.0 – 25.0m

BOREHOLE LOG

CLIENT: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.9 AHD
EASTING: 318405
NORTHING: 6245549
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.04	ASPHALTIC CONCRETE		A	0.2				
	0.4	FILLING: grey brown, slightly gravelly (roadbase), cemented sand filling.		A	0.4				
	0.8	FILLING: orange and brown, clay filling with some sandstone gravel.		A	0.9				
	1	SILTY CLAY: orange-brown mottled grey, silty clay, MC ~ PL.		A	1.4				
23		1.5m: decomposed plant root							
	2			A	2.4				
22		2.4m: becoming stiff, light brown mottled grey							
	3			A	3.0				
		3.0m: becoming more grey							
	3.5			A	3.5				
21		SHALE extemely low strength, extremely weathered, grey shale.							
	4	3.8m: becoming very low strength							
	4.0	Bore discontinued at 4.0m Limit of Investigation							
20	5								
19	6								
18	7								
17	8								
16	9								
15									

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 4.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.5 AHD
EASTING: 318416
NORTHING: 6245530
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.04	ASPHALTIC CONCRETE							
		FILLING: grey-brown, slightly gravelly, cemented sand filling (roadbase) with basalt gravels.		A	0.2				
	0.8	FILLING: orange-brown, slightly gravelly, silty clay filling with some basalt gravels.		A	1.0				
23	1.5	SILTY CLAY: stiff, orange-brown mottled grey, silty clay, MC ~ PL.		A	1.5				
22		2.3m: becoming grey		A	2.5				
	3.0	SHALE: extremely low strength, extremely weathered, grey shale.		A	3.0				
21		4.0m: becoming brown		A	4.0				
	4.2	Bore discontinued at 4.2m Limit of Investigation							
20									
19									
18									
17									
16									
15									

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 4.2m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.6 AHD
EASTING: 318369
NORTHING: 6245529
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24.6	0.35	FILLING: dark brown, sand filling with some gravel and rootlets.		A	0.1				
		Bore discontinued at 0.35m Refusal on concrete at 0.35m							

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 0.35m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.6 AHD
EASTING: 318388
NORTHING: 6245540
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24.6	0.0	FILLING: dark brown, sand filling with some clay and rootlets (topsoil).		A	0.1				
24.2	0.4	FILLING: dark grey, gravelly, sandy clay filling with basalt gravels.		A B	0.4 0.5		Bulk sample taken from 0.5-2.0m		
23.8	0.8	SILTY CLAY: very stiff, orange-brown, silty clay.		A	0.8				
	1.0	1.0m: becoming brown		A	1.0				
23.2		1.5m: becoming orange mottled grey		A	1.5				
	2.0	2.0m: becoming red and slightly gravelly (ironstone gravel)		A	2.0				
22.6		2.5m: becoming gravelly (ironstone gravel)							
21.2	3.4	SHALE: extremely low strength,extremely weathered, grey shale.		A	3.5				
20.5	4.1	4.0m: becoming very low strength, grey-brown Bore discontinued at 4.1m Limit of Investigation							

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 4.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.3 AHD
EASTING: 318387
NORTHING: 6245515
DIP/AZIMUTH: 90°/--

BORE No: BH10
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.0	FILLING: dark brown, clayey sand fillnig with rootlets (topsoil).		A	0.1				
	0.4	FILLING: orange, brown and grey, silty clay filling with some sandstone gravel and ash.		A B	0.4 0.5		Bulk sample taken from 0.5 to 1.5m		
23	1.2	SILTY CLAY: orange-brown, silty clay, MC ~ PL.		A	1.2				
		1.8m: becoming red		A	2.0				
22		2.5m: with ironstone gravel		A	2.5				
21	3.4	SHALE: extremely low strength, extremely weathered, grey-red shale.		A	3.5				
		4.0m: becoming brown							
20		4.5m: becoming very low strength, grey-brown		A	4.5				
	4.7	Bore discontinued at 4.7m Limit of Investigation							
19									
18									
17									
16									
15									

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 4.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.3 AHD
EASTING: 318400
NORTHING: 6245511
DIP/AZIMUTH: 90°/--

BORE No: BH11
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.04	ASPHALTIC CONCRETE		A	0.2				
	0.4	FILLING: grey-brown, gravelly, cemeneted sand filling (roadbase).		A	0.5				
		FILLING: orange-brown mottled grey, silty clay filling with tree bark and some gravel (possible natural).							
23	1.0	SILTY CLAY: stiff, orange-brown, silty clay with some ironstone gravel.		A	1.0				
		1.5m: becoming more red, increased ironstone gravel content		A	1.5				
21	3.4	SILTY CLAY: very stiff, grey-orange, slightly gravelly, silty clay.		A	3.4				
	3.8	SHALE: extremely low strength, extremely weathered, dark grey shale.		A	3.9				
20	4.1	Bore discontinued at 4.0m Limit of Investigation							
19	5								
18	6								
17	7								
16	8								
15	9								

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 4.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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: Western Sydney University
PROJECT: Bankstown City Campus Development
LOCATION: 74 Rickard Rd, Bankstown

SURFACE LEVEL: 24.0 AHD
EASTING: 318423
NORTHING: 6245521
DIP/AZIMUTH: 90°/--

BORE No: BH12
PROJECT No: 86462.00
DATE: 13/7/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.15	ASPHALTIC CONCRETE		A	0.2				
	0.4	FILLING: grey-brown, gravelly, cemented sand filling (roadbase) with some concrete gravel.		A	0.4				
	0.8	FILLING: dark brown, slightly sandy, silty clay filling with some gravel.		A	0.9				
23	1	FILLING: grey-brown, silty clay filling (possible natural).							1
	1.3	SILTY CLAY: very stiff, grey mottled orange, silty clay with trace gravel, MC ~ PL.		A	1.8				
22	2	2.0m: becoming dark brown-grey and wet		A	2.0				2
		2.2m: becoming hard and orange with very low strength shale gravel		A	2.5				
	2.9								
21	3	SHALE: very low strength, brown shale.		A	3.0				3
	3.3	Bore discontinued at 3.3m Limit of Investigation							
20	4								4
19	5								5
18	6								6
17	7								7
16	8								8
15	9								9

RIG: Scout 2 **DRILLER:** SS **LOGGED:** CLN **CASING:** None

TYPE OF BORING: Solid flight auger (TC-Bit) to 3.3m

WATER OBSERVATIONS: No free groundwater observed whilst augering.

REMARKS:

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

Appendix D

Permeability Testing

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

Permeability Testing - Falling Head Test Report

Client:	Western Sydney University	Project No:	86462.00
Project:	Western Sydney Uni, Bankstown	Test date:	30-Jul-18
Location:	74 Rickard Rd, Bankstown	Tested by:	JAP

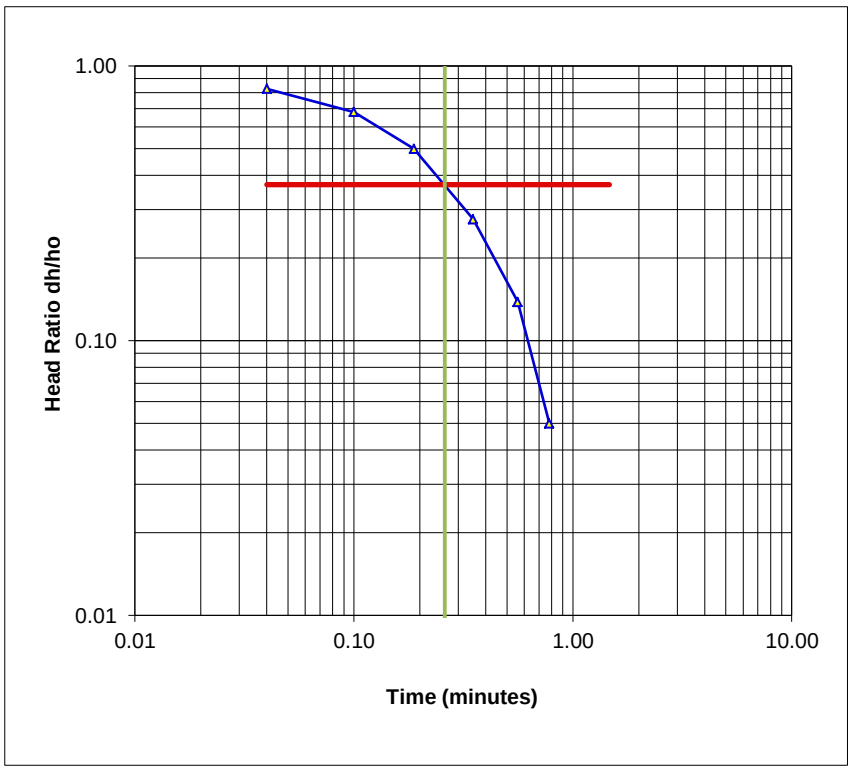
Test Location		**Test No.**	BH1	
Description:	BH1 Falling Head Test	Easting:	318381	m
Material type:	Typically Shale and Laminite	Northing	6245551	m
		Surface Level:	24.9	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	8.6	m
Well screen diameter (2R)	76	mm	Depth to water at start of test	6	m
Length of well screen (Le)	21.1	m			

Test Results

Time (min)	Depth (m)	Change in Head: dH (m)	dH/Ho
0.01	5.99	2.61	1.004
0.04	6.45	2.15	0.827
0.10	6.83	1.77	0.681
0.19	7.3	1.30	0.500
0.35	7.88	0.72	0.277
0.56	8.24	0.36	0.138
0.78	8.47	0.13	0.050
1.47	8.6	0.00	0.000



To = 0.26 mins
15.6 secs

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 =**	**6.0E-06**	m/sec
	=	**2.160**	cm/hour

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

Permeability Testing - Falling Head Test Report

Client:	Western Sydney University	Project No:	86462.00
Project:	Western Sydney Uni, Bankstown	Test date:	30-Jul-18
Location:	74 Rickard Rd, Bankstown	Tested by:	JAP

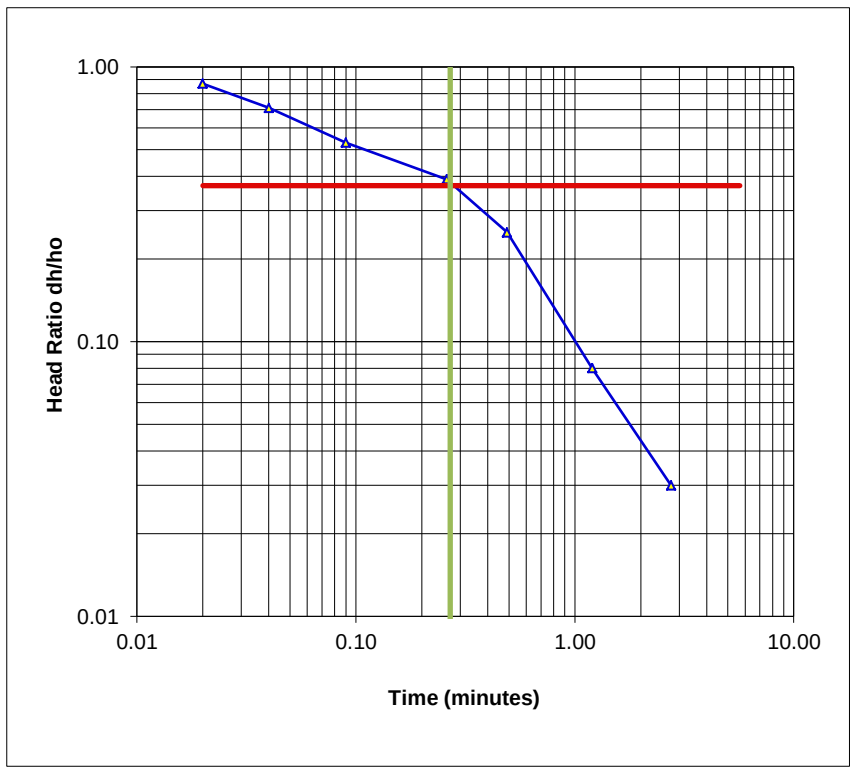
Test Location		**Test No.**	BH4	
Description:	BH4 Falling Head Test	Easting:	318367	m
Material type:	Typically Shale and Laminite	Northing	6245510	m
		Surface Level:	24.3	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	7.9	m
Well screen diameter (2R)	76	mm	Depth to water at start of test	6.9	m
Length of well screen (Le)	19.5	m			

Test Results

Time (min)	Depth (m)	Change in Head: dH (m)	dH/Ho
0.01	6.93	0.97	0.970
0.02	7.03	0.87	0.870
0.04	7.19	0.71	0.710
0.09	7.37	0.53	0.530
0.26	7.51	0.39	0.390
0.49	7.65	0.25	0.250
1.20	7.82	0.08	0.080
2.75	7.87	0.03	0.030
5.66	7.9	0.00	0.000



To = 0.27 mins
16.2 secs

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 =**	**6.2E-06**	m/sec
	=	**2.222**	cm/hour

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

Permeability Testing - Rising Head Test Report

Client:	Western Sydney University	Project No:	86462.00
Project:	Western Sydney Uni, Bankstown	Test date:	30-Jul-18
Location:	74 Rickard Rd, Bankstown	Tested by:	JAP

Test Location

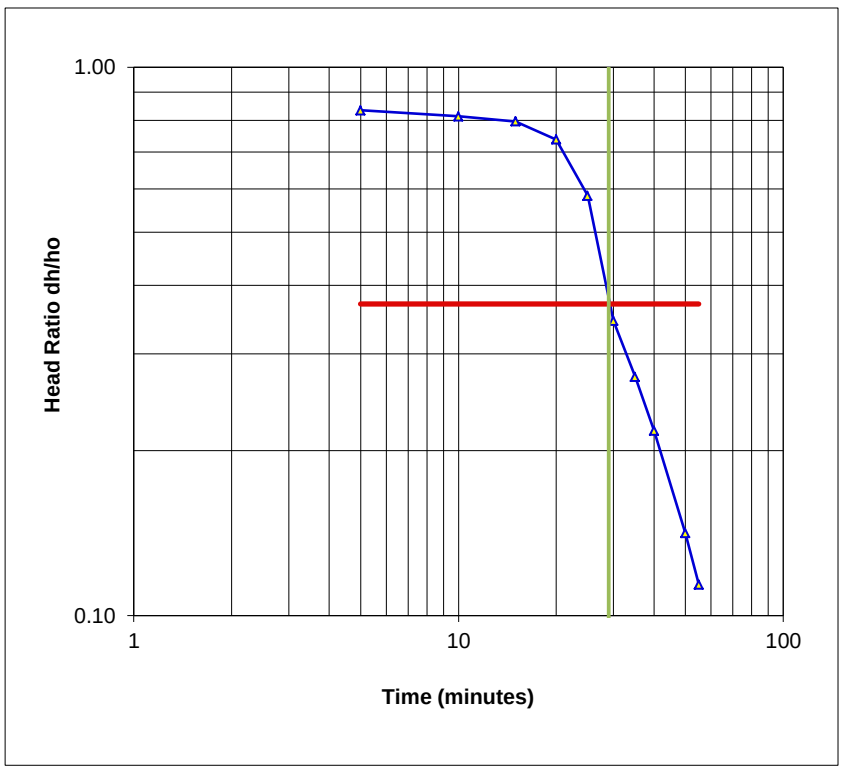
Description:	BH5 Rising Head Test	**Test No.**	BH5	
Material type:	Typically Shale and Laminite	Easting:	318418	m
		Northing	6245503	m
		Surface Level:	23.8	m AHD

Details of Well Installation

Well casing diameter (2r)	50	mm	Depth to water before test	8.3	m
Well screen diameter (2R)	76	mm	Depth to water at start of test	11.2	m
Length of well screen (Le)	19.5	m			

Test Results

Time (min)	Depth (m)	Change in Head: dH (m)	dH/Ho
0	11.20	2.90	1.000
5	10.72	2.42	0.834
10	10.66	2.36	0.814
15	10.61	2.31	0.797
20	10.44	2.14	0.738
25	9.99	1.69	0.583
30	9.3	1.00	0.345
35	9.09	0.79	0.272
40	8.93	0.63	0.217
50	8.71	0.41	0.141
55	8.63	0.33	0.114



To = 29 mins
1740 secs

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 =**	**5.7E-08**	m/sec
	=	**0.021**	cm/hour

Appendix E

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: mick.gref@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

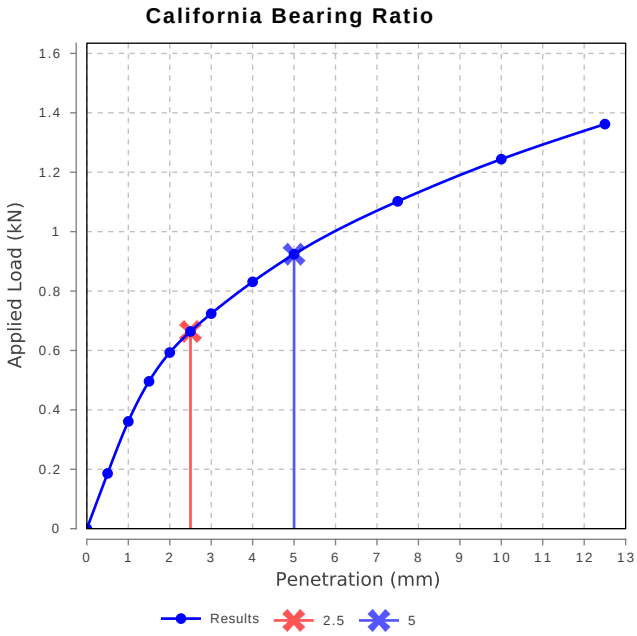
Approved Signatory: Michael Gref
NATA Accredited Laboratory Number: 828

Report Number: **86462.00-2**
Issue Number: 1
Date Issued: 31/07/2018
Client: Western Sydney University
Victoria Road, Rydalmere NSW 2730
Contact: Michelle Lee
Project Number: 86462.00
Project Name: Bankstown City Campus Development
Project Location: 74 Rickard Rd, Bankstown
Work Request: 3506
Sample Number: 18-3506A
Date Sampled: 13/07/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH4 (1.5 - 2.0m)**
Material: Brown sandy silt and clay with trace of gravel

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.75		
Optimum Moisture Content (%)	18.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.75		
Field Moisture Content (%)	18.4		
Moisture Content at Placement (%)	18.5		
Moisture Content Top 30mm (%)	20.1		
Moisture Content Rest of Sample (%)	18.8		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	194		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	44		
Plastic Limit (%)	15		
Plasticity Index (%)	**29**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.5		
Cracking Crumbling Curling	None		



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: mick.gref@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

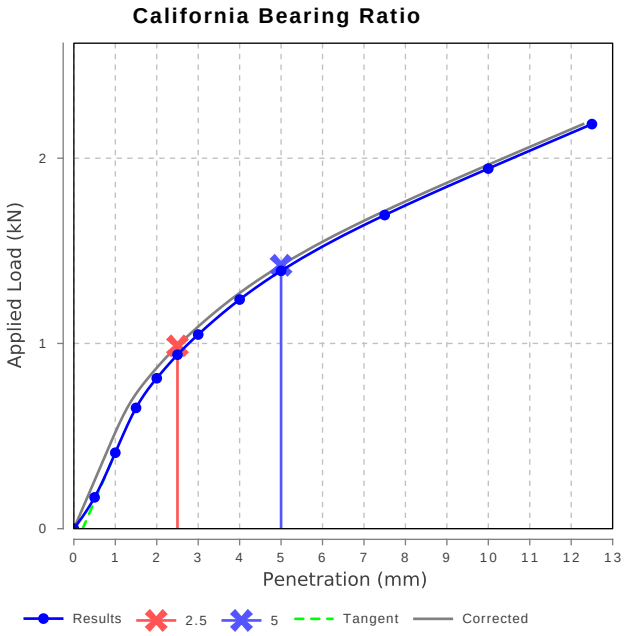
Approved Signatory: Michael Gref
NATA Accredited Laboratory Number: 828

Report Number: **86462.00-2**
Issue Number: 1
Date Issued: 31/07/2018
Client: Western Sydney University
Victoria Road, Rydalmere NSW 2730
Contact: Michelle Lee
Project Number: 86462.00
Project Name: Bankstown City Campus Development
Project Location: 74 Rickard Rd, Bankstown
Work Request: 3506
Sample Number: 18-3506B
Date Sampled: 13/07/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH9 (0.5 - 2.0m)**
Material: Brown slightly gravelly, clayey silty sand

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**7**		
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)	1.91		
Optimum Moisture Content (%)	14.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.91		
Field Moisture Content (%)	14.8		
Moisture Content at Placement (%)	14.5		
Moisture Content Top 30mm (%)	16.2		
Moisture Content Rest of Sample (%)	14.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	192		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	1.9		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	48		
Plastic Limit (%)	15		
Plasticity Index (%)	**33**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.5		
Cracking Crumbling Curling	None		



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: mick.gref@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

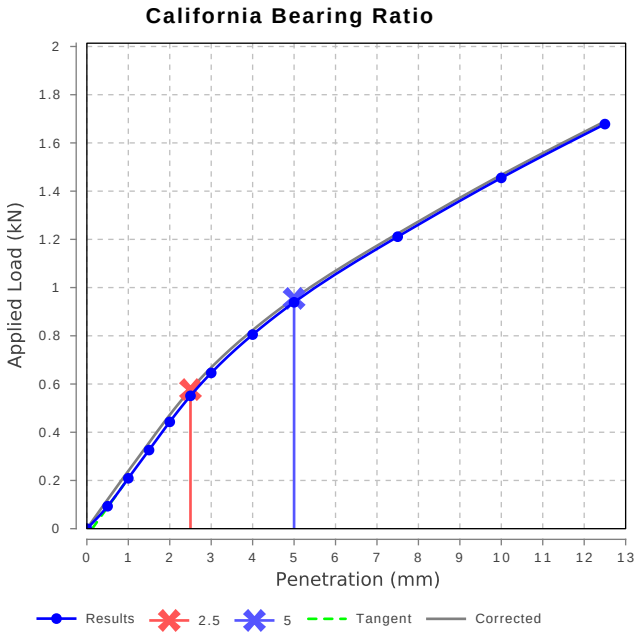
Approved Signatory: Michael Gref
NATA Accredited Laboratory Number: 828

Report Number: **86462.00-2**
Issue Number: 1
Date Issued: 31/07/2018
Client: Western Sydney University
Victoria Road, Rydalmere NSW 2730
Contact: Michelle Lee
Project Number: 86462.00
Project Name: Bankstown City Campus Development
Project Location: 74 Rickard Rd, Bankstown
Work Request: 3506
Sample Number: 18-3506C
Date Sampled: 13/07/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH10 (0.5 - 1.5m)**
Material: Orange brown gravelly sandy clayey silt

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.98		
Optimum Moisture Content (%)	14.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.96		
Field Moisture Content (%)	14.7		
Moisture Content at Placement (%)	14.0		
Moisture Content Top 30mm (%)	17.7		
Moisture Content Rest of Sample (%)	15.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	197		
Swell (%)	1.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	49		
Plastic Limit (%)	15		
Plasticity Index (%)	**34**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	14.5		
Cracking Crumbling Curling	None		



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: mick.gref@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

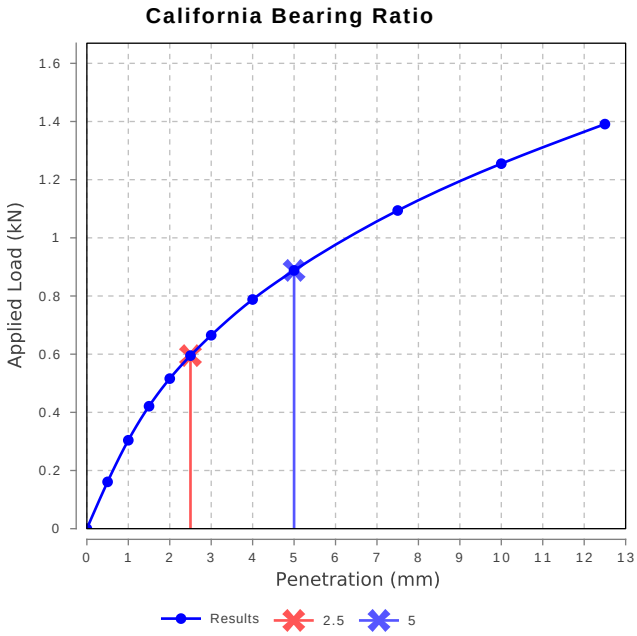
Approved Signatory: Michael Gref
NATA Accredited Laboratory Number: 828

Report Number: **86462.00-2**
Issue Number: 1
Date Issued: 31/07/2018
Client: Western Sydney University
Victoria Road, Rydalmere NSW 2730
Contact: Michelle Lee
Project Number: 86462.00
Project Name: Bankstown City Campus Development
Project Location: 74 Rickard Rd, Bankstown
Work Request: 3506
Sample Number: 18-3506D
Date Sampled: 13/07/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH11 (0.5 - 1.5m)**
Material: Brown sandy clayey silt with some gravel

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**4.5**		
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)	1.82		
Optimum Moisture Content (%)	16.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.82		
Field Moisture Content (%)	12.8		
Moisture Content at Placement (%)	16.7		
Moisture Content Top 30mm (%)	18.8		
Moisture Content Rest of Sample (%)	17.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	194		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	37		
Plastic Limit (%)	15		
Plasticity Index (%)	**22**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	12.0		
Cracking Crumbling Curling	None		

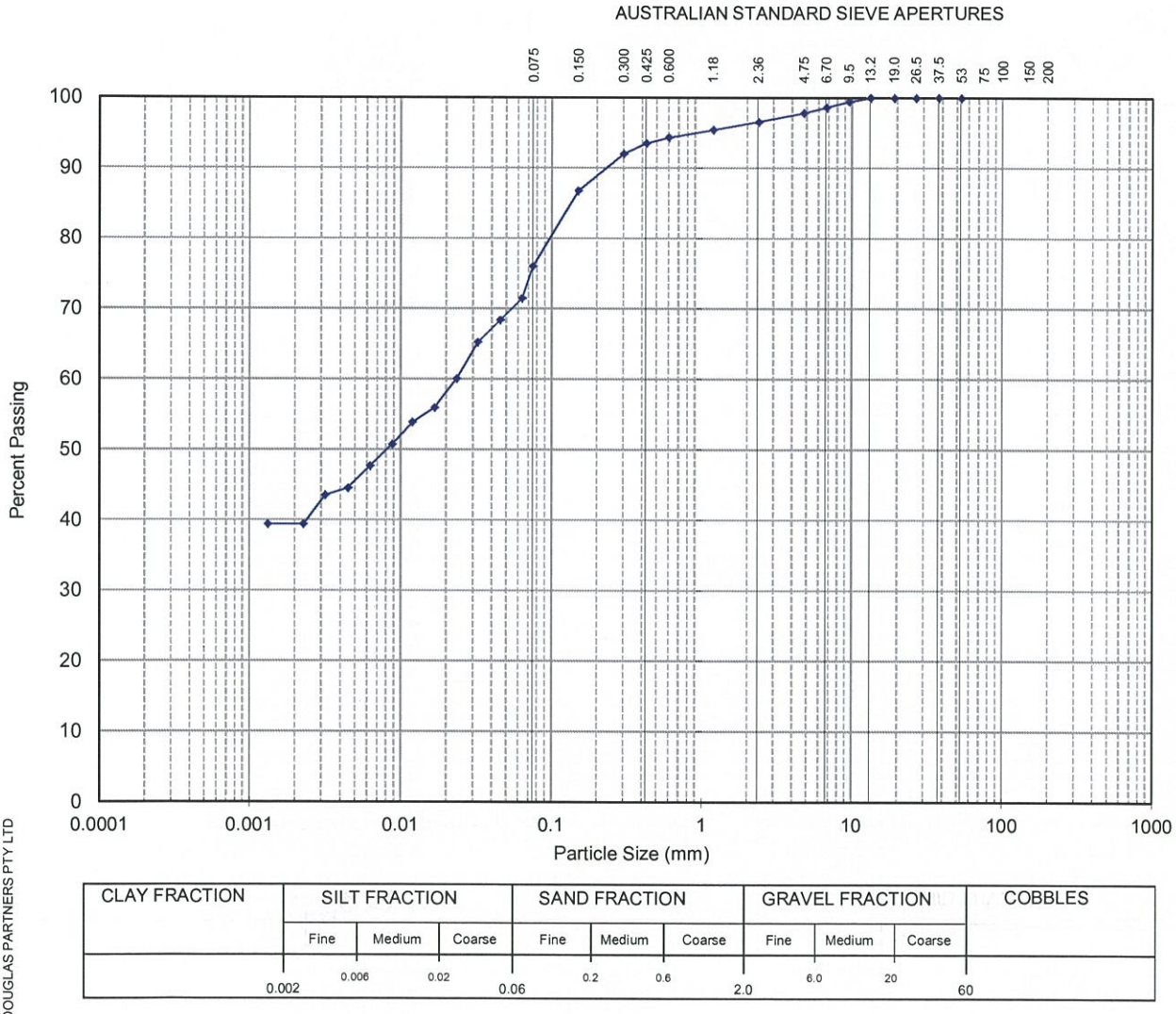


Douglas Partners
Geotechnics / Environment / Groundwater

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 Particle Size Distribution (Hydrometer)

Client :	Western Sydney University	**Project No. :**	86462
		Report No. :	2
Project :	Bankstown City Campus Development	**Report Date :**	30/7/2018
		Date Sampled:	13-Jul-18
Location :	74 Rickard Road, Bankstown	**Date of Test:**	18-Jul-18
Road No:	- **Sample / Pit No:** BH4	**Depth / Layer:**	1.5 - 2.0m
Chainage:	- **Section / Lot No:** -	**Test Request No:**	
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	100%
37.5	100%
26.5	100%
19.0	100%
13.2	100%
9.5	99%
6.7	99%
4.75	98%
2.36	97%
1.18	95%
0.600	94%
0.425	94%
0.300	92%
0.150	87%
0.075	76%
0.046	68%
0.033	65%
0.023	60%
0.017	56%
0.012	54%
0.009	51%
0.006	48%
0.004	45%
0.003	44%
0.002	39%
0.001	39%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02		0.06	0.2	0.6	2.0	6.0	20	60

Description: Brown sandy silt and clay with trace of gravel

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Engineering Department

Loss in pretreatment: 0%

Remarks:

Type of Hydrometer: g/l

NATA ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number:828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested:	AH
Checked:	LW

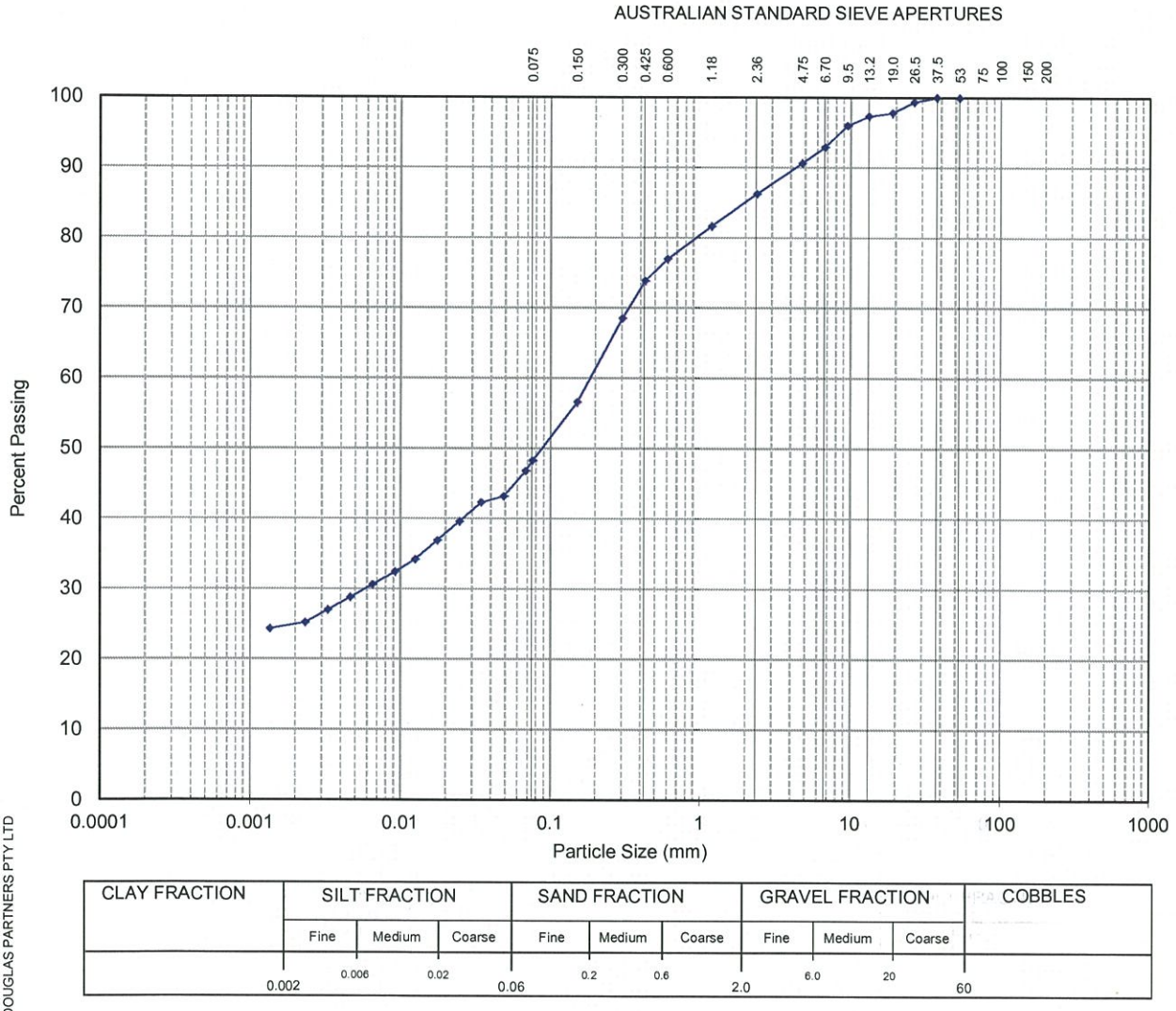
Michael Gref
Senior Soil Technician

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 Particle Size Distribution (Hydrometer)

Client :	Western Sydney University	**Project No. :**	86462
		Report No. :	3
Project :	Bankstown City Campus Development	**Report Date :**	30/7/2018
		Date Sampled:	13-Jul-18
Location :	74 Rickard Road, Bankstown	**Date of Test:**	18-Jul-18
Road No:	- **Sample / Pit No:** BH9	**Depth / Layer:**	0.5 - 2.0m
Chainage:	- **Section / Lot No:** -	**Test Request No:**	
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	100%
37.5	100%
26.5	99%
19.0	98%
13.2	97%
9.5	96%
6.7	93%
4.75	91%
2.36	86%
1.18	82%
0.600	77%
0.425	74%
0.300	69%
0.150	57%
0.075	48%
0.048	43%
0.034	42%
0.025	40%
0.018	37%
0.012	34%
0.009	32%
0.007	31%
0.005	29%
0.003	27%
0.002	25%
0.001	24%

Description: Brown slightly gravelly, clayey silty sand

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Engineering Department

Loss in pretreatment: 0%

Remarks:

Type of Hydrometer: g/l

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number:828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested:	AH
Checked:	LW

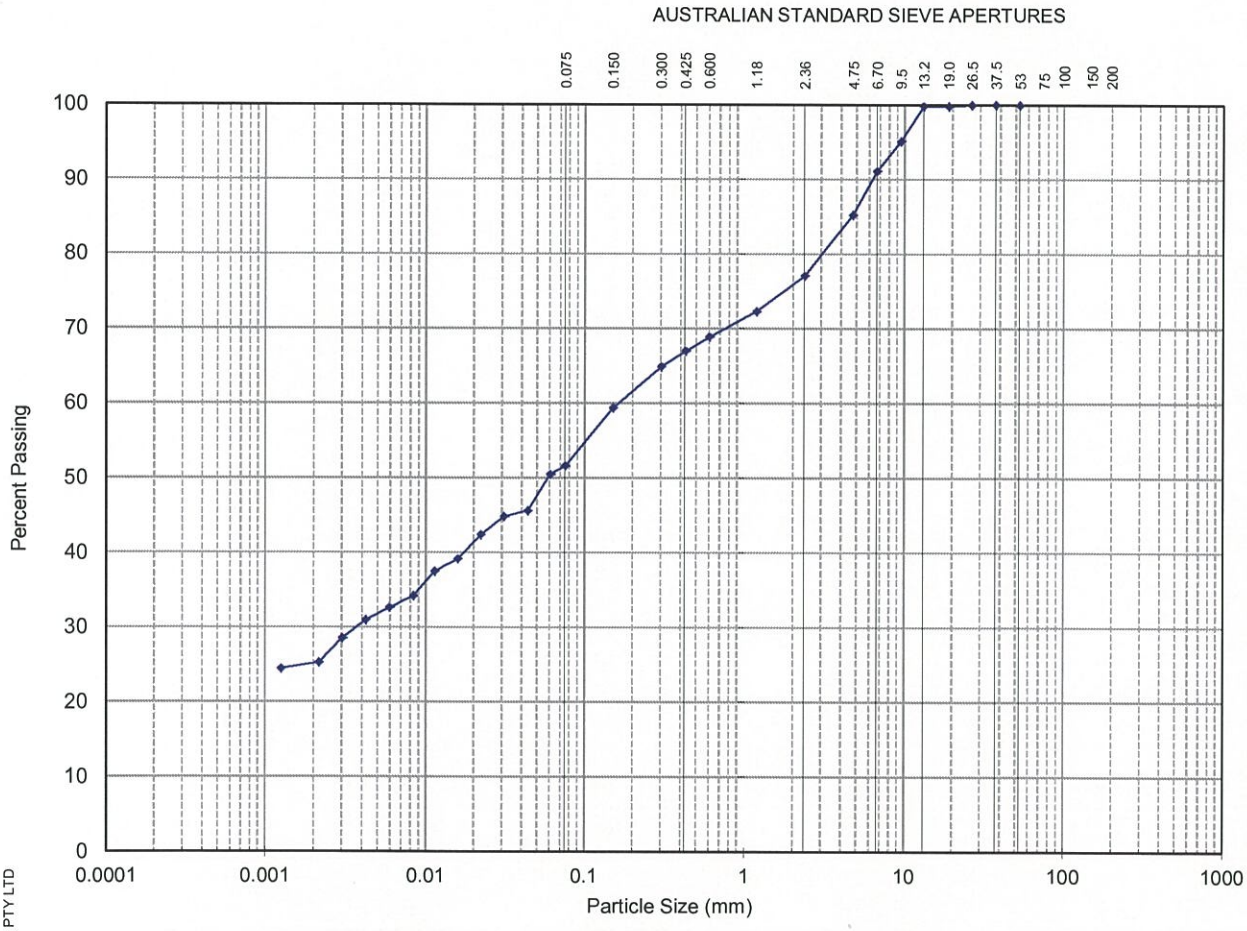
Michael Gref
Senior Soil Technician

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 Particle Size Distribution (Hydrometer)

Client :	Western Sydney University	**Project No. :**	86462
		Report No. :	4
Project :	Bankstown City Campus Development	**Report Date :**	30/7/2018
		Date Sampled:	13-Jul-18
Location :	74 Rickard Road, Bankstown	**Date of Test:**	18-Jul-18
Road No:	- **Sample / Pit No:** BH10	**Depth / Layer:**	0.5 - 1.5m
Chainage:	- **Section / Lot No:** -	**Test Request No:**	
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	100%
37.5	100%
26.5	100%
19.0	100%
13.2	100%
9.5	95%
6.7	91%
4.75	85%
2.36	77%
1.18	72%
0.600	69%
0.425	67%
0.300	65%
0.150	59%
0.075	52%
0.044	46%
0.031	45%
0.022	42%
0.016	39%
0.011	38%
0.008	34%
0.006	33%
0.004	31%
0.003	29%
0.002	25%
0.001	24%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: Orange brown gravelly sandy clayey silt

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Engineering Department

Loss in pretreatment: 0%

Remarks:

Type of Hydrometer: g/l

NATA ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number:828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested:	AH
Checked:	LW

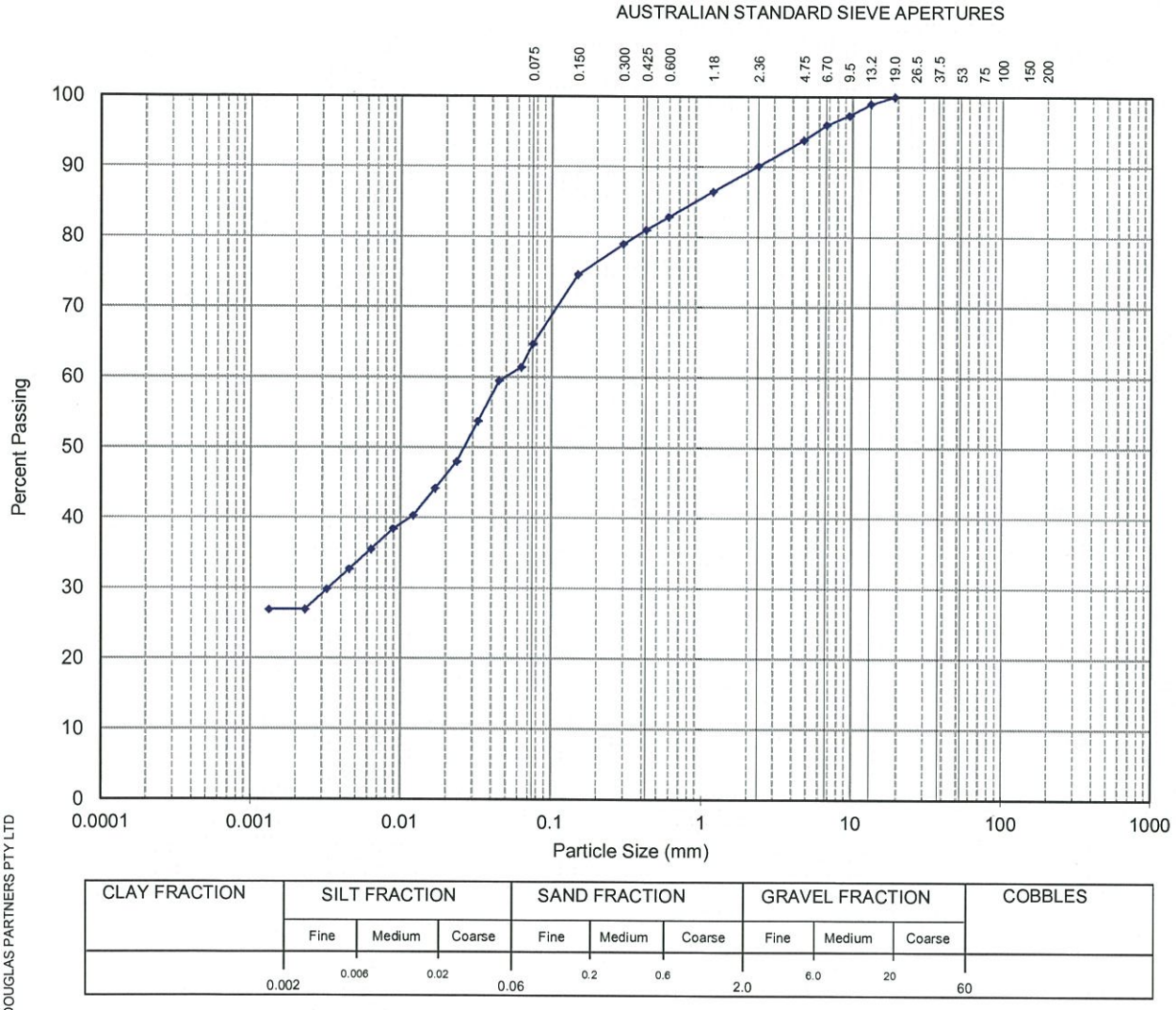
Michael Gref
Senior Soil Technician

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 Particle Size Distribution (Hydrometer)

Client :	Western Sydney University	**Project No. :**	86462
		Report No. :	5
Project :	Bankstown City Campus Development	**Report Date :**	31/7/2018
		Date Sampled:	13-Jul-18
Location :	74 Rickard Road, Bankstown	**Date of Test:**	18-Jul-18
Road No:	- **Sample / Pit No:** BH11	**Depth / Layer:**	0.5 - 1.5m
Chainage:	- **Section / Lot No:** -	**Test Request No:**	
		Page:	1 of 1



Sieve Size (mm)	% Passing
75.0	~
53.0	~
37.5	~
26.5	~
19.0	100%
13.2	99%
9.5	97%
6.7	96%
4.75	94%
2.36	90%
1.18	86%
0.600	83%
0.425	81%
0.300	79%
0.150	75%
0.075	65%
0.045	59%
0.032	54%
0.023	48%
0.017	44%
0.012	40%
0.009	38%
0.006	36%
0.005	33%
0.003	30%
0.002	27%
0.001	27%

CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02		0.06	0.2	0.6	2.0	6.0	20	60

Description: Brown sandy clayey silt with some gravel

Test Method(s): AS 1289.3.6.1, AS1289.3.6.3

Sampling Method(s): Sampled by Engineering Department

Loss in pretreatment: 0%

Remarks:

Type of Hydrometer: g/l

NATA ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number:828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

Tested:	AH
Checked:	LW

Michael Gref
Senior Soil Technician

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 197063

Client Details

Client	Douglas Partners Pty Ltd
Attention	Chamali Nagodavithane
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86462.00, Bankstown**
Number of Samples	4 SOIL
Date samples received	26/07/2018
Date completed instructions received	26/07/2018

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	02/08/2018
Date of Issue	30/07/2018

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

sPOCAS field test					
Our Reference		197063-1	197063-2	197063-3	197063-4
Your Reference	UNITS	BH1	BH2	BH5	BH6
Depth		2.5-2.95	2.5-2.95	2.5-2.95	2.5-2.95
Type of sample		SOIL	SOIL	SOIL	SOIL
Date prepared	-	26/07/2018	26/07/2018	26/07/2018	26/07/2018
Date analysed	-	26/07/2018	26/07/2018	26/07/2018	26/07/2018
pH_F (field pH test)*	pH Units	6.5	8.6	8.1	5.5
pH_{FOX} (field peroxide test)*	pH Units	5.8	7.2	7.8	4.1
Reaction Rate*	-	Slight	Slight	Slight	Moderate

Method ID	Methodology Summary
Inorg-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions.

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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

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.

Miscellaneous Inorganics				
Our Reference		197408-1	197408-2	197408-3
Your Reference	UNITS	BH1	BH4	BH5
Date Sampled		30/07/2018	30/07/2018	31/07/2018
Type of sample		Water	Water	Water
Date prepared	-	31/07/2018	31/07/2018	31/07/2018
Date analysed	-	31/07/2018	31/07/2018	31/07/2018
pH	pH Units	7.4	7.3	7.7
Electrical Conductivity	µS/cm	22,000	21,000	14,000
Sulphate, SO4	mg/L	540	640	590
Chloride, Cl	mg/L	7,200	7,100	4,200

sPOCAS field test				
Our Reference		195910-2	195910-5	195910-6
Your Reference	UNITS	BH3	BH4	BH3
Depth		1.5-1.6	2.4-2.5	2.5-2.95
Date Sampled		10/07/2018	09/07/2018	10/07/2018
Type of sample		SOIL	SOIL	SOIL
Date prepared	-	13/07/2018	13/07/2018	13/07/2018
Date analysed	-	13/07/2018	13/07/2018	13/07/2018
pH_F (field pH test)*	pH Units	8.9	5.4	6.7
pH_{FOX} (field peroxide test)*	pH Units	8.5	4.4	6.4
Reaction Rate*	-	Slight	High	High

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 197063-A

Client Details

Client	Douglas Partners Pty Ltd
Attention	Brendan O'Kane
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86462.00, Bankstown**
Number of Samples	4 SOIL
Date samples received	26/07/2018
Date completed instructions received	03/08/2018

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	10/08/2018
Date of Issue	09/08/2018

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
Nick Sarlamis, Inorganics Supervisor

Authorised By

Jacinta Hurst, Laboratory Manager

sPOCAS + %S w/w		
Our Reference		197063-A-4
Your Reference	UNITS	BH6
Depth		2.5-2.95
Type of sample		SOIL
Date prepared	-	06/08/2018
Date analysed	-	06/08/2018
pH $_{kcl}$	pH units	4.4
TAA pH 6.5	moles H^+ /t	14
s-TAA pH 6.5	%w/w S	0.02
pH $_{Ox}$	pH units	5.2
TPA pH 6.5	moles H^+ /t	15
s-TPA pH 6.5	%w/w S	0.02
TSA pH 6.5	moles H^+ /t	<5
s-TSA pH 6.5	%w/w S	<0.01
ANC_E	% $CaCO_3$	<0.05
a-ANC_E	moles H^+ /t	<5
s-ANC_E	%w/w S	<0.05
S_{KCl}	%w/w S	0.02
S_P	%w/w	0.02
S_{POS}	%w/w	<0.005
a-S_{POS}	moles H^+ /t	<5
Ca_{KCl}	%w/w	<0.005
Ca_P	%w/w	<0.005
Ca_A	%w/w	<0.005
Mg_{KCl}	%w/w	0.10
Mg_P	%w/w	0.14
Mg_A	%w/w	0.040
S_{HCl}	%w/w S	0.027
S_{NAS}	%w/w S	0.010
a-S_{NAS}	moles H^+ /t	<5
s-S_{NAS}	%w/w S	<0.01
Fineness Factor	-	1.5
a-Net Acidity	moles H^+ /t	20
s-Net Acidity	%w/w S	0.03
Liming rate	kg $CaCO_3$ /t	1.5
s-Net Acidity without -ANCE	%w/w S	0.033
a-Net Acidity without ANCE	moles H^+ /t	20
Liming rate without ANCE	kg $CaCO_3$ /t	1.5

SCr		
Our Reference		197063-A-4
Your Reference	UNITS	BH6
Depth		2.5-2.95
Type of sample		SOIL
Date prepared	-	06/08/2018
Date analysed	-	06/08/2018
Chromium Reducible Sulfur	%w/w	<0.005
a-Chromium Reducible Sulfur	moles H^+ /t	<3

Method ID	Methodology Summary
Inorg-064	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: sPOCAS + %S w/w						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/08/2018	[NT]	[NT]	[NT]	[NT]	06/08/2018	[NT]
Date analysed	-			06/08/2018	[NT]	[NT]	[NT]	[NT]	06/08/2018	[NT]
pH $_{kcl}$	pH units		Inorg-064	[NT]	[NT]	[NT]	[NT]	[NT]	90	[NT]
TAA pH 6.5	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	95	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pH $_{Ox}$	pH units		Inorg-064	[NT]	[NT]	[NT]	[NT]	[NT]	98	[NT]
TPA pH 6.5	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	112	[NT]
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TSA pH 6.5	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-ANC_E	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_P	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_{POS}	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-S_{POS}	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ca_P	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ca_A	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Mg_P	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Mg_A	%w/w	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_{HCl}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-S_{NAS}	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-S_{NAS}	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fineness Factor	-	1.5	Inorg-064	<1.5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Net Acidity	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-Net Acidity	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Liming rate	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
s-Net Acidity without -ANCE	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

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

QUALITY CONTROL: SCr						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/08/2018	[NT]	[NT]	[NT]	[NT]	06/08/2018	[NT]
Date analysed	-			06/08/2018	[NT]	[NT]	[NT]	[NT]	06/08/2018	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H^+ /t	3	Inorg-068	<3	[NT]	[NT]	[NT]	[NT]	96	[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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

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.

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 195910-A

Client Details

Client	Douglas Partners Pty Ltd
Attention	Brendan O'Kane
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86462.00, Bankstown**
Number of Samples	6 SOIL
Date samples received	10/07/2018
Date completed instructions received	03/08/2018

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	10/08/2018
Date of Issue	09/08/2018

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
Nick Sarlamis, Inorganics Supervisor

Authorised By

Jacinta Hurst, Laboratory Manager

sPOCAS + %S w/w		
Our Reference		195910-A-5
Your Reference	UNITS	BH4
Depth		2.4-2.5
Date Sampled		09/07/2018
Type of sample		SOIL
Date prepared	-	06/08/2018
Date analysed	-	06/08/2018
pH $_{kcl}$	pH units	4.3
TAA pH 6.5	moles H^+ /t	26
s-TAA pH 6.5	%w/w S	0.04
pH $_{Ox}$	pH units	4.3
TPA pH 6.5	moles H^+ /t	42
s-TPA pH 6.5	%w/w S	0.07
TSA pH 6.5	moles H^+ /t	16
s-TSA pH 6.5	%w/w S	0.03
ANC_E	% $CaCO_3$	<0.05
a-ANC_E	moles H^+ /t	<5
s-ANC_E	%w/w S	<0.05
S_{KCl}	%w/w S	0.02
S_P	%w/w	0.03
S_{POS}	%w/w	0.01
a-S_{POS}	moles H^+ /t	6
Ca_{KCl}	%w/w	0.02
Ca_P	%w/w	0.02
Ca_A	%w/w	<0.005
Mg_{KCl}	%w/w	0.068
Mg_P	%w/w	0.073
Mg_A	%w/w	0.005
S_{HCl}	%w/w S	0.039
S_{NAS}	%w/w S	0.015
a-S_{NAS}	moles H^+ /t	7
s-S_{NAS}	%w/w S	0.01
Fineness Factor	-	1.5
a-Net Acidity	moles H^+ /t	39
s-Net Acidity	%w/w S	0.06
Liming rate	kg $CaCO_3$ /t	3.0
s-Net Acidity without -ANCE	%w/w S	0.063
a-Net Acidity without ANCE	moles H^+ /t	39
Liming rate without ANCE	kg $CaCO_3$ /t	3.0

SCr		
Our Reference		195910-A-5
Your Reference	UNITS	BH4
Depth		2.4-2.5
Date Sampled		09/07/2018
Type of sample		SOIL
Date prepared	-	06/08/2018
Date analysed	-	06/08/2018
Chromium Reducible Sulfur	%w/w	0.005
a-Chromium Reducible Sulfur	moles H^+ /t	<3

Method ID	Methodology Summary
Inorg-064	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL: sPOCAS + %S w/w						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/08/2018	5	06/08/2018	06/08/2018		06/08/2018	[NT]
Date analysed	-			06/08/2018	5	06/08/2018	06/08/2018		06/08/2018	[NT]
pH $_{kcl}$	pH units		Inorg-064	[NT]	5	4.3	4.1	5	90	[NT]
TAA pH 6.5	moles H^+ /t	5	Inorg-064	<5	5	26	26	0	95	[NT]
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	5	0.04	0.04	0	[NT]	[NT]
pH $_{Ox}$	pH units		Inorg-064	[NT]	5	4.3	4.5	5	98	[NT]
TPA pH 6.5	moles H^+ /t	5	Inorg-064	<5	5	42	38	10	112	[NT]
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	5	0.07	0.06	15	[NT]	[NT]
TSA pH 6.5	moles H^+ /t	5	Inorg-064	<5	5	16	11	37	[NT]	[NT]
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	5	0.03	0.02	40	[NT]	[NT]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	5	<0.05	<0.05	0	[NT]	[NT]
a-ANC_E	moles H^+ /t	5	Inorg-064	<5	5	<5	<5	0	[NT]	[NT]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	5	<0.05	<0.05	0	[NT]	[NT]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	5	0.02	0.03	40	[NT]	[NT]
S_P	%w/w	0.005	Inorg-064	<0.005	5	0.03	0.03	0	[NT]	[NT]
S_{POS}	%w/w	0.005	Inorg-064	<0.005	5	0.01	0.007	35	[NT]	[NT]
a-S_{POS}	moles H^+ /t	5	Inorg-064	<5	5	6	<5	18	[NT]	[NT]
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	5	0.02	0.02	0	[NT]	[NT]
Ca_P	%w/w	0.005	Inorg-064	<0.005	5	0.02	0.03	40	[NT]	[NT]
Ca_A	%w/w	0.005	Inorg-064	<0.005	5	<0.005	0.006	18	[NT]	[NT]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	5	0.068	0.071	4	[NT]	[NT]
Mg_P	%w/w	0.005	Inorg-064	<0.005	5	0.073	0.075	3	[NT]	[NT]
Mg_A	%w/w	0.005	Inorg-064	<0.005	5	0.005	<0.005	0	[NT]	[NT]
S_{HCl}	%w/w S	0.005	Inorg-064	<0.005	5	0.039	0.038	3	[NT]	[NT]
S_{NAS}	%w/w S	0.005	Inorg-064	<0.005	5	0.015	0.013	14	[NT]	[NT]
a-S_{NAS}	moles H^+ /t	5	Inorg-064	<5	5	7	6	15	[NT]	[NT]
s-S_{NAS}	%w/w S	0.01	Inorg-064	<0.01	5	0.01	<0.01	0	[NT]	[NT]
Fineness Factor	-	1.5	Inorg-064	<1.5	5	1.5	1.5	0	[NT]	[NT]
a-Net Acidity	moles H^+ /t	5	Inorg-064	<5	5	39	36	8	[NT]	[NT]
s-Net Acidity	%w/w S	0.01	Inorg-064	<0.01	5	0.06	0.06	0	[NT]	[NT]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-064	<0.75	5	3.0	2.7	11	[NT]	[NT]
s-Net Acidity without -ANCE	%w/w S	0.01	Inorg-064	<0.01	5	0.063	0.058	8	[NT]	[NT]
a-Net Acidity without ANCE	moles H^+ /t	5	Inorg-064	<5	5	39	36	8	[NT]	[NT]

QUALITY CONTROL: sPOCAS + %S w/w						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	5	3.0	2.7	11	[NT]	[NT]

QUALITY CONTROL: SCr						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			06/08/2018	5	06/08/2018	06/08/2018		06/08/2018	[NT]
Date analysed	-			06/08/2018	5	06/08/2018	06/08/2018		06/08/2018	[NT]
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	5	0.005	<0.005	0	[NT]	[NT]
a-Chromium Reducible Sulfur	moles H^+ /t	3	Inorg-068	<3	5	<3	<3	0	96	[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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.

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.