PLANS AND DOCUMENTS
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Draft

Updated Report
Additional Slope Stability Assessment
Oxley PDA - Stage 2
Blackheath Road, Oxley

Prepared for
Economic Development Queensland
Project No. 018-118B

23 April 2021

Butler Partners
geotechnical • geo–environmental • groundwater

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Updated Report Additional Slope Stability Assessment
Oxley PDA – Stage 2
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SECTION 1 - INTRODUCTION

1.1 Project

It is understood that Economic Development Queensland (EDQ) is proposing to redevelop the former Oxley Secondary College site in stages by the construction of a residential subdivision and community development and that additional stability assessment of the sloping ground around the eastern perimeter of Stage 2 portion of the overall site was required in 2019 as input to the planning of site development. The proposed Stage 2 development precinct layout, location and extent are indicated approximately in Figure 1.

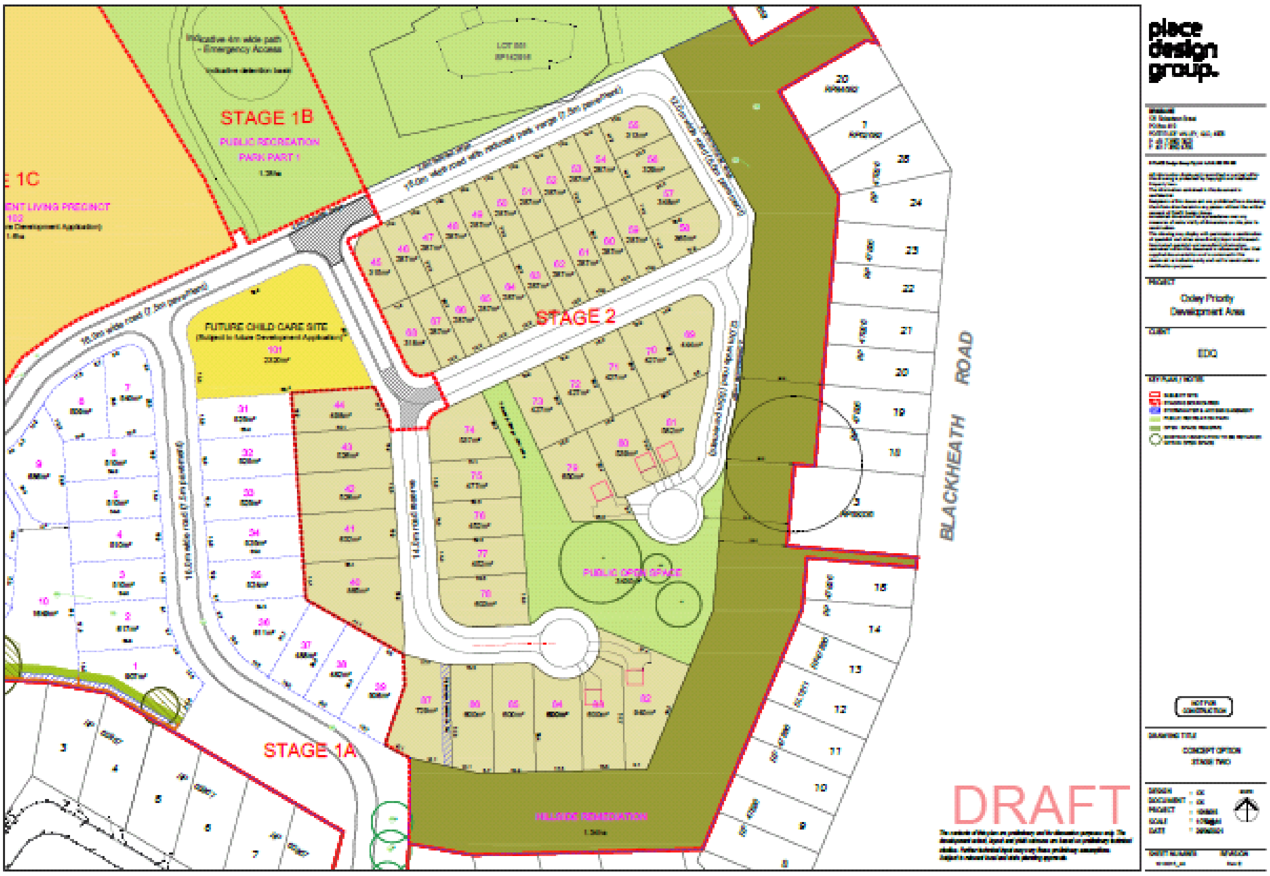

Figure 1: Site location, extent and proposed Stage 2 development area

1.2 Proposed Scope of Work

Based on Butler Partners Pty Ltd's (Butler Partners) prior investigation of the site, it was anticipated that the ground conditions over the eastern sloping areas of Stage 2 would generally comprise a relatively thin surface layer of fill underlain (or exposed from ground surface level), by interbedded layers of firm to hard silty and sandy clay with layers of dense and very dense silty and clayey sands, all underlain by extremely low to low strength sedimentary rock. A relatively shallow depth to groundwater was not anticipated.

It was proposed to undertake an additional slope stability assessment of the sloping ground around the perimeter of the site by the drilling and sampling of five bores to 15m depth (or prior refusal) at accessible locations; a groundwater monitoring well was also proposed to be installed in each bore, to enable groundwater level monitoring over time.

Using the results of the proposed fieldwork, laboratory testing outcomes and the results of previous investigations (conducted at the site), it was proposed that an existing broadscale stability assessment report for the site would be updated in 2019 to provide geotechnical design information on each of the following topics, as appropriate.

- details and descriptions of the existing strata;
- laboratory test results;
- groundwater conditions;
- slope stability calculation results; and
- options for remedial slope stabilisation works, if required.

1.3 Commission

Based on the proposed development and anticipated subsurface conditions, a fee to undertake the additional slope stability assessment of the site was presented in a proposal of 12 December 2018. Butler Partners was subsequently commissioned by EDQ to conduct the investigation as proposed, which has been conducted in consultation with EDQ.

This report was first issued on 26 August 2019 and EDQ required the report to be updated to include the current Stage 2 planning scheme and the results of a groundwater assessment of the overall site and the up to date results of groundwater level monitoring. A proposal to update the report was presented to EDQ on 8 March 2021, who subsequently commissioned the report updating work to be carried out.

SECTION 2 - THE SITE

2.1 Background

2.1.1 Past Investigations

Butler Partners has previously undertaken preliminary geotechnical investigation (in conjunction with a preliminary contamination assessment) of the site, by drilling and sampling fifteen bores to approximately 5m depth. Five bores (Bores 5, 12 to 15) were carried out near the perimeter of the site with groundwater observations made in Bores 1 and 4 during drilling. The results of the preliminary geotechnical investigation are given in the following report:

Preliminary Geotechnical Investigation
Former Oxley Secondary College
Blackheath Road, Oxley
Project No.: 018-118A, Dated: 16 May 2018

Butler Partners has also previously undertaken a broadscale slope stability assessment of the site and the results are contained in the following report:

Broadscale Slope Stability Assessment
Former Oxley Secondary College
Blackheath Road, Oxley
Project No.: 018-118B, Dated: 31 October 2018

Relevant Bore Report sheets from the preliminary geotechnical investigation and from the broadscale slope stability assessment reports are included in Appendix B and relevant factual laboratory test data from the reports are included herein.

This report was previously issued prior to the development of the Stage 2 development plan, as follows:

Additional Slope Stability Assessment
Former Oxley Secondary College
Blackheath Road, Oxley
Project No.: 018-118B, Dated: 26 August 2019

The October 2018 report was superseded by the 2019 report.

2.1.2 Groundwater Assessment

A groundwater assessment has been undertaken of the Stage 1A site and the results are included in the following report:

Groundwater Assessment
Oxley PDA – Stage 1A
Blackheath Road, Oxley
Project No.: 018-118D, Dated: 15 September 2020

The groundwater assessment model used for Stage 1A covered the full Oxley PDA site and the model was subsequently interrogated to assess the potential effects on groundwater levels in the Stage 2 area.

2.1.3 Slope Analysis Results

Bornhorst + Ward Pty Ltd (B+W) undertook an analysis of the site slopes to categorise them into the following slope ranges:

15° to 18°;
18° to 21°;
21° to 25°; and
>25°.

The results of the B+W analysis are indicated by coloured shading on Drawing No. 1, attached.

2.2 Site Description

The site is located in Cliveden Avenue, close to the intersection with Blackheath Road. At the time of the current investigation, the site was partially fenced and demolition of the former Oxley Secondary College was in progress. The previously developed areas were surrounded by a variably moderate to heavy cover of medium to tall trees, with grass undergrowth. The eastern and southern boundaries of the site contained large natural slopes with overall slope angles varying between 5° and 10° and up to 20° in localised areas. The ground surface level across the site is highly variable and non-uniform and varied at the current bore locations between RL19.0m (Bores 25 and 29) and RL26.5m (Bore 27).

An aerial view of the site taken on 4 November 2018 is given in Photograph 1, with the approximate site boundary outlined in red and two panoramic views of the site taken at the time of the additional investigation are given in Photograph 2 and Photograph 3.

Photograph 1: An aerial view of the overall site on 4 November 2018. Source: NearMap

A number of the existing (off-site) properties located along the eastern boundary of the Stage 2 site (along Blackheath Road) appear to have had fill placed along some sections of their rear (western) boundaries to ‘level’ the sites. Concentrated surface water flow zones also emanate from several of the properties.

A detailed walk-over inspection of the Stage 2 site slopes by senior experienced geotechnical engineers and a (non-stereo) inspection of aerial photographs of the site did not reveal any indications of any significant instability over the area. Several small zones that appeared to comprise very shallow topsoil 'creep' were identified, which were generally located in areas of concentrated surface water flow and are considered to be a result of the saturation of the surface topsoil materials.

Several depressions (referred to as 'sink-holes' by others) were noted on the slopes, generally in the vicinity of old service lines etc.

Photograph 2: Panoramic view of the site looking south-east to west from near Bore 20

Photograph 3: Panoramic view of the site looking north-east to south-east from near Bore 28

2.3 Geology

An extract of the Geological Survey of Queensland's 1:31,680 geological series City of Brisbane sheets is given in Figure 2 (with the approximate site boundary indicated in red). The geology map indicates that the eastern side of the site is mapped in an area of Tertiary deposits of the Corinda Formation (comprising mudstone, shale with minor sandstone and limestone); the western side of the site is mapped in an area of Triassic deposits of Moorooka Formation (comprising massive siliceous conglomerate, sandstone and minor shale); and an intrusion is mapped of Quaternary deposits (comprising alluvial sand, silt, mud, clay and gravel) onto a small section of the north-western section of the site.

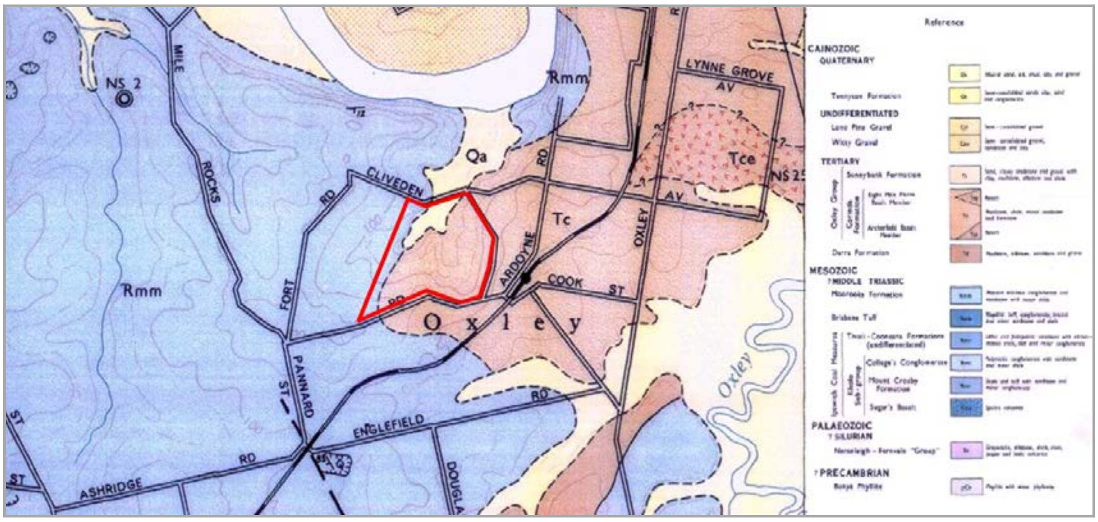

Figure 2: Extract from the 1:31,680 Geological Survey of Queensland – City of Brisbane map

2.4 Landslide History

2.4.1 Brisbane City Council – Landslide Overlay

The relevant section of Brisbane City Council's (BCC) Landslide overlay map 1:22,000 sheets is reproduced in Figure 3, which indicates that the sloping ground encountered around the perimeter of the site (along Seventeen Mile Rocks and Blackheath Roads) are landslide susceptible areas, in accordance with the requirements of the State Planning Policy (SPP). The indicated landslide risk areas are located in areas mapped as Corinda Formation in the 1:31,680 City of Brisbane geology map (Figure 2).

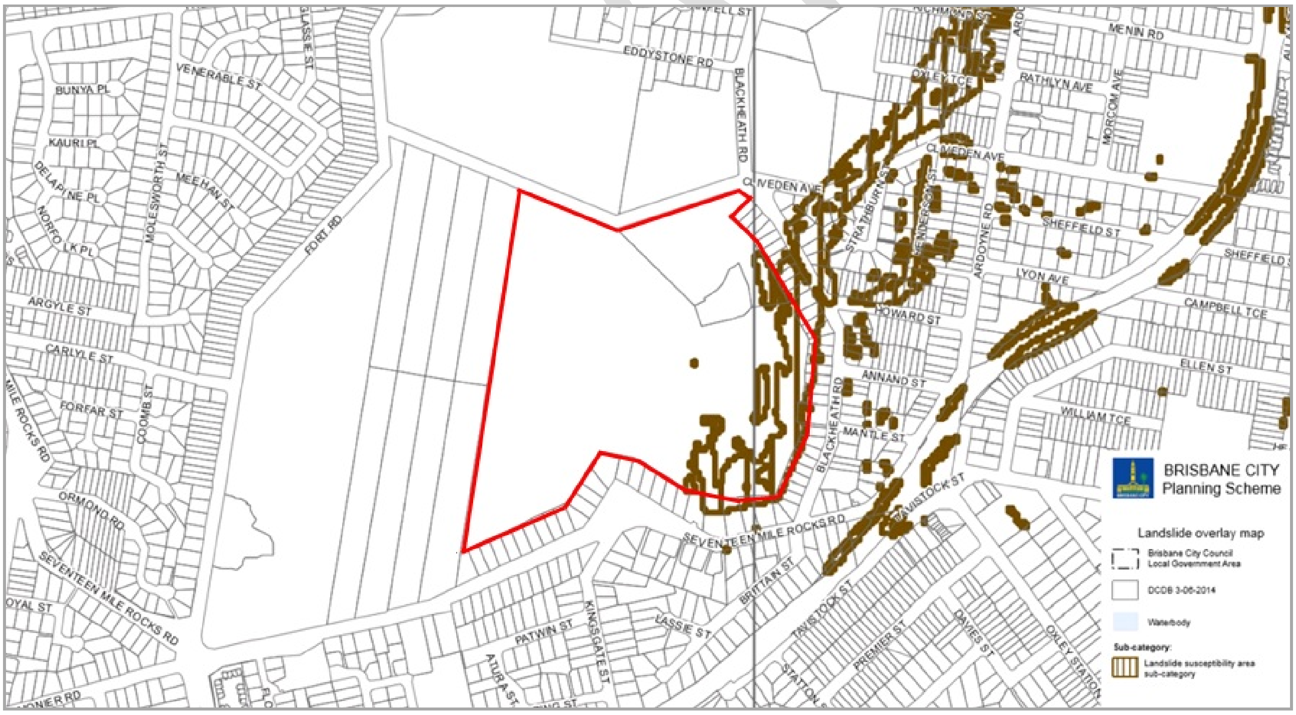

Figure 3: Extract from the BCC Landslide Overlay Map, with approximate site boundary indicated in red and landslide susceptibility areas indicated in brown

2.4.2 Past Landslides

It is understood that past significant landslides have previously occurred within the Corinda Formation (and overlying soils) along Seventeen Mile Rocks Road, in the vicinity of the site.

Hoffman and Willmott (1984)[1] note that "*the prime cause of slope failure is excessive pore pressure in interbedded, inclined claystone and sandstone beds in the Tertiary units….* (due to) *….. infiltration of extra water (for example by earthworks, pipe trenches, garden watering, etc.) into permeable layers within the slope, or from compacting of soil at the toe of the slope thus prohibiting natural seepage into drainage channels. Most significant, however, is the rise of the water table, and pore pressure, when the natural forest cover of an area is cleared. Loss of root support also directly reduces the effective strength of the soil."*

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[1] Hoffman, G.W. & Willmott, W.F., 1984: "Landslide Susceptibility of Natural Slopes in the City of Brisbane" Department of Natural Resources, Mines and Water 1984/10

SECTION 3 - FIELDWORK

3.1 Drilling and Sampling Methods

The 2019 investigation comprised the drilling and sampling of five additional bores (Bores 25 to 29) to between 15.1m and 15.4m depth, with a truck mounted Hydrapower Scout drilling rig. All bores were initially drilled using solid flight augers to approximately 3.0m depth, then extended using washboring methods, with drill fluid circulation for cuttings removal. Strata identification was based on inspection of cuttings recovered on the augers, supplemented with inspection of disturbed Standard Penetration test (SPT) and 'undisturbed' 50mm diameter tube samples, recovered at selected depths. Hand 'pocket' penetrometer readings were taken in the ends of the tube samples to assist with strength classification in cohesive soils.

3.2 Groundwater Monitoring Wells

A standpipe groundwater monitoring well was installed in each of Bores 25 to 29 at the completion of drilling; construction details for the wells are indicated on the relevant Bore Report sheets. Groundwater monitoring wells had previously been installed in Bore 21 as part of previous geotechnical investigation of the overall site.

3.3 Bore Locations and Supervision

The bores were set out in the field by direct measurement from existing site features and their approximate locations are indicated on Drawing No. 1 (attached). The approximate ground surface level at each bore location was estimated by interpolation between contours given on a plan supplied by EDQ.

An experienced geotechnical engineer set out the bore locations, logged the subsurface profiles, determined the insitu sampling and testing program and supervised the fieldwork.

SECTION 4 - INVESTIGATION RESULTS

4.1 Subsurface Conditions

The subsurface conditions encountered in the bores are given on Bore Report sheets included in Appendix A, using classification and descriptive terms defined in accompanying notes (which are based on Australian Standard AS1726-1993). It should be noted that the rock types indicated on the Bore Report sheets are based on visual assessment only; no petrographic analysis has been undertaken for confirmation.

For a description of the subsurface conditions encountered at the current bore locations (Bores 25 to 29) and previously drilled bores (Bores 5, 12 to 21), the Bore Report sheets should be consulted. However, in broad summary the subsurface conditions encountered in the bores generally comprised a surface layer of topsoil to between 0.2m and 0.7m depth in all bores except Bores 14, 18, 27 to 29, where fill was encountered to between 0.2m and 7.0m depth. The fill (probably uncontrolled) encountered in Bore 18 comprises silty clays that essentially have the same appearance as the natural soils, and it was therefore very difficult to distinguish the fill from the natural soils. As a result, the depth of fill indicated in the Bore Report sheet for Bore 18 should be considered as approximate only and subject to confirmation.

The topsoils and fill were underlain by interbedded layers of firm to hard silty/sandy clay and dense to very dense clayey sand. The clays and weathered mudstone contained some zones of slickensides. The soils were underlain in turn (at twelve locations) by extremely low to very low strength sandstone/mudstone/siltstone (rock) below 8.5m and 15.0m depth approximately. A layer of extremely low strength mudstone/siltstone/sandstone was encountered at between 2.5m and 9.0m depth in Bores 15, 17, and 26 to 28. It should be noted that 'harder' rock may exist close below bore termination depths and at shallower depth elsewhere on the site.

'Strength inversions' (i.e. 'weaker' material underlying 'stronger' material) were encountered in several bores (e.g. stiff silty clay underlying very stiff silty clay at 7.0m depth in Bore 18 and at 2.5m depth in Bore 20; very stiff silty clay underlying hard silty clay at 10m depth in Bore 20, at 5.5m depth in Bore 21 and at 6.0m in Bore 26; firm to stiff sandy clay underlying stiff sandy clay at 3.0m depth in Bore 27).

As a guide to stratigraphic interpretation at the site, a section (Section 1-1) has been drawn through selected bores and the section is presented in Drawing No. 2, attached.

4.2 Groundwater

Free groundwater was only encountered during the drilling of Bores 1, 4, 17 and 18 (during previous investigations) at the depths/reduced levels given in Table 1. The use of water/mud circulation for cuttings removal during the drilling of Bores 20, 21 and 25 to 29 precluded groundwater observations during drilling at these locations. Groundwater observations made (after well development) in the groundwater monitoring well previously installed in Bores 21, and the wells installed during the 2019 investigation in Bores 25 to 29 are also given in Table 1.

It should be noted that groundwater levels can vary seasonally and with prevailing weather (and vegetation) conditions. If a significant time elapses following this investigation and/or following significant 'wet' weather, it would be prudent to confirm groundwater levels.

Table 1: Groundwater Observations During Auger Drilling and Subsequently in the Monitoring Wells

Bore/ Well	Groundwater Observations																		
	Depth (m)																		
	2018	2019							2020						2021				
	27 Sep	19 Feb	12 Mar	20 Mar+	8 May	20 May	5 Jul++	11 Jul	7 Feb+	10Mar++	17 Mar	29 Jun	31 Jul	10 Aug	5 Feb	12 Feb**	24 Mar**	8 Apr**	15 Apr
17	10.0 [RL7.1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	7.0 [RL31.1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	9.9 {RL4.6}	9.8 [RL4.7]	9.8 [RL4.7]	9.9 [RL4.6]	9.8 [RL4.7]	10.0 [RL4.5]	10.1 [RL4.4]	–	3.1* [RL11.4]	7.1 [RL7.4]	10.1 [RL4.4]	10.1 [RL4.4]	10.1 [RL4.4]	10.1 [RL4.4]	–	10.1 [RL4.4]	2.8 [RL11.7]	7.5 [RL7.0]	10.2 [RL4.3]
25	–	12.3 [RL6.7]	12.3 [RL6.7]	12.3 [RL6.7]	12.3 [RL6.7]	12.5 [RL6.5]	12.5 [RL6.5]	12.8 [RL6.2]	12.6 [R:6.4]	12.7 [RL6.3]	12.6 [RL6.4]	12.6 [RL6.4]	12.5 [RL6.5]	12.5 [RL6.5]	12.5 [RL6.5]	12.6 [RL6.4]	12.6 [RL6.4]	12.6 [RL6.4]	12.8 [RL6.2]
26	–	12.9 [RL7.6]	13.0 [RL7.5]	RL12.6 [RL7.9]	12.9 [RL7.6]	13.3 [RL7.2]	13.4 [RL7.1]	13.3 [RL7.2]	13.2 [RL73]	14.1 [RL6.4]	14.0 [RL6.5]	13.6 [RL6.9]	13.6 [RL6.9]	13.8 [RL6.7]	13.6 [RL6.9]	14.2 [RL6.3]	13.2 [RL7.3]	13.3 [RL7.2]	13.4 [RL7.1]
27	–	14.8 [RL11.7]	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	–	–	–	–	14.6 [RL11.9]	14.8 [RL11.8]	14.9 [RL11.6]
28	–	12.2 [RL12.8]	12.0 [RL13.0]	12.0 [RL13.0]	12.0 [RL13.0]	11.9 [RL13.1]	11.9 [RL13.1]	11.8 [RL13.2]	12.2 [RL12.8]	13.1 [RL11.9]	13.0 [RL12.0]	12.3 [RL12.7]	12.2 [RL12.8]	12.6 [RL12.4]	–	12.1 [RL12.9]	13.1 [RL11.9]	13.0 [RL12.0]	12.9 [RL12.1]
29	–	–	11.7 [RL7.3]	10.5 [RL8.5]	10.6 [RL8.4]	10.9 [RL8.1]	12.4 [RL6.6]	11.4 [RL7.6]	14.0 [RL5.0]	7.3 [RL11.8]	9.5 [RL9.5]	–	–	–	Destroyed				

+ After significant rainfall over the previous week; ++ Following a period of prolonged (generally light) rainfall; * Possibly surface water seeping into groundwater well/bore; ** After rain

The long term monitoring of Wells 21 and 25 to 29 indicates two instances of measured 'shallow' groundwater depths in Well 21; 3.1m (on 7 February 2020) and 2.8m (on 24 March 2021). In order to confirm if the monitoring well was correctly recording groundwater depths, a pressure transducer was installed in Wells 21 and 26, just after a period of intense and heavy rainfall. The time-groundwater depth readings from the two monitoring wells are shown in Figure 4 and the results are considered to indicate that Well 21 is not providing reliable groundwater level information and 'shallow' depth readings should be ignored. It is considered likely that surface water seepage is somehow entering the well.

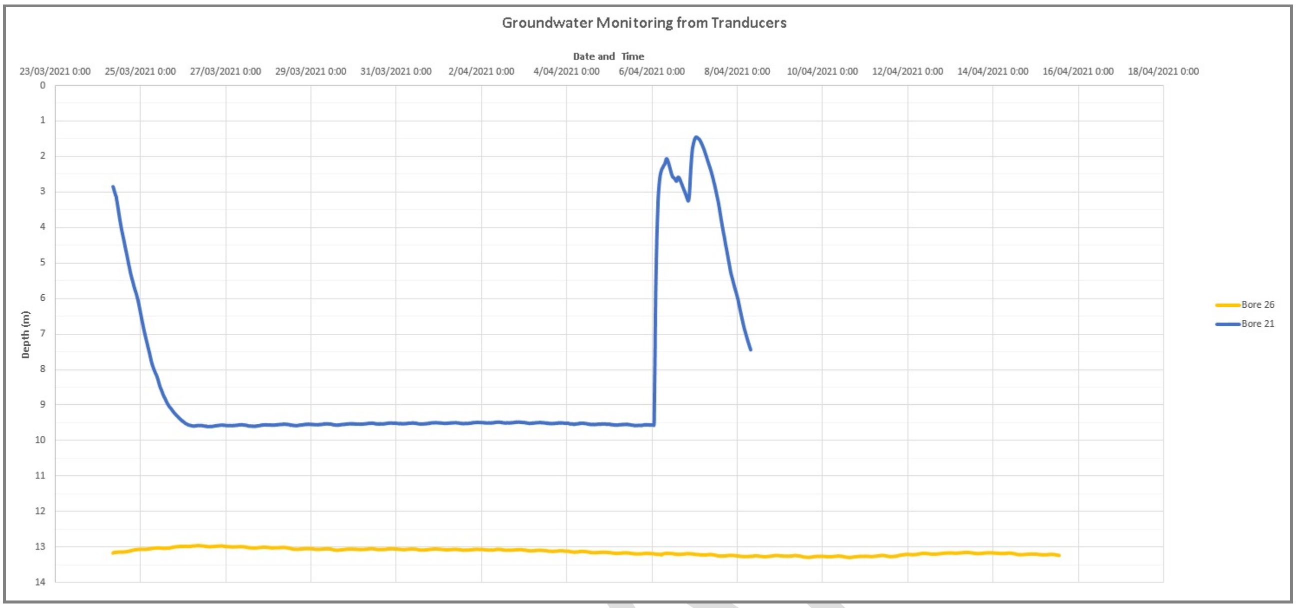

Figure 4: Continuous Groundwater Depth Monitoring in Wells 21 and 26

4.3 Laboratory Testing

Selected soil and fill samples were tested in one of Ground Testing Services Pty Ltd's (GTS) NATA endorsed geotechnical testing laboratories (using Australian Standard AS2870 testing methods) to determine erosion and sediment control parameters, particle size distribution, plasticity, and triaxial strength. The test results are summarised in the following sections and laboratory test report sheets are included in Appendix C; the results of relevant previous laboratory test results from earlier investigation/assessment reports are also included for completeness.

It should be noted that sample descriptions provided in the laboratory results summary tables (and the laboratory test result sheets) are based on the inspection of each individual laboratory test sample only. No allowance has been made in sample descriptions for sampling, sub-sampling or test methodology in determination of the mass material properties. Estimates of mass material properties are provided on each individual Bore Report sheet and as such, the laboratory test results should be read in conjunction with the relevant report sheets.

4.3.1 Dispersion Potential

Eleven selected samples recovered from the bores were tested to determine Emerson Class Number (ECN), pH and electrical conductivity and a summary of the reported test results is presented in Table 2. The results of the Emerson Class Number testing indicate that the samples tested had a potential for dispersion varying between low (i.e. ECN = 4) and high (i.e. ECN = 2).

Table 2: Summary of Erosion and Sediment Control Parameters Test Results

Bore	Depth (m)	Sample Description	Emerson Class No.	pH	Electrical Conductivity (mS/cm)
16	0.5 – 0.95	Silty Clay	3	4.3	-
17	0.5 – 0.95	Silty Clay	4	4.5	-
	4.5 – 4.95	Silty Clay	2	5.3	-
18	0.5 – 0.95	Silty Clay	3	4.1	-
19	0.5 – 0.95	Silty Clay	4	4.6	-
20	0.5 – 0.95	Silty Clay	2	4.5	-
21	1.5 – 1.95	Silty Clay	2	4.6	-
25	0.5 – 0.95	Silty Clay	4	4.2	0.09
26	0.5 – 0.95	Silty Clay	4	4.5	0.05
27	1.5 – 1.95	Sandy Clay	3	4.4	0.21
28	0.5 – 0.95	Fill - Sandy Clay	3	4.4	0.04

4.3.2 Particle Size Distribution

Four samples of soil recovered from the bores were tested for measurement of particle size distribution using wash sieve grading techniques, and the reported results are summarised in Table 4.

Table 3: Summary of Particle Size Distribution Test Results

Bore	Depth (m)	Sample Description	Sample Moisture Content (%)	Gravel Fraction(1) (%)	Sand Fraction(2) (%)	Silt and Clay Fraction(3) (%)
17	9.0 – 9.05	Clayey Sand	4.7	12	75	13
19	4.5 – 4.95	Clayey Sand	10.0	0	60	40
27	0.5 – 0.95	Sandy Clay	12.4	1	23	76
28	0.5 – 0.95	Fill – Sandy Clay	10.4	3	25	72

4.3.3 Plasticity

Seventeen samples of silty/sandy clay and weathered rock recovered from the bores were tested for measurement of plasticity using Atterberg limits and linear shrinkage test methods. The test results are summarised in Table 4, together with the sample classifications and an estimate of the drained internal friction angle (ϕ') for each sample, inferred from a published correlation with plasticity[2]. The plasticity test results indicate that the samples tested varied between relatively low and high plasticity.

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[2] Gibson, R.E. (1953), *Experimental determination of the true cohesion and true angle of internal friction in clays*, Proc 3rd I.C.S.M.F.E., Zurich, pp126 - 130

Table 4: Summary of Plasticity Test Results and Correlations

Bore	Depth (m)	Sample Description	Sample Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Classification*	Inferred Drained Friction Angle	
									Peak (ø’) (degrees)$^+$	Residual (ø’$_r$) (degrees)$^+$
16	3.0 – 3.45	Silty Clay	18.3	58	14	44	14.5	CH	23	16
	4.5 – 4.95	Silty Clay	20.1	64	18	46	17.0	CH	23	16
17	4.5 – 4.95	Silty Clay	14.8	42	15	27	12.0	CI	26	20
18	4.5 – 4.95	Silty Clay	28.5	52	23	29	12.0	CH	25	20
	7.5 – 7.95	Silty Clay	29.3	32	15	17	6.0	CI	30	23
19	3.0 – 3.45	Silty Clay	11.3	51	21	30	12.0	CH	25	19
20	1.5 – 1.95	Silty Clay	20.9	69	15	54	18.0	CH	22	15
	3.0 – 3.45	Silty Clay	26.4	73	20	53	20.0	CH	22	15
	10.5 – 10.95	Silty Clay	31.8	73	24	49	19.0	CH	22	16
21	1.5 – 1.95	Silty Clay	36.4	95	24	71	24.5	CH	20	12
25	4.5 – 4.95	Silty Clay	16.2	43	14	29	11.0	CI	26	20
26	7.5 – 7.95	Silty Clay	27.1	87	28	59	21.0	CH	21	14
27	1.5 – 1.95	Sandy Clay	15.1	52	15	37	7.0	CH	24	17
	6.0 – 6.45	Silty Clay	14.3	47	14	33	11.0	CI	25	18
29	4.5 – 4.95	Silty Clay	22.8	47	22	25	10.0	CI	26	20
	7.5 – 7.95	Silty Clay	24.2	49	17	32	15.0	CI	25	18
	12.0 – 12.43	Siltstone XW	18.4	43	18	25	10.5	XW	26	20

* Australian Standard AS1726 – 1993 *Geotechnical site investigation*; $^+$ Estimated from a published correlation with plasticity index

The average values of the inferred drained strengths values given in Table 4 are as follows:

Average Inferred Peak Strength (ø’)	:	24 degrees
Average Inferred Residual Strength (ø’$_r$)	:	18 degrees

4.3.4 Drained Shear Strength

4.3.4.1 Triaxial Shear

Four ‘undisturbed’ samples of silty clay recovered from Bores 18, 20, 25 and 26 were tested for measurement of ‘effective’ shear strength using a staged, consolidated, undrained triaxial test method with pore pressure measurement and a summary of the reported results is presented in Table 5.

Table 5: Reported Triaxial Test Results

Bore	Sample Depth (m)	Sample Description	Sample Moisture Content (%)	Effective Shear Strength Parameters	
				c' (kPa)	ϕ' (degrees)
18	7.5 – 7.95	Silty Clay	31.3	23	23
20	1.5 – 1.95	Silty Clay	19.1	17	27
25	4.5 – 4.95	Silty Clay	16.3	11	27.5
26	7.5 – 7.95	Silty Clay	27.0	8	28.5

4.3.4.2 Direct Shear

Two ‘undisturbed’ samples of silty clay recovered from Bores 16 and 27 were tested in direct shear to assess ‘effective’ shear strength using staged, consolidated, direct shear test methods and a summary of the test results is presented in Table 6.

Table 6: Reported Direct Shear Results

Bore	Depth (m)	Sample Description	Sample Moisture Content (%)	Effective Shear Strength Parameters	
				c' (kPa)	ϕ' (degrees)
16	4.5 – 4.95	Silty Clay	17.9	18	23
27	6.0 – 6.45	Silty Clay	14.5	27	37

4.3.4.3 Average Peak Effective Friction Angle Values

The approximate average value of the measured drained effective strength friction angle values given in both Table 5 and Table 6 is 28 degrees, which is approximately 4 degrees higher than the average inferred peak drained friction angle (refer Section 4.3.3).

SECTION 5 - GEOTECHNICAL COMMENTS

5.1 Ground Model

The results of geotechnical investigation indicate that the current bores located on the sloping sections of the site generally indicated a surface layer of topsoil to between 0.3m and 0.7m depth in all but four bores, where (probably uncontrolled) fill was encountered to between 0.2m and 1.0m depth and potentially up to 7.0m depth at one particular location. However, the deep fill comprised silty clays that essentially had the same appearance as the natural soils and it was very difficult to distinguish the fill from the natural soils; the estimated depth of fill should be considered as approximate only and subject to confirmation.

The topsoil and fill were underlain by interbedded layers of firm to hard sandy/silty clay and dense to very dense clayey sand to depths between 8.5m and 13.2m, which contained strength inversions. The soils were underlain in turn by extremely low to very low strength sandstone/mudstone/siltstone (rock). Free groundwater was observed between 12.2m and 14.8m depth in the monitoring wells installed during the current investigation and between 2.3m and 10.9m depth in earlier bores. The groundwater level would be expected to vary in depth with season, prevailing weather conditions and vegetation/trees.

5.2 Landslide Susceptibility

A number of known landslides has previously been reported in the vicinity of the site (predominantly within the Corinda Formation), reportedly (generally) linked to an increase of pore water pressure within the soil and rock generally occurring after significant heavy rain events, poor drainage channels and surface water infiltration into slopes (i.e. service trenches, garden watering, roof drainage pipes discharging to the ground behind the crest of slopes, etc.). Other factors contributing to the development of landslides may be associated with localized zones of reduced soil shear strength (i.e. fissures/slickensides within the near surface clays), erosion, and clearing of vegetation and loss of root support over existing slopes.

It would be important to adopt proper design and construction techniques for the proposed site redevelopment, to prevent similar issues occurring.

5.3 Sinkholes

Based on visual observations made on site and the results of the ECN testing (refer Table 2), it is considered that the ‘sinkholes’ reported for the site are likely to have resulted from zones of dispersive soils being located close to areas of past disturbance (e.g. service trenches etc.) and dispersing/eroding under the influence of free water flow through trench backfill, concentrated surface water flow zones etc.

It will be important to adopt proper design and construction techniques for the proposed site redevelopment, to prevent similar issues occurring.

5.4 Slickensides

Slickensides were encountered in the silty clays and weathered mudstone in eight bores at the site at between 6.0m and 15.0m depth and the potential for long term strength reduction effects from fissures/slickensides have been considered in the stability analysis by reducing the effective stress soil strength parameters for the clay soils; no extensive zones of fissures/slickensides have been detected in the investigation work conducted to date, so the strength reduction adopted for the stability analysis is considered to provide conservative results (i.e. a lower factor of safety than is actually the case).

5.5 Existing Fill

It is not known whether the existing fill material at the site is 'controlled' (i.e. it is not known whether the fill has been placed and uniformly compacted to an appropriate engineering specification). If the existing fill is required to support settlement sensitive elements of future development (e.g. services etc.) supporting documentation should be obtained and checked to confirm that the fill has been placed in a controlled manner to a specification that is appropriate for the proposed development. If documentation does not exist (or the specification used for filling is not appropriate) then it is suggested that the existing fill be assumed to be uncontrolled.

If the fill cannot be shown to be controlled, then consideration should be given to the potential for adverse variation to exist in both the composition and degree of compaction of the fill. The presence of voids within uncontrolled fill as well as potential soft/loose zones or inclusions of deleterious materials may lead to potentially significant future total and differential settlements, occurring possibly over relatively short distances.

5.6 Slope Stability Assessment

5.6.1 Acceptable Factor of Safety

It is typical to adopt minimum calculated Factor of Safety (FOS) values in the range of 1.4 to 1.5 under 'long term' conditions and in the range of 1.2 to 1.3 under 'short term' (construction type or varying groundwater level etc.) conditions, depending on the level of uncertainty in input parameters. Where detailed investigation has been carried out and applied loads are well defined, a FOS at the low end of the range could be considered, however, as the degree of uncertainty in parameters, geometry, applied loads, groundwater conditions and variability increases the acceptable FOS limit from slope stability analysis should increase.

5.6.2 Geometry

Stability analysis of the sloping ground around the eastern perimeter of the site has been carried out using four approximate cross-sections taken through selected locations near Bores 16, 18, 19 and 25, based on ground surface contours given on survey information provided by EDQ and the investigation results undertaken by Butler Partners.

The ground surface profiles selected for the analysis generally represent the typical slope profiles encountered around the perimeter of the site (ranging from 5 to 21 degrees). Very localised areas of sloping ground with steeper angles (greater than 25 degrees) have been identified at the site.

Table 7: Approximate Range of Slope Angles Assessed

Bore	Bornhorst & Ward's Slope Analysis Range	Approximate Range of Slope Angles Through Cross-Section
16	from 15° to 18°	10° to 17°
18	less than 15°	5° to 19°
19	less than 15°	8° to 21°
25	from 15° to >25°	14° to 19°

5.6.3 Stability Assessment Model

The slope stability analysis was undertaken using the commercially available geotechnical analysis software Slope/W, which uses limit equilibrium methods to calculate a minimum FOS on slope stability. The analyses were carried out were based on the following assumptions:

- adoption of four slope geometries based on survey information provided by EDQ;
- subsurface profiles based on the results of current and previous bores;
- Mohr-Coulomb strength model for soils;
- strength parameters based on the results of the strata strengths encountered at the current and previous bore locations and the results of laboratory testing;
- three groundwater levels (2m, 4m and 6m below ground surface level from crest to toe); and
- ‘long term’ analysis carried out using effective stress soil strength parameters in cohesive strata.

No building loads or slope modifications (e.g. cuts/fill etc.) have been incorporated into the analyses. If building loads, slope modification works etc. are proposed, additional stability analysis will be required to confirm that the proposed works do not adversely affect slope stability.

5.6.4 Adopted Material Properties and Subsurface Profiles

The ‘long term’, effective soil strength parameters are summarised in Table 8. The peak strength friction angle value of 24 degrees adopted for the stability analyses has been based on the average inferred value from Table 4 and is less than the average value obtained from the triaxial and direct shear tests.

As some of the clays and weathered mudstone encountered at site have been found to contain slickensides, a separate ‘long term’ analysis case has been undertaken to assess the potential effects if any zones of significant slickensides exist. The analysis was based on the assumption that the very stiff to hard clays are slickensided and has been carried out adopting a drained residual friction angle of 18 degrees for these clays, which is the average of the inferred residual friction angle values given in Table 4.

Table 8: Summary of Material Properties Adopted for Analysis

Bore	Layer	Material	Unit Weight (kN/m^2)	Long Term Drained Parameters		
				Cohesion – c’ (kPa)	Peak Friction Angle (ø’) (degrees)	Residual Friction Angle ($ø'_r$) (degrees)
16	1	Fill*	21	3	25	-
	2	Stiff Clay	19	0	24	-
	3	Very stiff Clay	19	0	24	18
	4	Hard Clay	19	0	24	18
	5	Extremely Low Strength Mudstone	20	5	25	-
18	1	Clay Fill*	19	0	24	-
	2	Clay Fill*	19	0	24	-
	3	Stiff Clay	19	0	24	-
	4	Very stiff Clay	19	0	24	18
	5	Extremely Low Strength Mudstone	20	5	25	-
19	1	Stiff Clay	19	0	24	-
	2	Very stiff Clay	19	0	24	18
	3	Dense Clayey Sand	21	0	33	-
	4	Hard Clay	19	0	24	18
	5	Extremely Low Strength Mudstone	20	5	25	-
25	1	Stiff Clay	19	0	24	-
	2	Very stiff Clay	19	0	24	18
	4	Hard Clay	19	0	24	18
	5	Extremely Low Strength Mudstone	20	5	25	-

* Assumed to be controlled; to be confirmed

The slope profile and stratigraphy adopted for each of the four sections anlaysed are given in Figure 5 to Figure 8.

It should be carefully noted that at the location of Bore 18, the fill was <u>assumed</u> to be controlled for the purpose of the stability analysis; if the existing fill is uncontrolled, a lower FOS value would apply to this location.

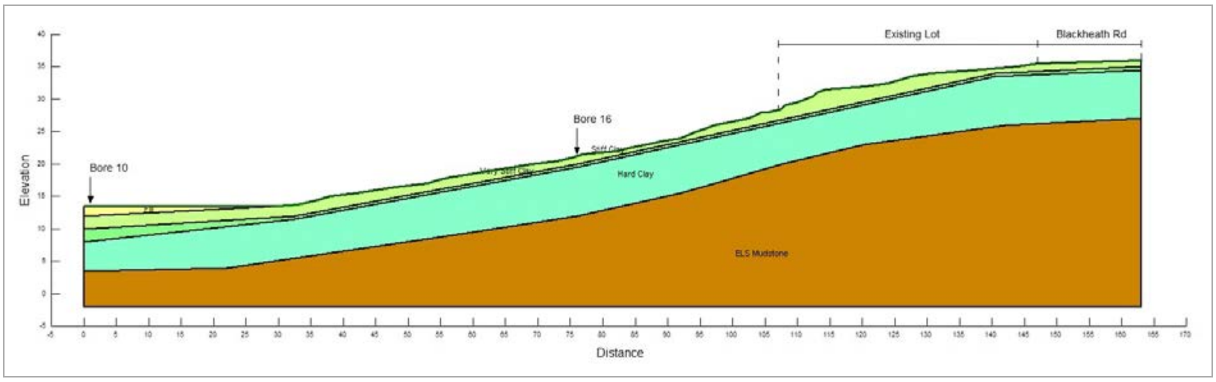

Figure 5: Adopted slope profile and stratigraphy of section near Bore 16

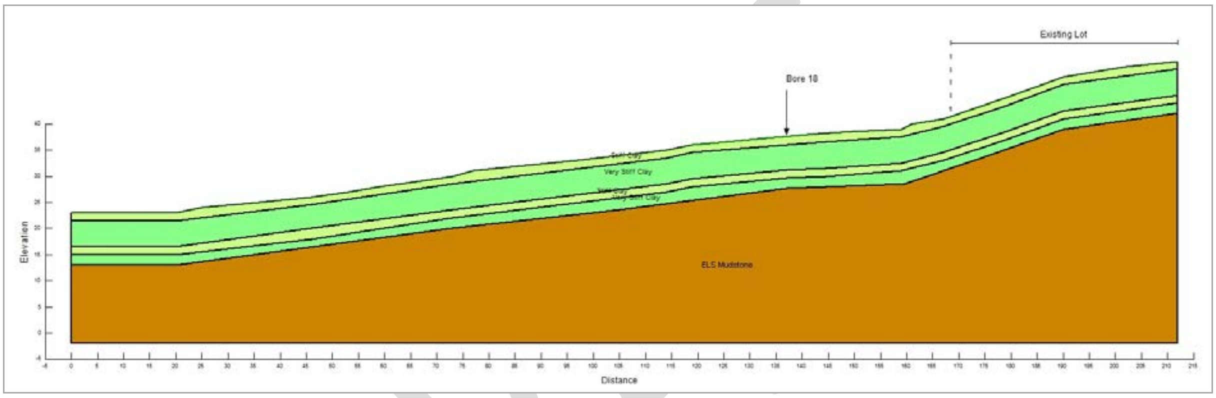

Figure 6: Adopted slope profile and stratigraphy of section near Bore 18

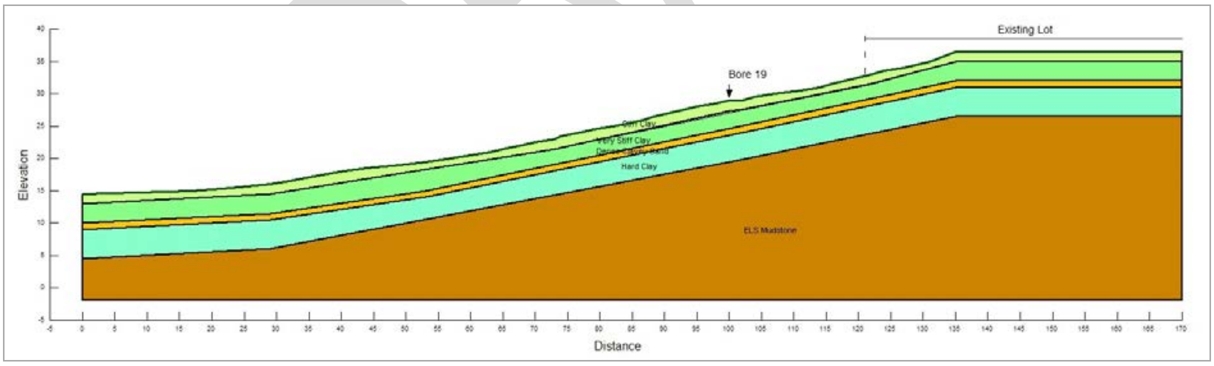

Figure 7: Adopted slope profile and stratigraphy of section near Bore 19

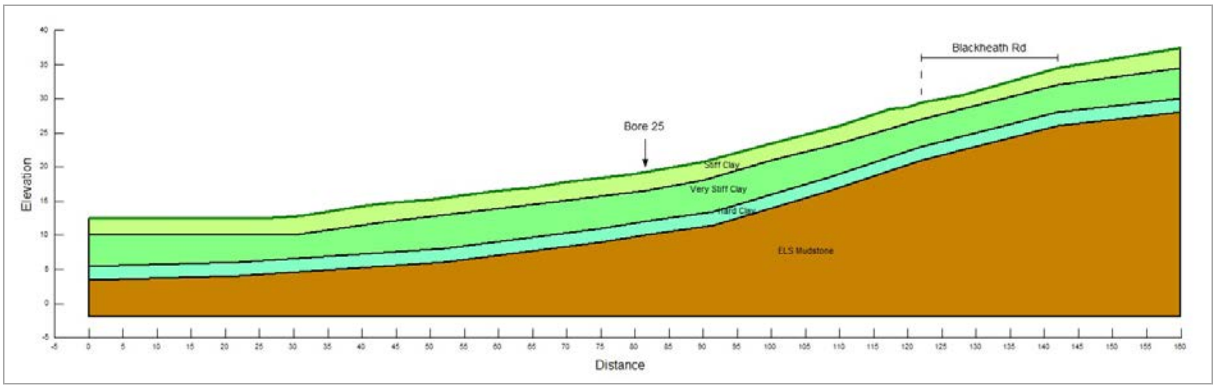

Figure 8: Adopted slope profile and stratigraphy of section near Bore 25

5.6.5 Analysis Results – Peak Strength

For the analysis conducted to date, an automated search of potential circular failure surfaces was carried out to assess the failure surface with the lowest calculated FOS and the results are given below.

5.6.5.1 Groundwater Depth – 2m

The results of the analysis for each slope profile, with the groundwater level at 2m below the ground surface, are presented graphically in Figure 9 to Figure 12 and show the failure surface with the lowest calculated FOS, for each analysis conducted.

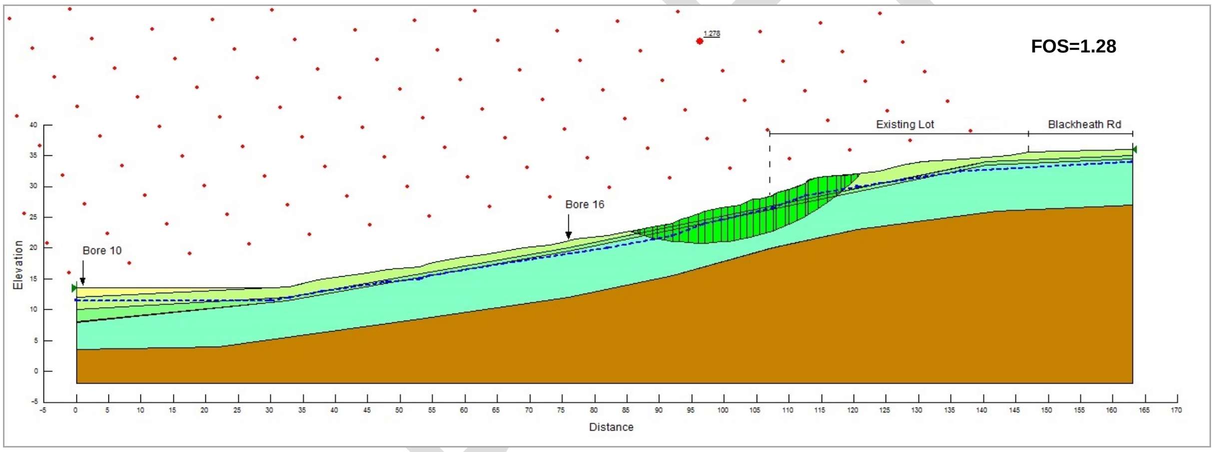

Figure 9: 'Long term' analysis of natural slope profile near Bore 16 (with 2m deep groundwater)

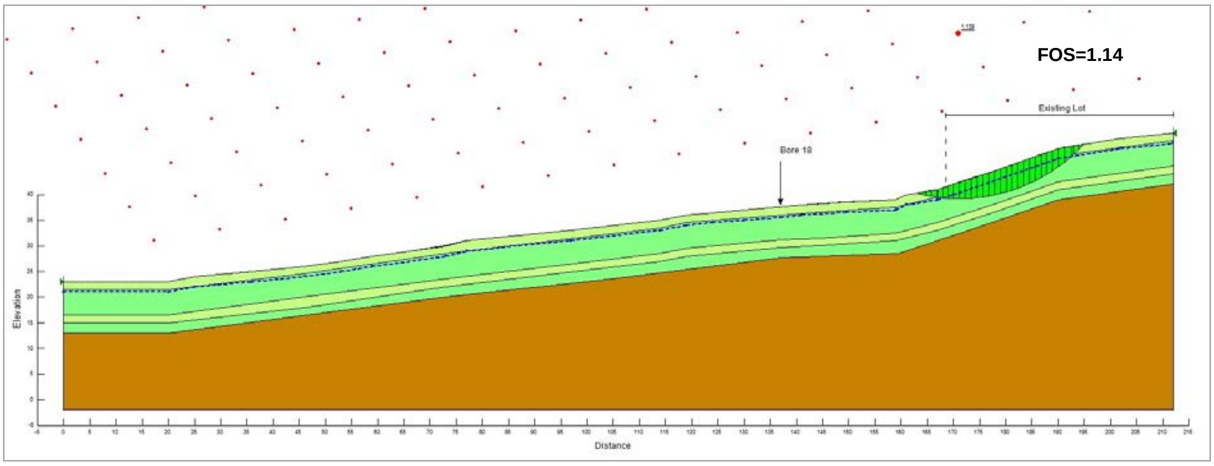

Figure 10: 'Long term' analysis of natural slope profile near Bore 18 (with 2m deep groundwater)

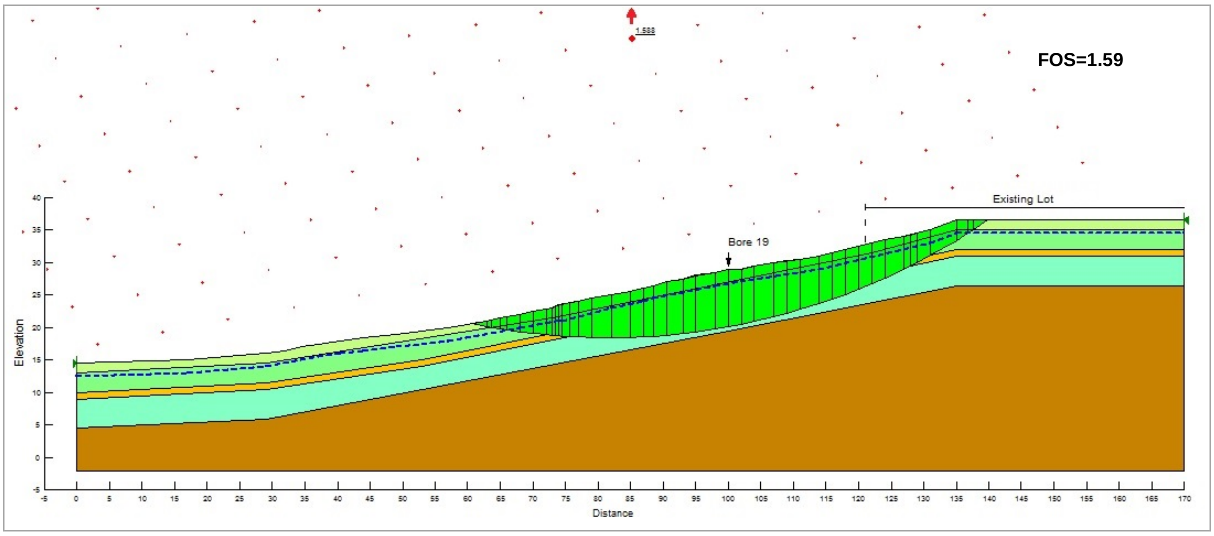

Figure 11: ‘Long term’ analysis of natural slope profile near Bore 19 (with 2m deep groundwater)

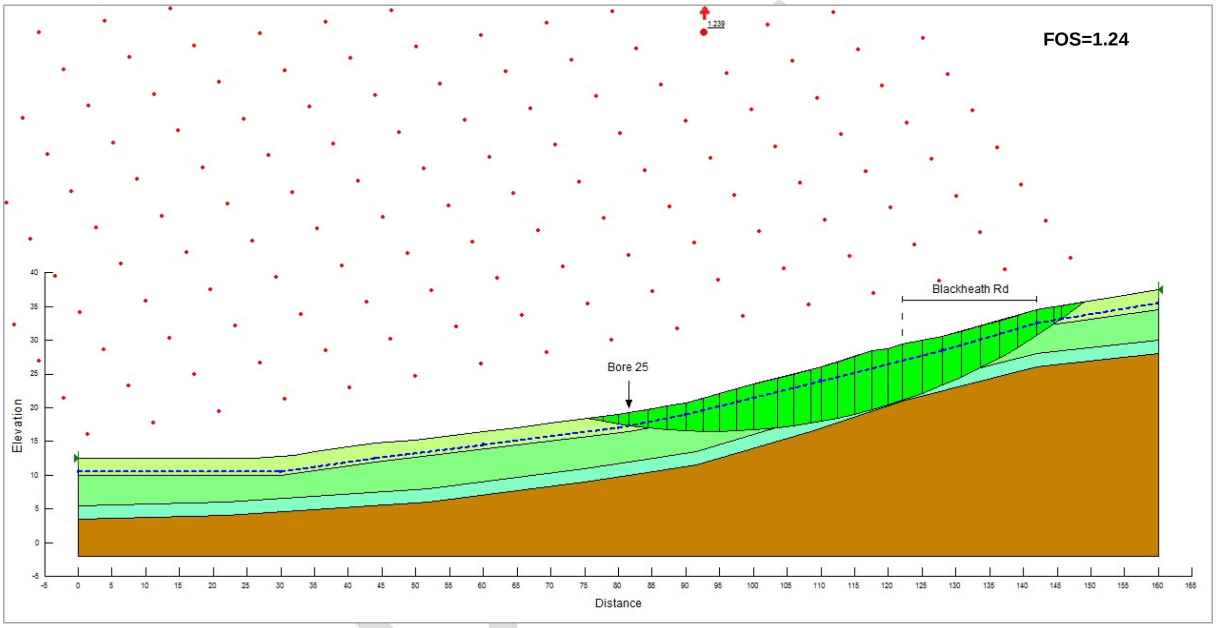

Figure 12: ‘Long term’ analysis of natural slope profile near Bore 25 (with 2m deep groundwater)

5.6.5.2 Groundwater Depth – 4m

The results of the analysis for each slope profile, with the groundwater level at 4m below the ground surface, are presented graphically in Figure 13 to Figure 16 and show the failure surface with the lowest calculated FOS, for each analysis conducted.

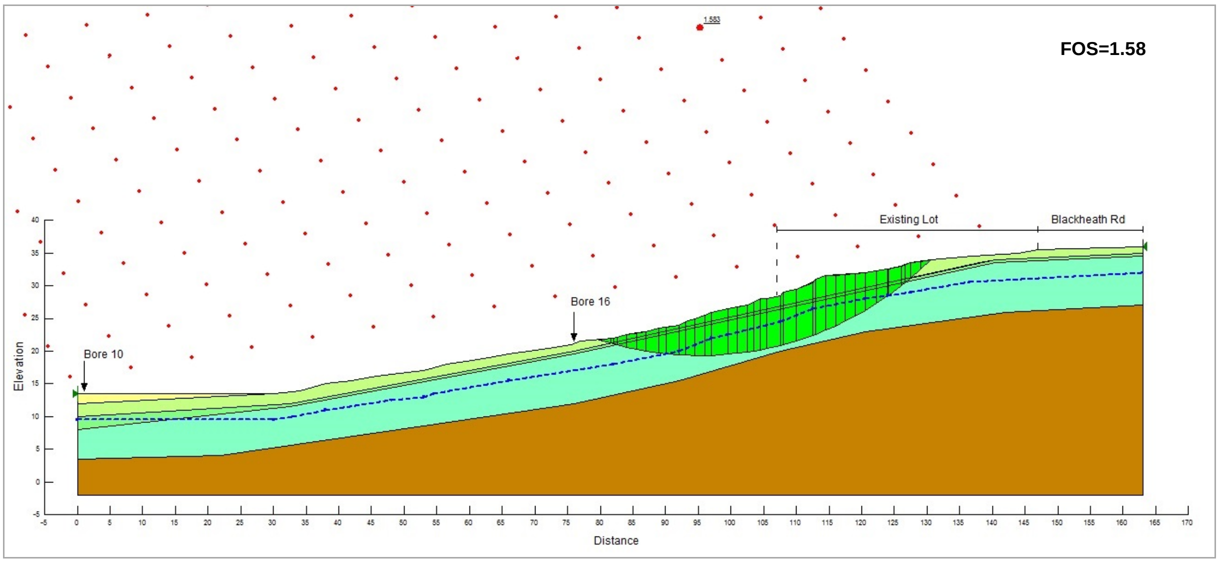

Figure 13: 'Long term' analysis of natural slope profile near Bore 16 (with 4m deep groundwater)

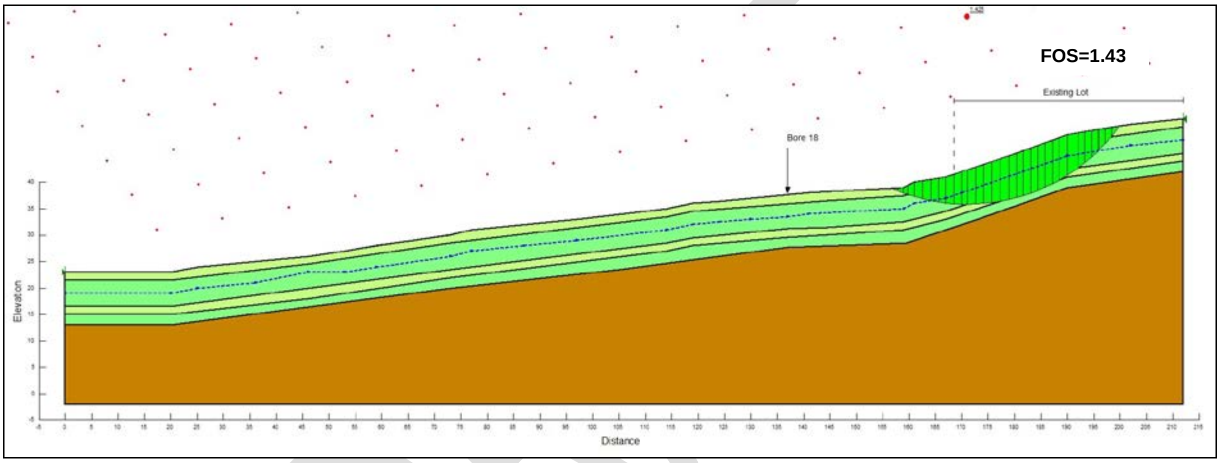

Figure 14: 'Long term' analysis of natural slope profile near Bore 18 (with 4m deep groundwater)

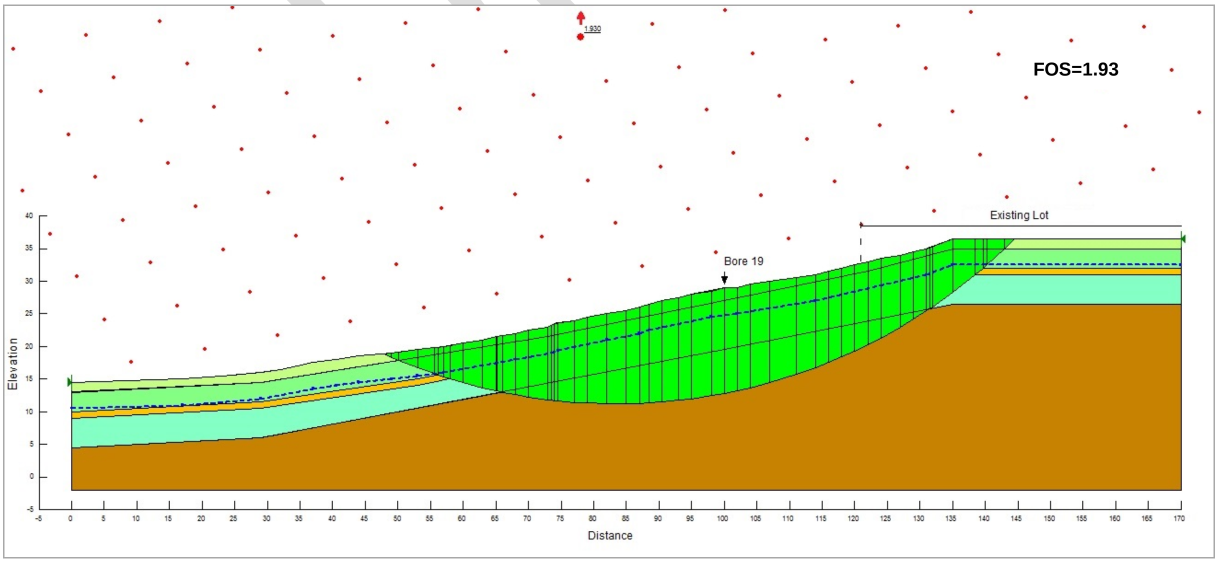

Figure 15: 'Long term' analysis of natural slope profile near Bore 19 (with 4m deep groundwater)

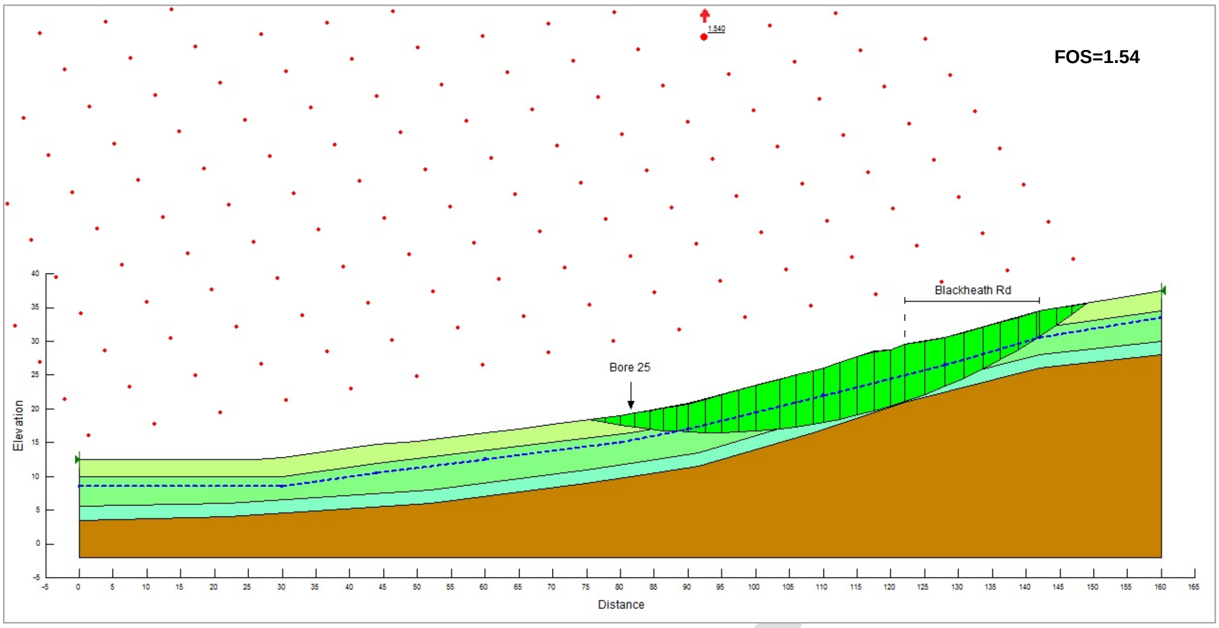

Figure 16: ‘Long term’ analysis of natural slope profile near Bore 25 (with 4m deep groundwater)

5.6.5.3 Groundwater Depth – 6m

The results of the analysis for each slope profile, with the groundwater level at 6m below the ground surface, are presented graphically in Figure 17 to Figure 20 and show the failure surface with the lowest calculated FOS, for each analysis conducted.

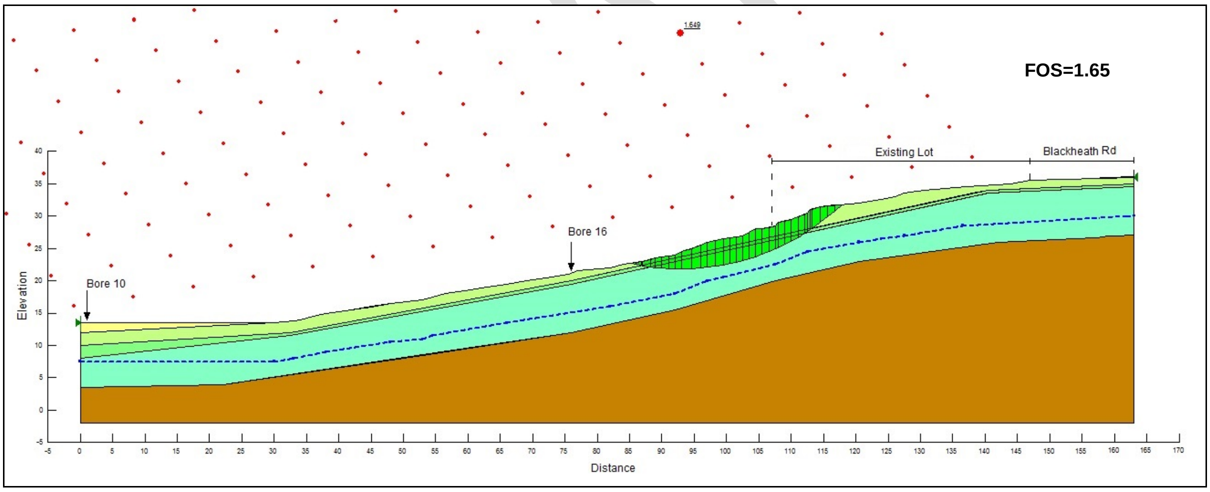

Figure 17: ‘Long term’ analysis of natural slope profile near Bore 16 (with 6m deep groundwater)

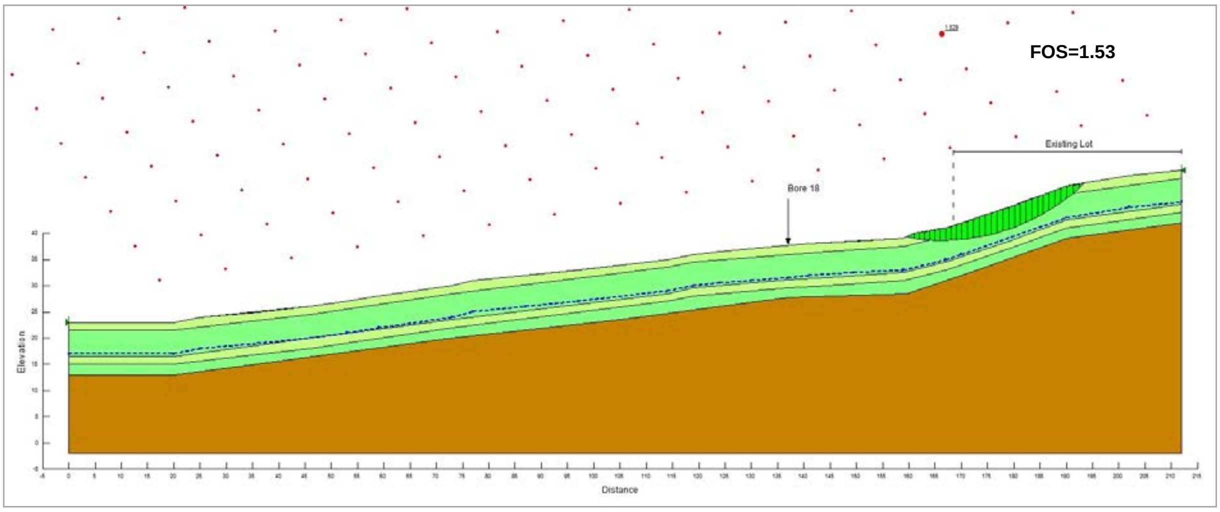

Figure 18: 'Long term' analysis of natural slope profile near Bore 18 (with 6m deep groundwater)

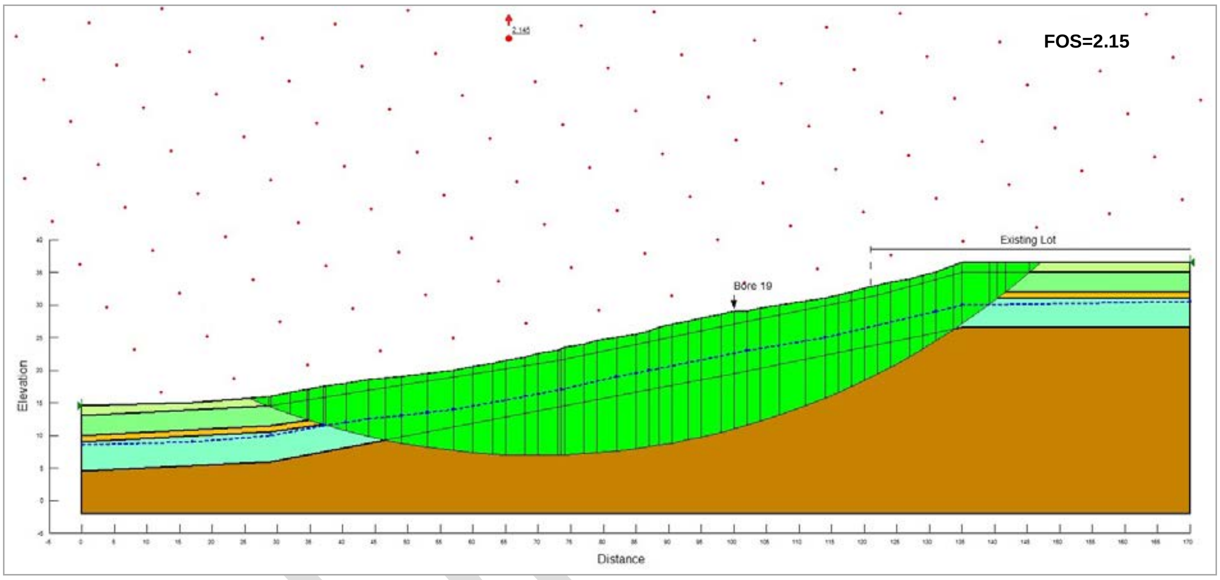

Figure 19: 'Long term' analysis of natural slope profile near Bore 19 (with 6m deep groundwater)

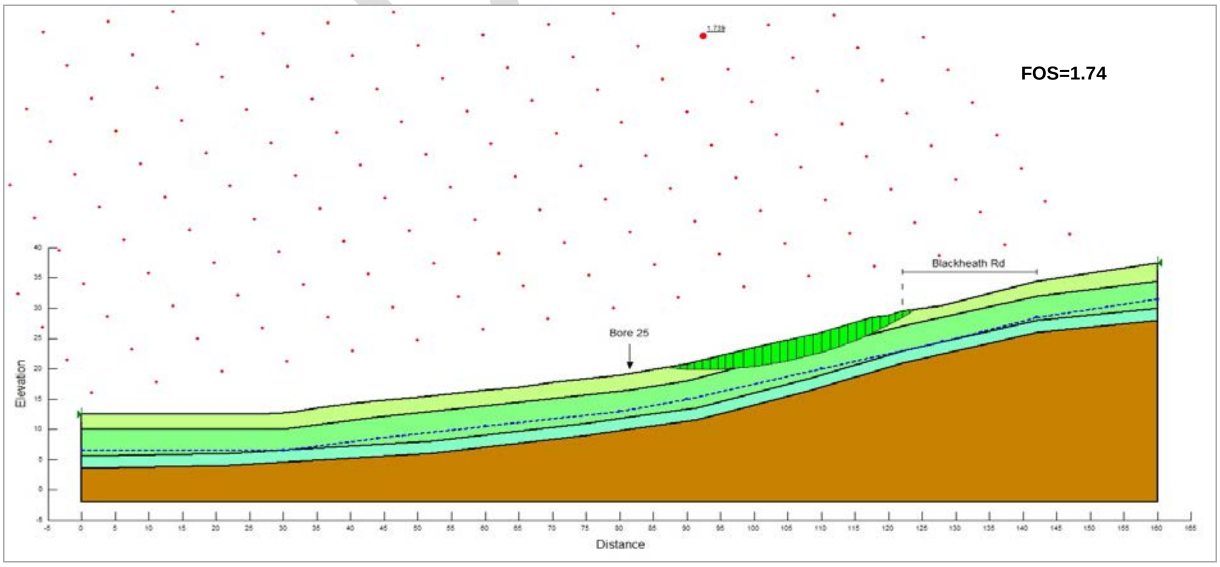

Figure 20: 'Long term' analysis of natural slope profile near Bore 25 (with 6m deep groundwater)

5.6.5.4 Results Summary

The results of all peak strength stability analyses conducted are summarised in Table 9.

Based on the results of the investigation sample inspection, fissures/slickensides were encountered in some of the samples recovered but, from the samples taken, there did not appear to be extensive zones of fissures/slickensides and no indications of past slope failures have been observed on site. However, if extensive zones of fissures/slickensides are present within the soils in an area(s) of the site, their presence could have an adverse effect on slope stability and stability analysis was conducted assuming that extensive zones of fissures/slickensides exist to estimate their potential effect on slope stability.

Each of the analyses carried out using peak strengths for groundwater depths of 2m, 4m and 6m have been reanalysed, using residual strength values as indicated in Table 8 and the results are summarised in Table 9.

Table 9: Summary of Calculated Minimum FOS Values for Long Term Conditions

Description	**Lowest Calculated FOS (Long Term)**		
	Groundwater at 2m Below Ground Surface	**Groundwater at 4m Below Ground Surface**	**Groundwater at 6m Below Ground Surface**
Analysis of natural slope profile near Bore 16	1.28 [0.94]*	1.58 [1.16]*	1.65 [1.24]*
Analysis of natural slope profile near Bore 18	1.14 [0.86]*	1.43 [1.09]*	1.53 [1.15]*
Analysis of natural slope profile near Bore 19	1.59 [1.21]*	1.93 [1.47]*	2.15 [1.63]*
Analysis of natural slope profile near Bore 25	1.24 [0.93]*	1.54 [1.15]*	1.74 [1.32]*

* Minimum FOS values using residual strength parameters

It should be noted that the stability analysis results summarised in Table 9 do not include any allowance for future building load or slope modification works (e.g. cut etc.).

5.7 Stability of Near Surface (Saturated) Soils

Stability analysis of saturated near surface soils has been undertaken for the four sections previously discussed to identify potential instability within the near surface materials during intense rainfall and the results of the analysis for each slope profile, are presented graphically in Figure 21 to Figure 24 and show the failure surface with the lowest calculated FOS.

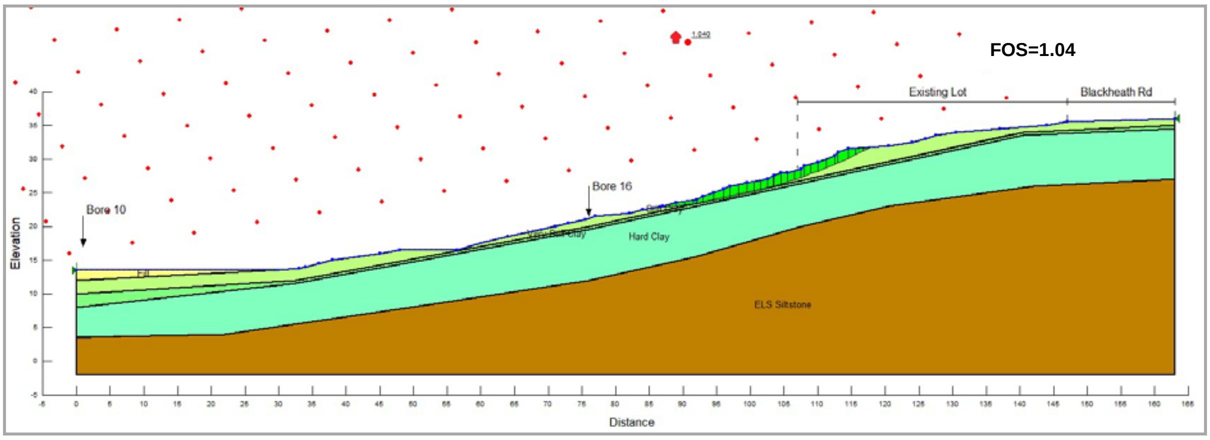

Figure 21: Analysis of near surface soils for the slope profile near Bore 16

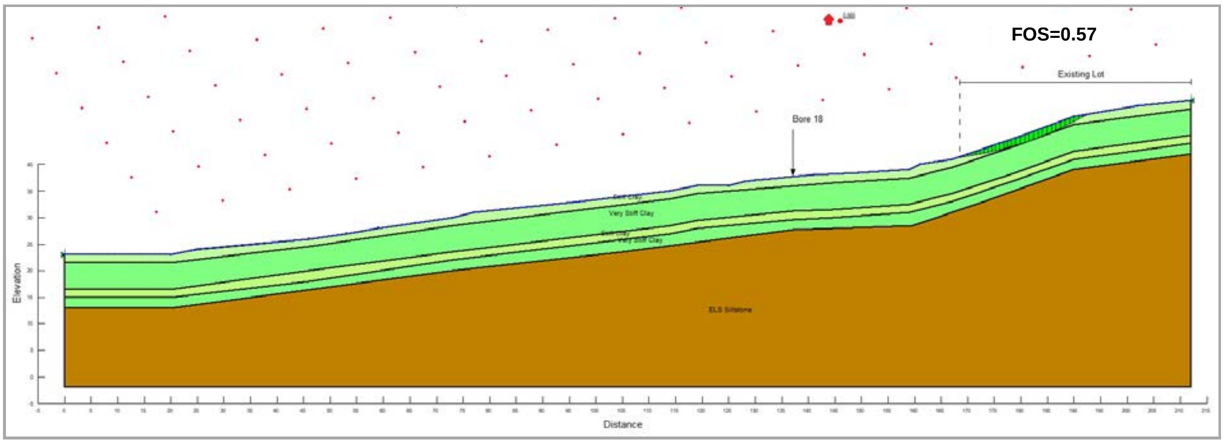

Figure 22: Analysis of near surface soils for the slope profile near Bore 18

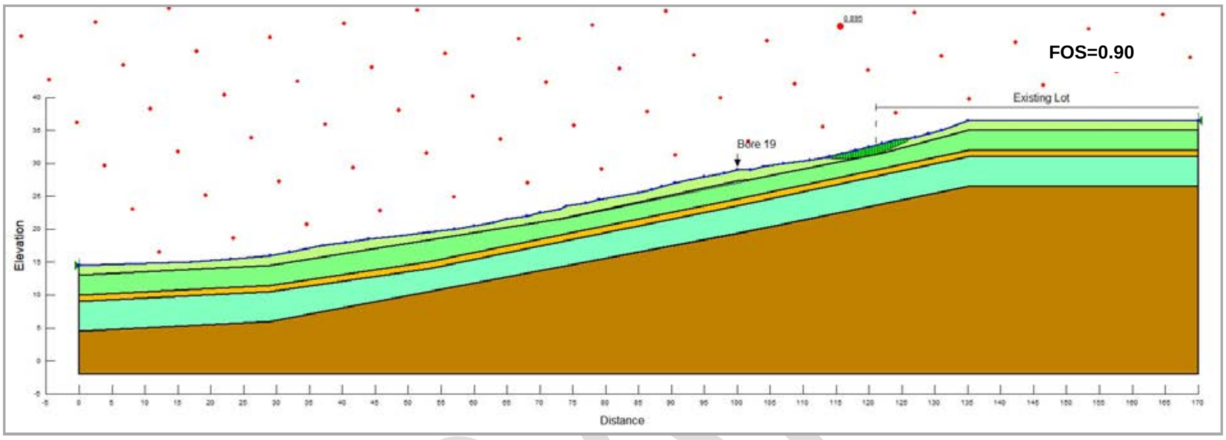

Figure 23: Analysis of near surface soils for the slope profile near Bore 19

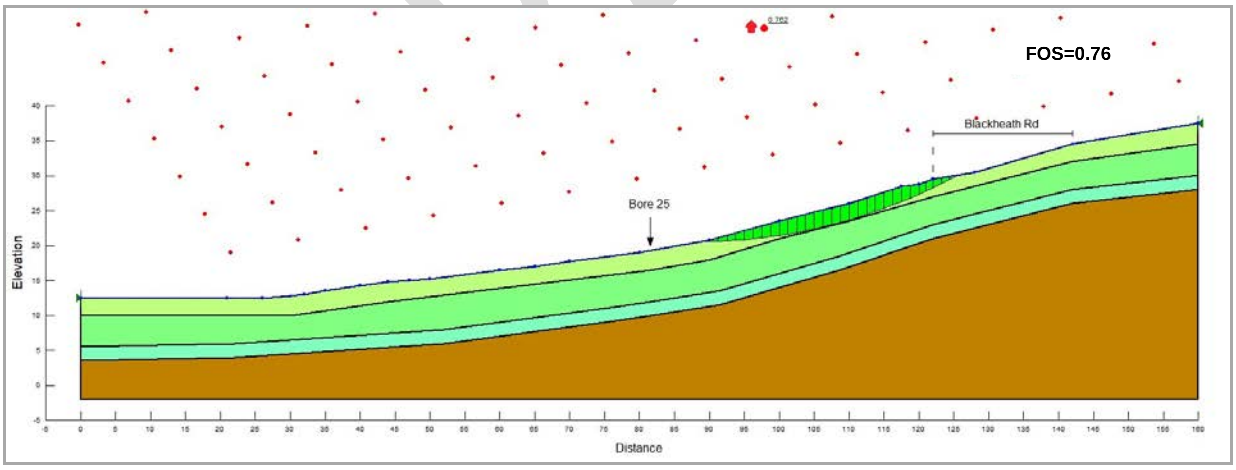

Figure 24: Analysis of near surface soils for the slope profile near Bore 25

5.7.1 Results Summary

The results of all stability analyses conducted for saturated near surface soils are summarised in Table 10 and confirm on site observations, that in zones of concentrated surface water flow, the topsoil materials could be expected to creep downhill.

Table 10: Summary of Calculated Minimum FOS Values for Long Term Conditions – Near Surface Soils

Description	Lowest Calculated FOS (Long Term)			
	Slope Profile near Bore 16	Slope Profile near Bore 18	Slope Profile near Bore 19	Slope Profile near Bore 25
Analysis of Near Surface Saturated Soils	1.04	0.57	0.90	0.76

5.8 Groundwater Modelling Results and Monitoring Well Observations

The groundwater model indicates that calculated minimum groundwater depths during and following storm events are significantly greater than 4m.

The groundwater level monitoring results from February 2019 to the present (refer Section 4.2), are all greater than 10m depth (with the exception of two readings of 7.3m and 9.5m depth in Well 29); the shallow depths recorded in Well 21 are not considered to be reliable (refer Section 4.2).

5.9 Conclusions

5.9.1 Peak Strengths

The stability analysis results for peak strength summarised in Table 9 indicate that at the four sections analysed, the minimum calculated FOS values are considered to be acceptable for the long term stability for non-fissured/slickensided clays and a groundwater level not higher than approximately 4m below the ground surface.

The calculated FOS value for a 2m deep groundwater level is considered to be acceptable for the Bore 19 slope and marginally acceptable (for a short term condition) for a water table depth of 2m for the slope at Bores 16 and 25. However at the time of writing, there has not been any indication of groundwater levels above approximately 9m depth, based on ongoing groundwater monitoring at the site; groundwater level monitoring should be continued for as long as possible.

5.9.2 Residual Strengths

The stability analysis results for heavily fissured/slickensided clays included in the slope profile are summarised in Table 9 and indicate that at two of the four sections analysed (i.e. slopes at Bores 19 and 25), the minimum calculated FOS values are considered to be acceptable for the long term stability for fissured/slickensided clays and a groundwater level not higher than approximately 6m below the ground surface for Bore 25 slope and not higher than approximately 4m below the ground surface for the Bore 19 slope. However at the time of writing, there has not been any indication of groundwater levels above approximately 9m depth, based on ongoing groundwater monitoring at the site.

Based on the groundwater observations made to the time of reporting, it is considered that a watertable depth shallower than 6m is considered to be unlikely. Provided the groundwater table remains below 6m depth, the risk of 'rapid' slope failure in any zones of extensive fissures/slickensides (if such zones do exist) is considered to be relatively low; extensive zones of fissures/slickensides are not indicated by the results of the investigation work completed to date. The FOS values for the slopes at Bores 16 and 18 (and possibly Bore 25) are below the values recommended for acceptance of long term slope stability, however they are not considered to be sufficiently low enough to indicate a potential for 'rapid' failure; if a failure occurs, it would be expected to be a 'slow', creep type failure.

5.9.3 Near Surface Soils

The stability analysis results for near surface soils summarised Table 10 indicate that localized instability of these materials is likely to occur under saturated conditions. Is it suggested that revegetation of the slopes would provide root support and help prevent surface erosion; installation of some shallow drainage and concrete lining of existing zones of concentrated surface water flow would assist in preventing near surface creep.

5.10 Prevention of Water Ingress into the Site Slopes

All areas where surface water can readily penetrate into the site slopes (e.g. the so called 'sinkholes'), should be backfilled with impervious, compacted materials to prevent inflow.

It is also suggested that the ground surface at the crest of slopes be grade away from the crest (with a concrete lined collector drain installed), to minimise surface water flow down the slope.

It is understood that some of the existing houses located adjacent to the site boundary (along Blackheath Road) may have roof drainage pipes that discharge to the ground. If this is the case, it is strongly recommended that all water currently discharged to the ground be collected into a piped disposal system to prevent the water discharge from infiltrating into the groundwater system and potentially reducing the stability of the adjacent site slopes.

5.11 Groundwater Level Monitoring

It is recommended that monitoring of groundwater levels should be continued after heavy rainfall events for as long as possible, prior to commencement of construction.

5.12 Guidelines for Site Development Layout to Minimise Slope Instability Risk

In order to minimise the potential for any future site development layout to adversely affect the stability of the existing eastern site slopes, the following are recommended for incorporation into site development layout design:

- do not develop within 30m of the eastern site boundary;
- limit cut depth on or below slopes to not more than 1m and retain the cut with fully engineered structural retaining walls (boulder walls or similar are not suitable for use);
- if the toe of slopes are to be filled over, the fill should consist of free draining materials only (or a purpose designed drain installed for the full depth of the fill), to prevent elevation of the groundwater level at the slope toe;
- do not place fill on slopes; and
- do not place development on slopes steeper than 18°.

5.13 Suggested Engineering Requirements to Supplement Site Layout Development

In addition to the site layout development recommendations given in Section 5.12, the following are strongly recommended to limit adverse effects on the stability of the eastern site slopes, based on the results of this slope stability assessment and on past experience:

- install drainage to prevent stormwater flow over the crest of slopes;
- install shallow sub soil drainage to prevent the saturation of topsoil (and near surface) layers;
- extensively plant (and maintain) the slopes with deep rooted vegetation/trees;
- ensure that any fill placed at the toe of slopes is free draining;
- do not place any fill on slopes;

- keep excavation of slopes to a minimum and ensure that they are retained with engineer designed retaining walls; and
- found any structures to be situated on slopes on deep foundations so that they do not add any load to slopes; and
- subject all site development proposals to location specific slope stability assessment.

The Australian Geomechanics Guidelines (the Guidelines) for Slope Management and Maintenance (Australian Geomechanics Vol 42, No. 1, March 2007) should be referred to, to provide additional guidance on minimising the risks associated with development on sloping site. Geoguide LR8 (Construction Practice) is attached in Appendix D from the Guideline for general information.

BUTLER PARTNERS PTY LTD

RICARDO ZANNIN-PESCE
Senior Geotechnical Engineer

BRUCE BUTLER
Senior Principal
(RPEQ No. 1196)

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

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Slope Analysis Overlay 12.12.18

LEGEND

25	Bore (2019 investigation)
1 16	Bore (previous investigations)
21	Bore/Monitoring Well (existing)
22	Bore (environmental)
	Site Boundary
	Stage 2 Boundary
1/2	Section Line

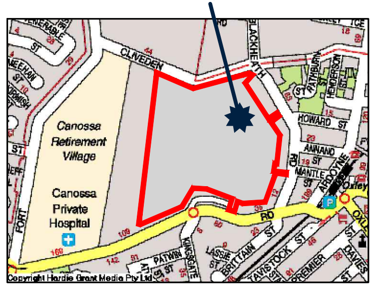
Bornhorst & Ward's Slope Analysis Range:

🟩	from 15 to 18
🟨	from 18 to 21
🟫	from 21 to 25
🟥	from 25>

Reference: 'Oxley Contour and Boundaries', dated 20 March 2018;
unreferenced 1018015_Concept Option3_100518.dwg, received 11 May 2018; and
Bornhorst & Ward's 'Slope Analysis Layout', Drawing No.15119/SK-C0005A, dated 03.12.2018
Bornhorst & Ward's 'Slope Analysis Layout', Drawing No.15119/SK-C0005A, dated 03.12.2018

File Location: Z:\Projects\2018Series\018-118B Oxley, Blackheath Road\Drawings\Geotechnical\2021 Drawings\018-118B GEO Dwg1 RevH 270421.dwg

Site



UBD Reference: Map 198 Grids G8-J6 (ACS,v8)
not to scale

Additional Slope Stability Assessment

Oxley PDA - Stage 2

Blackheath Road, Oxley

Locality Plan, Bore Locations and Slope Analysis

CLIENT:

Economic Development Queensland

SCALE AT A3:
0 25 50 75 100m
1:2500

DATE:	APRIL 2021
DRAWN:	LA / FD
APPROVED:	
PROJECT No:	018-118B RPT: Geo
DRAWING No:	1 REV: H

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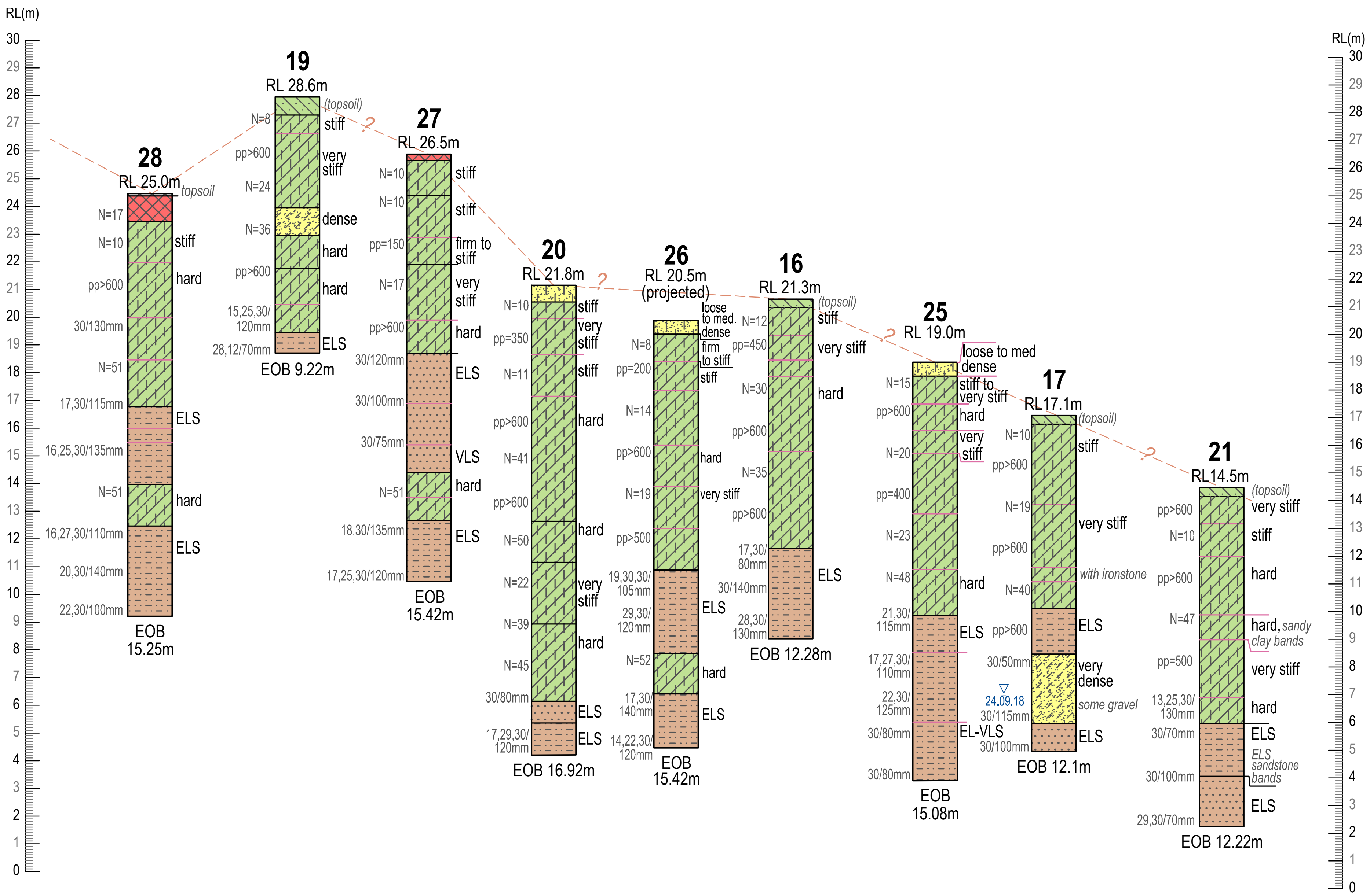

SECTION 1-1

Vertical: Scale 1:200 at A3
Horizontal: Not To Scale

LEGEND

▒	Asphalt/Bitumen
░	Pavement Gravel
🟥	Fill
🟨	Clayey Sand
🟨	Silty Sand
🟩	Sandy Clay
🟩	Silty Clay
░	Sandstone
▤	Mudstone
🟫	EL - LS Rock
🟫	M-HS Rock
▽ 25.09.2018	Groundwater observed at nominated date

N=5	SPT 'N' Value
U	Undisturbed Sample
C	NMLC Core Sample

ROCK STRENGTHS:

ELS - Extremely Low Strength
VLS - Very Low Strength
LS - Low Strength

Reference: 'Oxley Contour and Boundaries', dated 20 March 2018; and
unreferenced 1018015_Concept Option3_100518.dwg, received 11 May 2018

File Location: Z:\Projects\2018Series\018-118B Oxley, Blackheath Road\Drawings\Geotechnical\2021 Drawings\018-118B GEO Dwg2 RevC 230421.dwg

Additional Slope Stability Assessment
Oxley PDA - Stage 2
Blackheath Road, Oxley

Section 1-1

CLIENT: Economic Development Queensland

SCALE AT A3:

0 2 4 6 8m
1:200
(Vertical Scale at A3)

DATE: APRIL 2021
DRAWN: LA / FD
APPROVED:
PROJECT No: 018-118B RPT: Geo
DRAWING No: 2 REV: C

APPENDIX A

BORE REPORT SHEETS WITH EXPLANATORY NOTES

BORE REPORT

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BORE 25

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 1 of 2
Date: 23 January 2019
Ground Surface Level: RL19.0m*

Depth (m)	RL (m)
0	19.0
1	18.0
2	17.0
3	16.0
4	15.0
5	14.0
6	13.0
7	12.0
8	11.0
9	10.0
10	9.0
11	8.0
12	7.0
13	6.0

Description

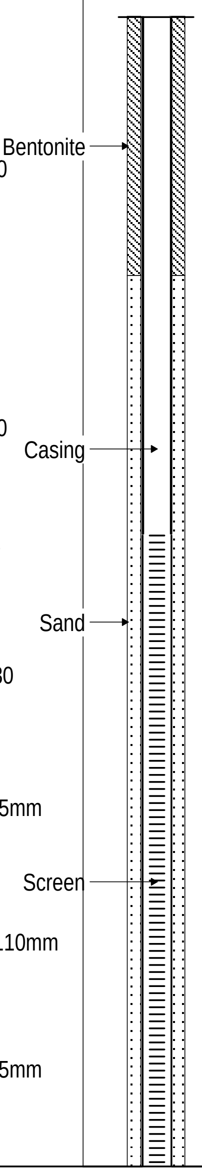
SILTY SAND (SM)
- loose to medium dense, brown-grey, fine to medium grained, with tree roots

SILTY CLAY (CI)
- stiff to very stiff, brown-grey mottled orange-brown, trace of tree roots
- hard
- very stiff, grey
- grey mottled orange-brown
- dark grey-black mottled orange-brown and grey
- hard, possible slickenslided

MUDSTONE (XW)
- extremely low strength, brown-grey mottled orange-brown
- brown-grey

Sample Type	Sample Depth (m)	Test Results
S	0.5 0.95	7,7,6 N=15
U	1.5 1.95	pp>600
S	3.0 3.45	6,8,12 N=20
U	4.5 4.95	pp=400
S	6.0 6.45	8,9,14 N=23
S	7.5 7.95	11,18,30 N=48
S	9.0 9.27	21,30/115mm
S	10.5 10.91	17,27,30/110mm
S	12.0 12.28	22,30/125mm

Groundwater Monitoring Bore



D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout
Logged by: FL
Drilling Method: Auger to 3m, then washbore
Groundwater: No free groundwater encountered during auger drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

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BORE 25

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 2 of 2
Date: 23 January 2019
Ground Surface Level: RL19.0m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results	Groundwater Monitoring Bore
	MUDSTONE (XW) - extremely low to very low strength, brown-grey			(S)	13.5 13.58	30/80mm	
14		5.0					
15		4.0		(S)	15.0 15.08	30/80mm	
	End of Bore at 15.08 m						
16		3.0					
17		2.0					
18		1.0					
19		0.0					
20		-1.0					
21		-2.0					
22		-3.0					
23		-4.0					
24		-5.0					
25		-6.0					
26		-7.0					

D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout

Logged by: FL

Drilling Method: Auger to 3m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

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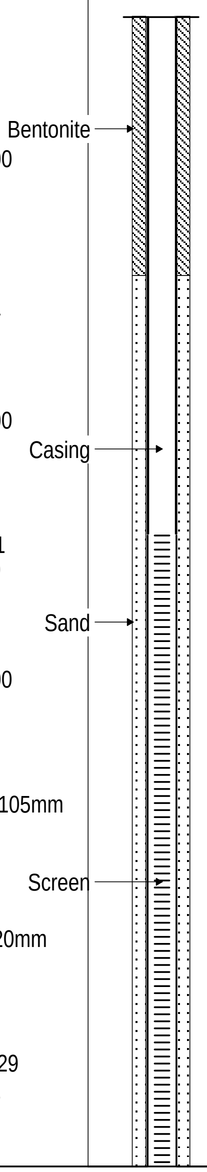
BORE 26

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 1 of 2
Date: 24 January 2019
Ground Surface Level: RL20.5m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
0		20.5				
	SILTY SAND (SM) - loose to medium dense, grey-brown, fine to medium grained, with tree roots			S	0.5 0.95	4,3,5 N=8
1	*SILTY CLAY (CH)* - firm to stiff, grey-brown mottled orange-brown, with tree roots	19.0		U	1.5 1.95	pp=200
2	- stiff					
	- grey	18.0				
3		17.0		S	3.0 3.45	3,6,8 N=14
4						
	- hard, grey mottled orange-brown	16.0		U	4.5 4.95	pp>600
5		15.0				
6	- very stiff, grey mottled dark brown and orange, slickensided	14.0		S	6.0 6.45	6,8,11 N=19
7						
	- dark grey	13.0		U	7.5 7.95	pp>500
8		12.0				
9	*MUDSTONE (XW)* - extremely low strength, brown-grey mottled orange-brown	11.0		S	9.0 9.41	19,30,30/105mm
10		10.0		S	10.5 10.77	29,30/120mm
11		9.0				
12	*SILTY CLAY (CH)* - hard, brown-grey mottled black	8.0		S	12.0 12.45	12,22,29 N=52
13						

Groundwater Monitoring Bore



D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout

Logged by: FL

Drilling Method: Auger to 3m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

BORE 26

Client: Economic Development Queensland

Project: Oxley PDA - Stage 2

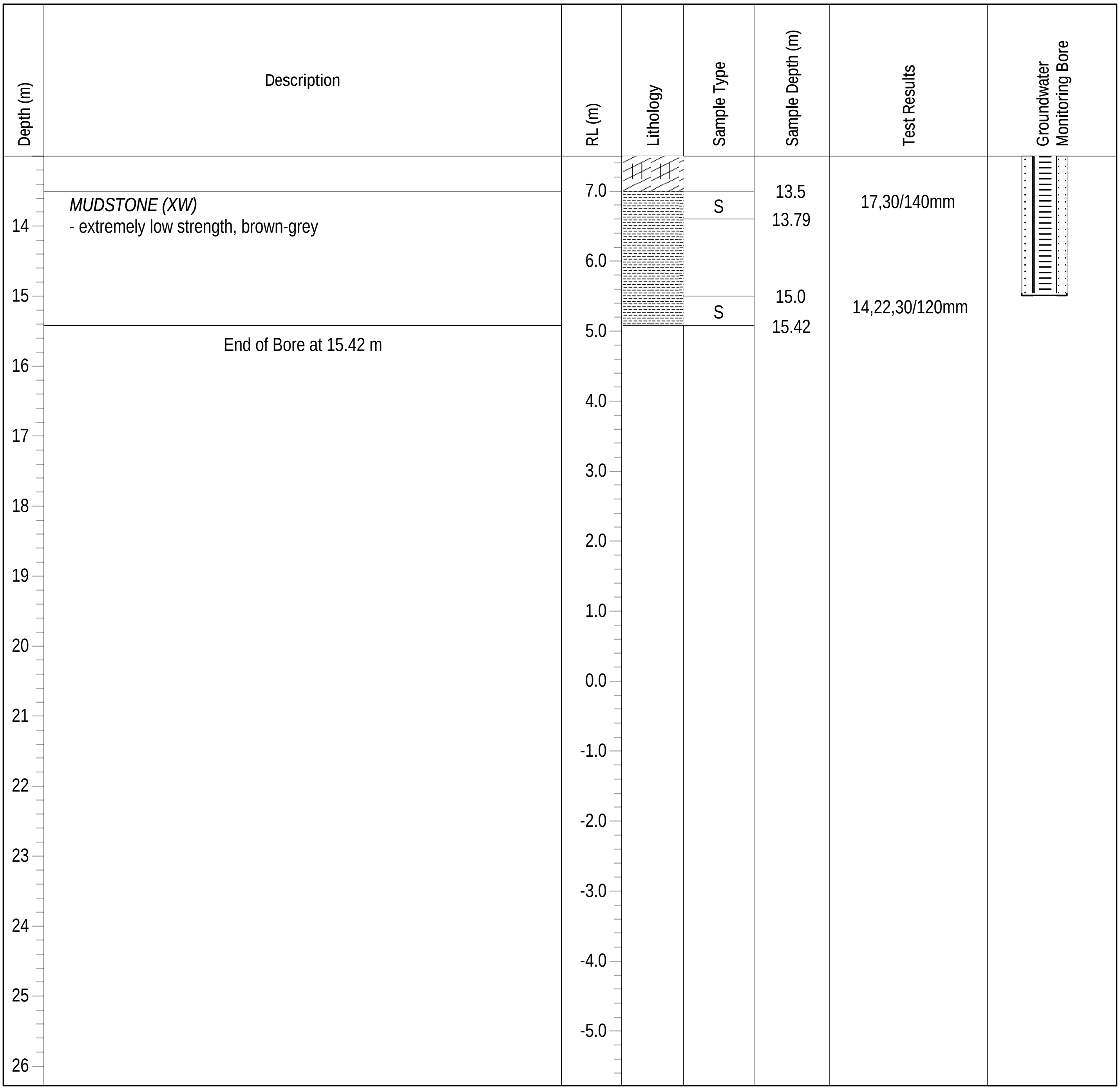
Location: Former Oxley Secondary College, Blackheath Road, Oxley

Project No: 018-118B

Page No: 2 of 2

Date: 24 January 2019

Ground Surface Level: RL20.5m*



Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results	Groundwater Monitoring Bore
13.5	*MUDSTONE (XW)* - extremely low strength, brown-grey	7.0		S	13.5 13.79	17,30/140mm	
15.0				S	15.0 15.42	14,22,30/120mm	
15.42	End of Bore at 15.42 m						

D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout

Logged by: FL

Drilling Method: Auger to 3m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

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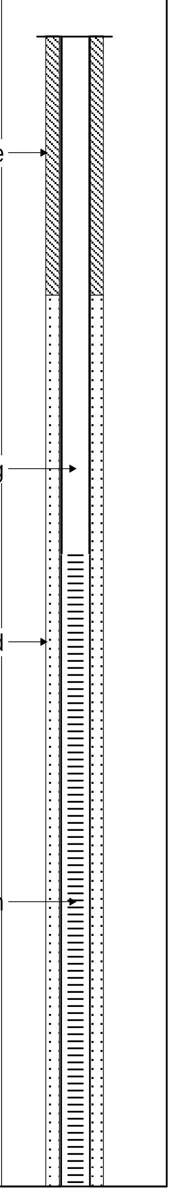
BORE 27

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 1 of 2
Date: 25 January 2019
Ground Surface Level: RL26.5m*

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)	Test Results
0	*FILL* - brown, silty sand, with organics and brick fragments	26.5	S	0.5 0.95	4,5,5 N=10
1	*SILTY CLAY (CH)* - stiff, dark brown-grey mottled black and orange-brown, with fine to medium grained sand, with tree roots	25.0			
2	*SANDY CLAY (CH)* - stiff, brown-grey mottled orange and black, fine to medium grained sand	24.0	S	1.5 1.95	3,4,6 N=10
3	- firm to stiff, grey mottled orange-brown	23.0	U	3.0 3.45	pp=150
4 5	*SILTY CLAY (CH)* - very stiff, grey mottled orange, tree roots	22.0 21.0	S	4.5 4.95	3,7,10 N=17
6 7	- hard, grey	20.0	U	6.0 6.45	pp>600
8	*SANDSTONE (XW)* - extremely low strength, pale brown-orange	19.0 18.0	S	7.5 7.62	30/120mm
9 10	- pale grey	17.0	S	9.0 9.1	30/100mm
11	- very low strength, pale brown-orange	16.0	S	10.5 10.58	30/75mm
12	*SILTY CLAY (CH)* - hard, grey, with slickensides	15.0	S	12.0 12.45	16,22,29 N=51
13	- dark grey-black	14.0			

Groundwater Monitoring Bore



D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout
Logged by: FL
Drilling Method: Auger to 3m, then washbore
Groundwater: No free groundwater encountered during auger drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

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BORE 27

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 2 of 2
Date: 25 January 2019
Ground Surface Level: RL26.5m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results	Groundwater Monitoring Bore
	MUDSTONE (XW) - extremely low strength, grey mottled pale grey	13.0		S	13.5 13.79	18,30/135mm	
14		12.0					
15				S	15.0 15.42	17,25,30/120mm	
	End of Bore at 15.42 m	11.0					
16		10.0					
17		9.0					
18		8.0					
19		7.0					
20		6.0					
21		5.0					
22		4.0					
23		3.0					
24		2.0					
25		1.0					
26							

D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout

Logged by: FL

Drilling Method: Auger to 3m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

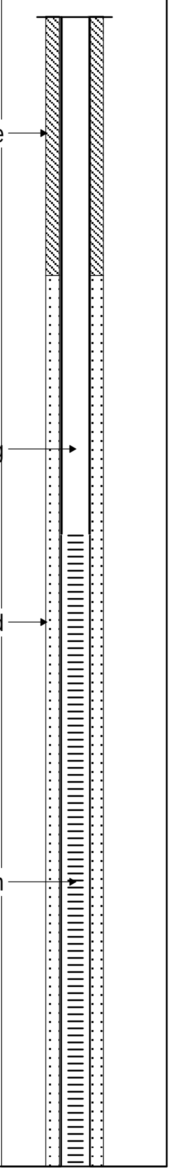
Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

BORE 28

Page No: 1 of 2
Date: 25 January 2019
Ground Surface Level: RL25.0m*

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)	Test Results
		25.0			
0	*FILL* - brown, fine to medium grained, with tree roots (topsoil)		S	0.5 0.95	6,8,9 N=17
1	- brown-grey mottled orange-brown and black, sandy clay, fine to medium grained sand, with tree roots	24.0			
	SILTY CLAY (CH) - stiff, brown-grey mottled black		S	1.5 1.95	4,5,5 N=10
2		23.0			
	- hard, dark grey				
3		22.0	U	3.0 3.45	pp>600
4		21.0			
	- grey (residual mudstone)		S	4.5 4.95	12,25,30/130mm
5		20.0			
6	- grey mottled pale grey and black	19.0	S	6.0 6.45	13,22,29 N=51
7		18.0			
			S	7.5 7.77	17,30/115mm
8	*MUDSTONE (XW)* - extremely low strength, orange-brown with iron staining	17.0			
	- grey mottled orange-brown				
9		16.0	S	9.0 9.44	16,25,30/135mm
	- grey mottled pale grey				
10		15.0			
	SILTY CLAY (CH) - hard, grey mottled pale grey and pale brown (residual mudstone)		S	10.5 10.95	14,21,30 N=51
11		14.0			
12	*MUDSTONE (XW)* - extremely low strength, grey	13.0	S	12.0 12.41	16,27,30/110mm
13		12.0			

Groundwater Monitoring Bore



D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout
Logged by: FL
Drilling Method: Auger to 3m, then washbore
Groundwater: No free groundwater encountered during auger drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

BORE 28

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 2 of 2
Date: 25 January 2019
Ground Surface Level: RL25.0m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results	Groundwater Monitoring Bore
	MUDSTONE (XW) - extremely low strength, grey			S	13.5 13.79	20,30/140mm	
14		11.0					
15		10.0		S	15.0 15.25	22,30/100mm	
	End of Bore at 15.25 m						
16		9.0					
17		8.0					
18		7.0					
19		6.0					
20		5.0					
21		4.0					
22		3.0					
23		2.0					
24		1.0					
25		0.0					
26		-1.0					

D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

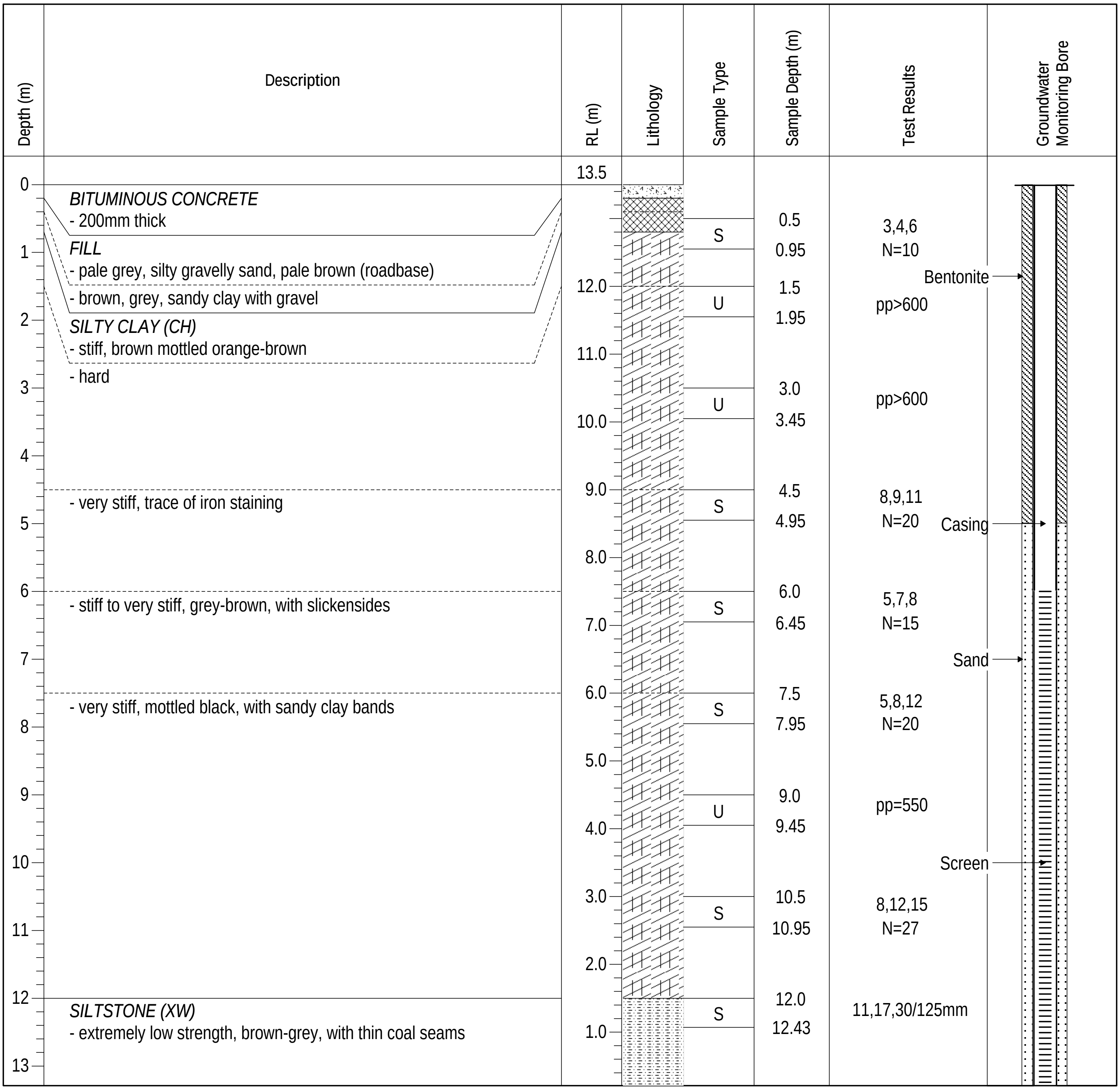
Rig: Hydrapower Scout
Logged by: FL
Drilling Method: Auger to 3m, then washbore
Groundwater: No free groundwater encountered during auger drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

BORE 29

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 1 of 2
Date: 7 March 2019
Ground Surface Level: RL13.5m*



Description	Sample Type	Sample Depth (m)	Test Results
BITUMINOUS CONCRETE - 200mm thick			
FILL - pale grey, silty gravelly sand, pale brown (roadbase)	S	0.5 0.95	3,4,6 N=10
- brown, grey, sandy clay with gravel	U	1.5 1.95	pp>600
SILTY CLAY (CH) - stiff, brown mottled orange-brown			
- hard	U	3.0 3.45	pp>600
- very stiff, trace of iron staining	S	4.5 4.95	8,9,11 N=20
- stiff to very stiff, grey-brown, with slickensides	S	6.0 6.45	5,7,8 N=15
- very stiff, mottled black, with sandy clay bands	S	7.5 7.95	5,8,12 N=20
	U	9.0 9.45	pp=550
	S	10.5 10.95	8,12,15 N=27
SILTSTONE (XW) - extremely low strength, brown-grey, with thin coal seams	S	12.0 12.43	11,17,30/125mm

D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout
Logged by: FL
Drilling Method: Auger to 3m, then washbore
Groundwater: No free groundwater encountered during auger drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

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BORE 29

Client: Economic Development Queensland
Project: Oxley PDA - Stage 2
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 2 of 2
Date: 7 March 2019
Ground Surface Level: RL13.5m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results	Groundwater Monitoring Bore
	SILTSTONE (XW) - extremely low strength, brown-grey, with thin coal seams	0.0		S	13.5 13.75	27,30/95mm	
14	- with interbedded sandstone bands	-1.0					
15				S	15.0 15.24	23,30/85mm	
	End of Bore at 15.24 m	-2.0					
16		-3.0					
17		-4.0					
18		-5.0					
19		-6.0					
20		-7.0					
21		-8.0					
22		-9.0					
23		-10.0					
24		-11.0					
25		-12.0					
26							

D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout

Logged by: FL

Drilling Method: Auger to 3m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

Notes on Description and Classification of Soil

The methods of description and classification of soils used in this report are generally based on Australian Standard AS1726-1993 Geotechnical Site Investigations.

Soil description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures or in undisturbed samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

In the case of cone or piezocone penetrometer tests, actual soil samples are not recovered and soil description is inferred based on published correlations, past experience and comparison with bore and/or test pit data (if available).

Soil classification is based on the particle size distribution of the soil and the plasticity of the portion of the material finer than 0.425mm. The description of particle size distribution and plasticity is based on the results of visual field estimation, laboratory testing or both. When assessed in the field, the properties of the soil are estimated; precise description will always require laboratory testing to define soil properties.

Where soil can be clearly identified as FILL this will be noted as the main soil type followed by a description of the composition of the fill (e.g. FILL – yellow-brown, fine to coarse grained gravelly clay fill with concrete rubble). If the soil is assessed as possibly being fill this will be noted as an additional observation.

Soils are generally described using the following sequence of terms. In certain instances, not all of the terms will be included in the soil description.

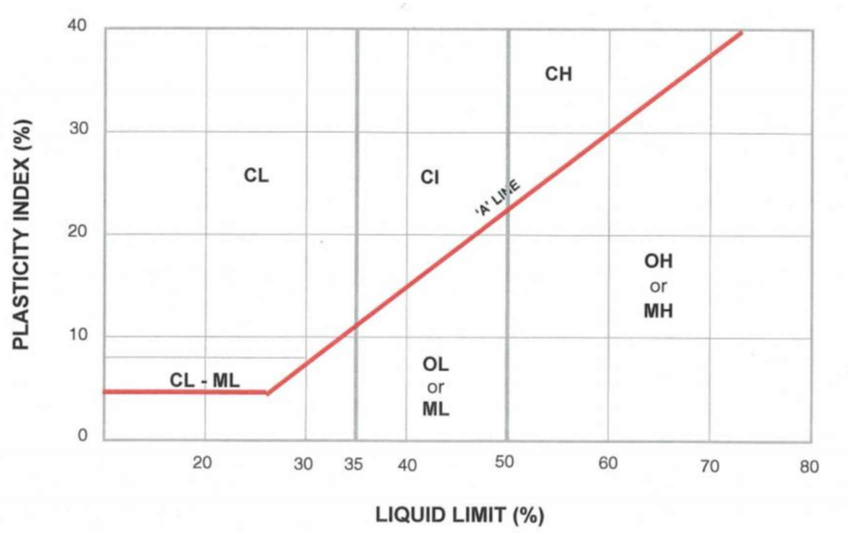
MAIN SOIL TYPE (CLASSIFICATION GROUP SYMBOL)
- strength/density, colour, structure/grain size, secondary and minor components, additional observations

Information on the definition of descriptive and classification terms follows.

SOIL TYPE and CLASSIFICATION GROUP SYMBOLS

	Major Divisions	Particle Size	Classification Group Symbol	Typical Names
COARSE GRAINED SOILS (more than half of material is larger than 0.075mm)	BOULDERS	>200mm		
	COBBLES	63 – 200mm		
	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	Coarse: 20 – 63mm Medium: 6 – 20mm Fine: 2.36 – 6mm	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
			GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	Coarse: 0.6 – 2.36mm Medium: 0.2 – 0.6mm Fine: 0.075 – 0.2mm	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
			SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (more than half of material is smaller than 0.075mm)	SILTS & CLAYS (liquid limit <50%)		ML	Inorganic silts and very fine sands, silty/clayey fine sands or clayey silts with low plasticity.
			CL and CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS & CLAYS (liquid limit >50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils.
			CH	Inorganic clays of high plasticity.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS



(Reference: Australian Standard AS1726-1993 Geotechnical site investigations)

DESCRIPTIVE TERMS FOR MATERIAL PROPORTIONS

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
<5	Omit, or use 'trace'	<15	Omit, or use trace.
5 – 12	Describe as 'with clay/silt' as applicable.	15 – 30	Describe as 'with sand/gravel' as applicable.
>12	Prefix soil as 'silty/clayey' as applicable	>30	Prefix soil as 'sandy/gravelly' as applicable.

STRENGTH TERMS – COHESIVE SOILS

Strength Term	Undrained Shear Strength	Field Guide to Strength
Very soft	<12kPa	Exudes between the fingers when squeezed in hand.
Soft	12 – 25kPa	Can be moulded by light finger pressure.
Firm	25 – 50kPa	Can be moulded by strong finger pressure.
Stiff	50 – 100kPa	Cannot be moulded by fingers, can be indented by thumb.
Very stiff	100 – 200kPa	Can be indented by thumb nail.
Hard	>200kPa	Can be indented with difficulty by thumb nail.

DENSITY TERMS – NON COHESIVE SOILS

Density Term	Density Index	**SPT "N"**	CPT Cone Resistance
Very loose	<15%	0 – 5	0 – 2MPa
Loose	15 – 35%	5 – 10	2 – 5MPa
Medium dense	35 – 65%	10 – 30	5 – 15MPa
Dense	65 – 85%	30 – 50	15 – 25MPa
Very dense	>85%	>50	>25MPa

COLOUR

The colour of a soil will generally be described in a 'moist' condition using simple colour terms (e.g. black, grey, red, brown etc.) modified as necessary by "pale", "dark", "light" or "mottled". Borderline colours will be described as a combination of colours (e.g. grey-brown).

EXAMPLE

e.g. CLAYEY SAND (SC) – medium dense, grey-brown, fine to medium grained with silt.

Indicates a medium dense, grey-brown, fine to medium grained clayey sand with silt.

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Notes on Description and Classification of Rock

The methods of description and classification of rock used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical site investigations*.

Rock description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures, or in core samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

Notes outlining the method and terminology adopted for the description of rock defects are given below, however, detailed information on defects can generally only be determined where rock core is taken, or excavations or exposures allow detailed observation and measurement.

Rocks are generally described using the following sequence of terms. In certain instances not all of the terms will be included in the rock description.

ROCK TYPE (WEATHERING SYMBOL), strength, colour, grain size, defect frequency

Information on the definition of descriptive and classification terms follows.

ROCK TYPE

In general, simple rock names are used rather than precise geological classifications.

ROCK MATERIALS WEATHERING CLASSIFICATION

Term	Weathering Symbol	Definition
Residual soil	RS	Soil developed from extremely weathered rock; the mass structure and substance fabrics are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered	XW	Rock is weathered to such an extent that it has ‘soil’ properties, i.e. it either disintegrates or can be remoulded in water.
Distinctly weathered *	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
- Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock, usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
- Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock may be no longer recognisable.
Slightly weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

** Subdivision of this weathering grade into highly and moderately may be used where applicable.*

STRENGTH OF ROCK MATERIAL

Term	Symbol	Point Load Index I_s (50)	Field Guide To Strength
Extremely low	EL	<0.03MPa	Easily remoulded by hand to a material with soil properties.
Very low	VL	0.03 – 0.1MPa	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low	L	0.1 – 0.3MPa	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 – 1.0MPa	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	1.0 – 3.0MPa	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very high	VH	3.0 – 10.0MPa	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely high	EH	>10MPa	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes:

1. *These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.*
2. *The field guide visual assessment for rock strength may be used for preliminary assessment or when point load testing is not available.*
3. *Anisotropy of rock may affect the field assessment of strength.*

COLOUR

The colour of a rock will generally be described in a ‘moist’ condition using simple colour terms (e.g. black, grey, red, brown, etc) modified as necessary by ‘pale’, ‘dark’, ‘light’ or ‘mottled’. Borderline colours will be described as a combination of colours (e.g. grey-brown).

GRAIN SIZE

Descriptive Term	Particle Size Range
Coarse grained	0.6 – 2.0mm
Medium grained	0.2 – 0.6mm
Fine grained	0.06 – 0.2mm

DEFECT FREQUENCY

Where appropriate, a defect frequency may be recorded as part of the rock description and will be expressed as the number of natural (or interpreted natural) defects present in an equivalent one metre length of core; by use of the following defect frequency descriptive terms; or both. The descriptive terms refer to the spacing of all types of natural defects along which the rock is discontinuous and include, bedding plane partings, joints and other rock defects, but excludes known artificial fractures such as drilling breaks.

Defect Frequency	Description
Fragmented	Rock core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter.
Highly Fractured	Core lengths are generally less than 20mm to 40mm with occasional fragments.
Fractured	Core lengths are mainly 30mm to 100mm with occasional shorter and longer sections.
Fractured to Slightly Fractured	Core lengths are mainly 100mm to 300mm with occasional shorter to longer sections.
Slightly Fractured	Core lengths are generally 300mm to 1,000mm with occasional longer sections and occasional sections of 100mm to 300mm.
Unbroken	The core does not contain any fractures.

EXAMPLE

e.g. SANDSTONE (XW) – low strength, pale brown, fine to coarse grained, slightly fractured.

ROCK DEFECT LOGGING

Defects are discontinuities in the rock mass and include joints, sheared zones, cleavages and bedding partings. The ability to observe and log defects will depend on the investigation methodology. Defects logged in core are described using the abbreviations noted in the following tables.

The *depth* noted in the description is measured in metres from the ground surface, the *defect angle* is measured in degrees from horizontal, and the defect *thickness* is measured normal to the plane of the defect and is in millimetres (unless otherwise noted).

Defects are generally described using the following sequence of terms:

Depth, Defect Type, Defect Angle (dip), Surface Roughness, Infill, Thickness

DEFECT TYPE

B – Bedding
J – Joint
S – Shear Zone
C – Crushed Zone

SURFACE ROUGHNESS

i - rough or irregular, stepped
ii - smooth, stepped
iii - slickensided, stepped
iv - rough or irregular, undulating
v - smooth, undulating
vi - slickensided, undulating
vii - rough or irregular, planar
viii - smooth planar
ix - slickensided, planar

INFILL

Infill refers to secondary minerals or other materials formed on the surface of the defect and some common descriptions are given in the following table together with their abbreviations.

Ls - limonite staining
Fe - iron staining
Cl - clay
Mn - manganese staining
Qtz - quartz
Ca - calcite
Clean - no visible infill

EXAMPLE

3.59m, J, 90, vii, Ls, 1mm

indicates a joint at 3.59m depth that is at 90° to horizontal (i.e. vertical), is rough or irregular and planar, limonite stained and 1mm thick.

APPENDIX B

SELECTED BORE REPORT SHEETS FROM PREVIOUS INVESTIGATIONS

BORE REPORT

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BORE 5

Client: Economic Development Queensland
Project: Former Oxley Secondary College
Location: Blackheath Road, Oxley
Project No: 018-118A

Page No: 1 of 1
Date: 11 April 2018
Ground Surface Level: RL32.0m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Sample ID	Test Results
		32.0					
0	*SANDY CLAY (CL)* - dark brown, fine to coarse grained		▨	E	0.0 0.2	B5-1	
	SANDY CLAY (CI) - stiff, pale brown, fine grained		▨	E/B	0.2 0.5	B5-2	
			▨	S	0.5 0.95		7,6,8 N=14
1		31.0	▨	E	1.0 1.4	B5-3	
	- pale brown with red mottled, fine grained (possibly siltstone		▨	S	1.5 1.95		14,27,30 N=57
2		30.0	▨				
	SANDY CLAY (CL) - hard, pale grey, fine to coarse grained		▨				
3		29.0	▨	S	3.0 3.45		16,18,20 N=38
4	*SILTY CLAY (CI)* - hard, grey	28.0	▧				
			▧	U	4.5 4.95		pp>600
5	End of Bore at 5 m	27.0					

D	Disturbed Sample	V	Vane Shear Strength, Uncorrected (kPa)	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	SPT	Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test
E	Environmental Sample	A	Asbestos Sample		

Rig: Hydrapower Trekker

Logged By: NA

Drilling Method: Auger

Groundwater: No free groundwater encountered during drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by EDQ

BORE REPORT

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Client: Economic Development Queensland
Project: Former Oxley Secondary College
Location: Blackheath Road, Oxley
Project No: 018-118A

BORE 12

Page No: 1 of 1
Date: 9 April 2018
Ground Surface Level: RL18.5m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Sample ID	Test Results
		18.5					
0	*SILTY CLAY (CI)* - stiff to very stiff, red-brown			B/E	0.0	B12-1	
		18.0		U	0.5		pp=250
1				E	0.95 1.0	B12-2	
		17.0		S	1.4 1.5		4,7,9 N=16
2	- very stiff, brown				1.95		
		16.0					
3				S	3.0		6,7,14 N=22
		15.0			3.45		
4	- pale brown						
		14.0		S	4.5		6,11,14 N=25
5	End of Bore at 5 m				4.95		
		13.0					

D	Disturbed Sample	V	Vane Shear Strength, Uncorrected (kPa)	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	SPT	Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test
E	Environmental Sample	A	Asbestos Sample		

Rig: Hydrapower Trekker
Logged By: NA
Drilling Method: Auger
Groundwater: No free groundwater encountered during drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by EDQ

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BORE REPORT

BORE 13

Client: Economic Development Queensland
Project: Former Oxley Secondary College
Location: Blackheath Road, Oxley
Project No: 018-118A
Page No: 1 of 1
Date: 10 April 2018
Ground Surface Level: RL24.8m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Sample ID	Test Results
0	*BITUMINOUS CONCRETE* - 20mm thick	24.8					
	PAVEMENT GRAVEL - pale brown, sandy gravel, fine to coarse grained sand, fine to medium subangular gravel			E	0.2 0.5	B13-1 QC01 QC02	
				S	0.5 0.95		4,5,6 N=11
1	*FILL* - brown, silty clay	24.0					
	- dark grey, silty clay			E	1.0 1.3	B13-2	
				S	1.5 1.95		3,14,21 N=35
2	*SILTY SAND (SC)* - dense, pale brown, fine to medium grained	23.0					
		22.0					
3				S	3.0 3.45		20,30,21 N=51
4		21.0					
		20.0		U	4.5 4.95		pp>600
5	End of Bore at 5 m						

D	Disturbed Sample	V	Vane Shear Strength, Uncorrected (kPa)	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	SPT	Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test
E	Environmental Sample	A	Asbestos Sample		

Rig: Hydrapower Trekker
Logged By: NA
Drilling Method: Auger
Groundwater: No free groundwater encountered during drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by EDQ

BORE REPORT

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BORE 14

Client: Economic Development Queensland
Project: Former Oxley Secondary College
Location: Blackheath Road, Oxley
Project No: 018-118A

Page No: 1 of 1
Date: 10 April 2018
Ground Surface Level: RL16.0m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Sample ID	Test Results
0	*BITUMINOUS CONCRETE* - 20mm thick	16.0		E	0.02 0.2	B14-1	
	PAVEMENT GRAVEL - pale brown, sandy gravel, fine to coarse grained sand, fine to medium subangular gravel			E	0.2 0.5	B14-2	
				U	0.5 0.7		
	FILL - brown, silty clay			U/E	0.7 0.95	B14-3	pp>600
1	- pale grey, sandy clay, fine to coarse grained, trace of fine to medium subangular gravel	15.0		E	1.1 1.5	B14-4	
	CLAYEY SAND (SC) - very dense, orange, fine to medium grained			S	1.5 1.775		18,30/125mm
2	*SILTY CLAY (CL)* - very stiff, grey with orange zones, trace of fine to coarse grained sand	14.0					
3		13.0		S	3.0 3.45		18,15,14 N=29
4	- hard, grey	12.0					
				S	4.5 4.93		15,25,30/ 130mm
5	End of Bore at 5 m	11.0					

D	Disturbed Sample	V	Vane Shear Strength, Uncorrected (kPa)	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	SPT	Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test
E	Environmental Sample	A	Asbestos Sample		

Rig: Hydrapower Trekker

Logged By: NA

Drilling Method: Auger

Groundwater: No free groundwater encountered during drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by EDQ

BORE REPORT

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BORE 15

Client: Economic Development Queensland
Project: Former Oxley Secondary College
Location: Blackheath Road, Oxley
Project No: 018-118A

Page No: 1 of 1
Date: 10 April 2018
Ground Surface Level: RL24.2m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Sample ID	Test Results
		24.2					
0	*SANDY SILT (ML)* - dark brown, fine to medium grained, rootlets (topsoil)			E	0.0	B15-1	
	SILTY CLAY (CI) - stiff, pale brown, trace of fine to coarse grained sand			E/B	0.2	B15-2	
	- very stiff to hard, grey			U	0.5 0.95		pp>600
1		23.0		E	1.0 1.4	B15-3	
	SILTY SAND (SC) - very dense, fine to medium grained			E	1.5 1.78		14,30/130mm
2		22.0					
	SILTSTONE (XW) - extremely low strength, grey with orange mottle						
3		21.0		S	3.0 3.24		19,30/90mm
4	*SILTY CLAY (CI)* - hard, grey with red mottle	20.0					
				S	4.5 4.95		13,22,25 N=47
5	End of Bore at 5 m	19.0					

D	Disturbed Sample	V	Vane Shear Strength, Uncorrected (kPa)	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	SPT	Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test
E	Environmental Sample	A	Asbestos Sample		

Rig: Hydrapower Trekker

Logged By: NA

Drilling Method: Auger

Groundwater: No free groundwater encountered during drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by EDQ

BORE REPORT

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BORE 16

Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B
Page No: 1 of 1
Date: 24 September 2018
Ground Surface Level: RL21.3m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
0	*SANDY CLAY (CL)* - brown, fine to coarse grained (topsoil)	21.3		S	0.5 0.95	3,6,6 N=12
1	*SILTY CLAY (CH)* - stiff, grey and brown mottled, trace of fine grained sand	20.0				
	- very stiff			U	1.5 1.95	pp=450
2	- pale brown with yellow mottle	19.0				
3	- hard, pale grey	18.0		S	3.0 3.45	8,14,16 N=30
4		17.0		U	4.5 4.95	pp>600
5		16.0				
6	- dark grey	15.0		S	6.0 6.45	10,15,20 N=35
7		14.0		U	7.5 7.95	pp>600
8		13.0				
9	*MUDSTONE (XW)* - extremely low strength, dark grey	12.0		S	9.0 9.23	17,30/80mm
10		11.0		S	10.5 10.64	30/140mm
11		10.0				
12		9.0		S	12.0 12.28	28,30/130mm
13	End of Bore at 12.28 m					

U	Undisturbed Tube Sample (50mm dia)	S	Standard Penetration Test (SPT)	E	Environmental Sample	Is(50)	Point Load Test Result (MPa)
D	Disturbed Sample	HB	SPT Hammer Bouncing	Up	Pushtube Sample	(d)	Diametral Test
B	Bulk Sample	( )	No Sample Recovery	C	NMLC Coring	(a)	Axial Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)			(i)	Lump Test

Rig: Jacro 350
Logged by: NA
Drilling Method: Auger
Groundwater: No free groundwater encountered during drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

Butler Partners
geotechnical • geo-environmental • groundwater

Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

BORE 17

Page No: 1 of 1
Date: 24 September 2018
Ground Surface Level: RL17.1m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
0	*SANDY CLAY (CL)* -brown, fine to coarse grained (topsoil)	17.1				
	SILTY CLAY (CI) - stiff, pale grey, with zones of dark grey, trace of fine grained sand			S	0.5 0.95	4,5,5 N=10
				U	1.5 1.95	pp>600
	- very stiff			S	3.0 3.45	7,8,11 N=19
				U	4.5 4.95	pp>600
	- with ironstone					
	- with slickensides			S	6.0 6.45	13,18,22 N=40
	MUDSTONE (XW) - extremely low strength, grey with yellow-brown mottle			U	7.5 7.95	pp>600
	CLAYEY SAND (SC) - very dense, brown, fine to coarse grained, with grained gravel			S	9.0 9.05	30/50mm
				S	10.5 10.615	30/115mm
	SANDSTONE (XW) - extremely low strength, orange-brown, fine grained			S	12.0 12.1	30/100mm
	End of Bore at 12.1 m					

U	Undisturbed Tube Sample (50mm dia)	S	Standard Penetration Test (SPT)	E	Environmental Sample	Is(50)	Point Load Test Result (MPa)
D	Disturbed Sample	HB	SPT Hammer Bouncing	Up	Pushtube Sample	(d)	Diametral Test
B	Bulk Sample	( )	No Sample Recovery	C	NMLC Coring	(a)	Axial Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)			(i)	Lump Test

Rig: Jacro 350
Logged by: NA
Drilling Method: Auger
Groundwater: Free groundwater encountered at 10m during drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

Butler Partners
geotechnical • geo-environmental • groundwater

Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

BORE 18

Page No: 1 of 1
Date: 25 September 2018
Ground Surface Level: RL38.1m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
0	*FILL* - brown, silty clay, trace of fine subrounded gravel (reworked natural)	38.1		S	0.5 0.95	5,7,8 N=15
	- brown with yellow and orange mottle			U	1.5 1.95	pp>600
	- brown with orange and red mottle			S	3.0 3.45	9,13,14 N=27
				U	4.5 4.95	pp=320
				S	6.0 6.45	7,9,10 N=19
7	*SILTY CLAY (CI)* - stiff, grey with red mottle	31.0		U	7.5 7.95	pp=220
	- very stiff, with bands of fine subangular gravel			S	9.0 9.45	7,9,11 N=20
				U	10.5 10.55	pp>600
	MUDSTONE (XW) - extremely low strength, pale brown, with slickensides			S	10.55 10.82	21,30/120mm
	- very low strength			S	12.0 12.06	30/60mm HB
	End of Bore at 12.06 m					

U	Undisturbed Tube Sample (50mm dia)	S	Standard Penetration Test (SPT)	E	Environmental Sample	Is(50)	Point Load Test Result (MPa)
D	Disturbed Sample	HB	SPT Hammer Bouncing	Up	Pushtube Sample	(d)	Diametral Test
B	Bulk Sample	( )	No Sample Recovery	C	NMLC Coring	(a)	Axial Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)			(i)	Lump Test

Rig: Jacro 350
Logged by: NA
Drilling Method: Auger
Groundwater: Free groundwater encountered at 7m during drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

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BORE 19

Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

Page No: 1 of 1
Date: 25 September 2018
Ground Surface Level: RL28.6m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
0	*SANDY CLAY (CL)* - brown, fine to coarse grained (topsoil)	28.6		S	0.5 0.95	4,4,4 N=8
1	*SILTY CLAY (CH)* - stiff, pale brown with orange mottle					
2	- very stiff, orange	27.0		U	1.5 1.95	pp>600
3	- pale grey with orange mottle	26.0 25.0		S	3.0 3.45	10,10,14 N=24
4	*CLAYEY SAND (SC)* - dense, orange, fine grained	24.0		S	4.5 4.95	16,16,20 N=36
5	*SILTY CLAY (CL)* - hard, red, with trace of fine grained sand	23.0				
6 7	*SILTY CLAY (CI)* - hard, grey	22.0		U	6.0 6.45	pp>600
8	- with slickensides	21.0		S	7.5 7.92	15,25,30/120mm
9	*MUDSTONE (XW)* - extremely low strength, grey	20.0		S	9.0 9.22	28,12/70mm
10 11 12 13	End of Bore at 9.22 m	19.0 18.0 17.0 16.0				

U	Undisturbed Tube Sample (50mm dia)	S	Standard Penetration Test (SPT)	E	Environmental Sample	Is(50)	Point Load Test Result (MPa)
D	Disturbed Sample	HB	SPT Hammer Bouncing	Up	Pushtube Sample	(d)	Diametral Test
B	Bulk Sample	( )	No Sample Recovery	C	NMLC Coring	(a)	Axial Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)			(i)	Lump Test

Rig: Jacro 350
Drilling Method: Auger
Groundwater: No free groundwater encountered during drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

Logged by: NA

BORE REPORT

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Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

BORE 20

Page No: 1 of 2
Date: 26 September 2018
Ground Surface Level: RL21.8m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
		21.8				
0	*SILTY SAND (SM)* - brown (topsoil)					
		21.0		S	0.5 0.95	4,4,5 N=9
1	*SILTY CLAY (CH)* - stiff, pale grey with red mottle, trace of fine grained sand					
	- very stiff, pale brown with orange mottle	20.0		U	1.5 1.95	pp=350
2						
	- stiff, pale brown	19.0				
3				S	3.0 3.45	4,5,6 N=11
		18.0				
4	- hard, with some fine grained sand					
		17.0		U	4.5 4.95	pp>600
5						
		16.0				
6				S	6.0 6.45	10,17,24 N=41
		15.0				
7						
		14.0		U	7.5 7.95	pp>600
8						
	SILTY CLAY (CL) - hard, pale brown	13.0				
9				S	9.0 9.45	12,23,27 N=50
		12.0				
10	*SILTY CLAY (CI)* - very stiff, dark grey					
		11.0		S	10.5 10.95	5,9,13 N=22
11						
		10.0				
12				S	12.0 12.45	8,16,23 N=39
	SILTY CLAY (CH) - hard, grey with brown mottle, with slickensides	9.0				
13						

U	Undisturbed Tube Sample (50mm dia)	S	Standard Penetration Test (SPT)	E	Environmental Sample	Is(50)	Point Load Test Result (MPa)
D	Disturbed Sample	HB	SPT Hammer Bouncing	Up	Pushtube Sample	(d)	Diametral Test
B	Bulk Sample	( )	No Sample Recovery	C	NMLC Coring	(a)	Axial Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)			(i)	Lump Test

Rig: Hydrapower Scout

Logged by: NA

Drilling Method: Auger to 1.5m, casing to 1.5m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

BORE 20

Page No: 2 of 2
Date: 26 September 2018
Ground Surface Level: RL21.8m*

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
	SILTY CLAY (CH) - hard, grey with brown mottle, with slickensides		▨	S	13.5 13.95	12,18,27 N=45
	SANDSTONE (XW) - extremely low strength, orange-brown, fine grained		░	S	15.0 15.08	30/80mm
	MUDSTONE - extremely low strength, dark grey mottled black, with carbonaceous bands		▤	S	16.5 16.92	17,29,30/120mm
	End of Bore at 16.92 m					

U	Undisturbed Tube Sample (50mm dia)	S	Standard Penetration Test (SPT)	E	Environmental Sample	Is(50)	Point Load Test Result (MPa)
D	Disturbed Sample	HB	SPT Hammer Bouncing	Up	Pushtube Sample	(d)	Diametral Test
B	Bulk Sample	( )	No Sample Recovery	C	NMLC Coring	(a)	Axial Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)			(i)	Lump Test

Rig: Hydrapower Scout

Logged by: NA

Drilling Method: Auger to 1.5m, casing to 1.5m, then washbore

Groundwater: No free groundwater encountered during auger drilling

Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

BORE REPORT

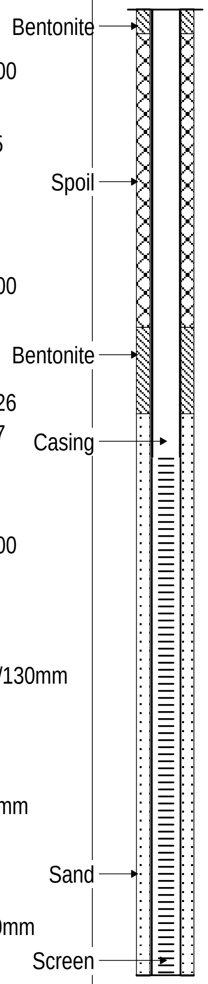
Client: Economic Development Queensland
Project: Broadscale Slope Stability Assessment
Location: Former Oxley Secondary College, Blackheath Road, Oxley
Project No: 018-118B

BORE 21

Page No: 1 of 1
Date: 26 September 2018
Ground Surface Level: RL14.5m*

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)	Test Results
0	*SANDY CLAY (CL)* - brown, fine to coarse grained (topsoil)	14.5	U	0.5 0.95	pp>600
1	*SILTY CLAY (CH)* - very stiff, brown with orange mottle, with some fine to coarse grained sand	13.0	S	1.5 1.95	3,3,5 N=8
2	- stiff, dark grey, with some fine to coarse grained sand				
3 4	- hard, pale brown	12.0 11.0 10.0	U	3.0 3.45	pp>600
5	- hard, grey, with bands of orange sandy clay		S	4.5 4.95	8,21,26 N=47
6 7	- very stiff	9.0 8.0 7.0	U	6.0 6.45	pp=500
8	- hard		S	7.5 7.93	13,25,30/130mm
9 10	*MUDSTONE (XW)* - extremely low strength, dark grey, with bands of sandstone (XW) extremely low strength, orange, fine to coarse grained	6.0 5.0	S	9.0 9.07	30/70mm
11 12	*SANDSTONE (XW)* - extremely low strength, grey and orange, fine grained	4.0 3.0	(S) S	10.5 10.6 12.0 12.22	30/100mm 29,30/70mm
13	End of Bore at 12.22 m	2.0			

Groundwater Monitoring Bore



D	Disturbed Sample	S	Standard Penetrometer Test (SPT)	C	NMLC Coring
B	Bulk Sample	HB	SPT Hammer Bouncing	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	( )	No Sample Recovery	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	V	Vane Shear Strength, Uncorrected (kPa)	(a)	Axial Point Load Strength Test

Rig: Hydrapower Scout
Logged by: NA
Drilling Method: Auger to 1.5m, HW casing to 1.5m, NW casing to 6.0m, then washbore
Groundwater: No free groundwater encountered during auger drilling
Remarks: *Approximate ground surface level estimated from a contour plan supplied by Economic Development Queensland

APPENDIX C

LABORATORY TEST REPORT SHEETS

GROUND
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Brisbane Laboratory
11 Moore Street
Albion Queensland 4010
Telephone: 61 (07) 3256 2900
Accreditation No. 19529

Certified System
Quality
ISO 9001
SAI GLOBAL

Accredited for compliance with ISO/IEC 17025 - Testing

EMERSON CLASS NUMBER TEST REPORT

Test Procedure: AS1289.3.8.1

pH TEST REPORT

Test Procedure: AS1289.4.3.1

CONDUCTIVITY REPORT

Soil Chemical Methods, Rayment & Lyons

Client:	Economic Decelopment Queensland	**Report No.:**	018-118B_ECN_T1801-08
Project:	Broadscale Slope Stability Assessment	Tested by:	NJ
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Date:	10/10/2018
		Checked by:	CL
Project No:	018-118B	Date:	12/10/2018

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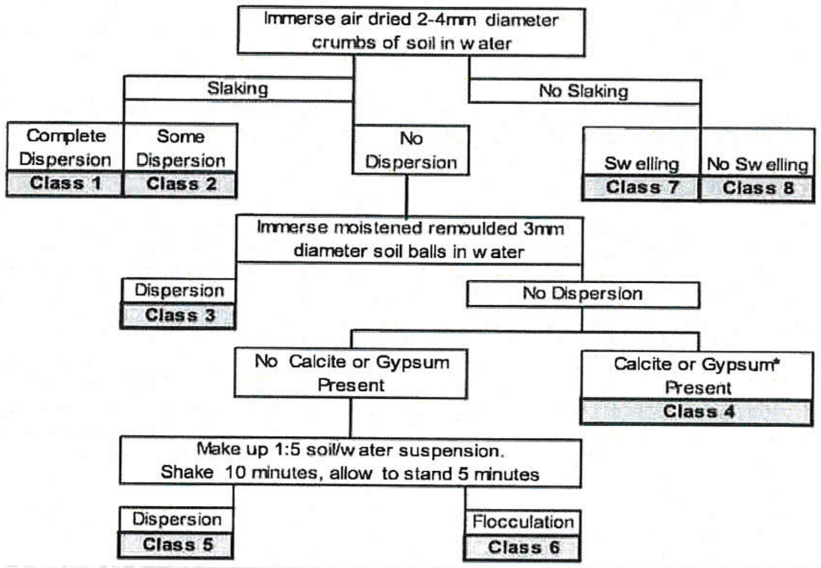
Determination of Emerson Class Number



Sample Number:	T1810-08	T1810-03	T1810-04	T1810-05	T1810-10
Sampling Method:					
AS1289.1.2.1	Clause 6.5.3	Clause 6.5.3	Clause 6.5.3	Clause 6.5.3	Clause 6.5.3
Bore:	16	17	17	18	19
Depth (m):	0.5 - 0.95	0.5 - 0.95	4.5 - 4.95	0.5 - 0.95	0.5 - 0.95
Date Sampled:	24/09/2018	24/09/2018	24/09/2018	25/09/2018	25/09/2018
Sample Description:	Silty Clay	Silty Clay	Silty Clay	Silty Clay	Silty Clay
Water Type:	Distilled	Distilled	Distilled	Distilled	Distilled
Water Temperature (°C):	21.0	21.0	21.0	21.0	21.0
Emerson Class Number	**3**	**4**	**2**	**3**	**4**
pH	**4.3**	**4.5**	**5.3**	**4.1**	**4.6**
Conductivity (mS/cm)	-	-	-	-	-

Comments:

Disclaimer:- Conductivity method is not NATA accredited

Authorised Signatory

Chris Luxton ***Date*** 30.10.18

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EMERSON CLASS NUMBER TEST REPORT

Test Procedure: AS1289.3.8.1

pH TEST REPORT

Test Procedure: AS1289.4.3.1

CONDUCTIVITY REPORT

Soil Chemical Methods, Rayment & Lyons

Client:	Economic Development Queensland	**Report No.:**	018-118B_ECN_T1901-205
Project:	Broadscale Slope Stability Assessment	Tested by:	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Date:	4/02/2019
		Checked by:	CT
Project No:	018-118B	Date:	5/02/2019

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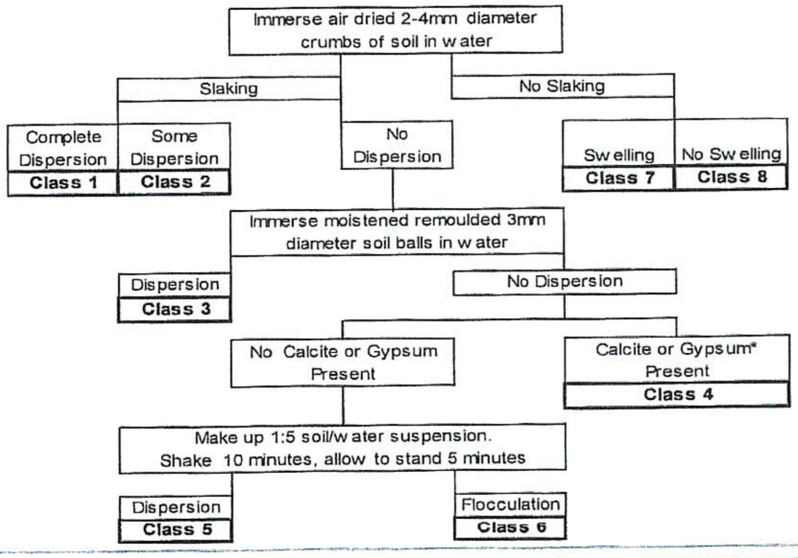
Determination of Emerson Class Number



Sample Number:	T1901-205	T1901-206	T1901-208	T1901-209	
Sampling Method:					
AS1289.1.2.1	Clause 6.5.3	Clause 6.5.3	Clause 6.5.3	Clause 6.5.3	
Bore:	25	26	27	28	
Depth (m):	0.5-0.95	0.5-0.95	1.5-1.95	0.5-0.95	
Date Sampled:	23/01/2019	24/01/2019	25/01/2019	25/01/2019	
Sample Description:	Silty Clay	Silty Clay	Sandy Clay	Fill - Silty Clay	
Water Type:	Distilled	Distilled	Distilled	Distilled	
Water Temperature (°C):	24.0	24.0	24.2	24.4	
Emerson Class Number	**4**	**4**	**3**	**3**	
pH	**4.2**	**4.5**	**4.4**	**4.4**	
Conductivity (mS/cm)	**0.09**	**0.05**	**0.21**	**0.04**	

Comments:

Disclaimer:- Conductivity method is not NATA accredited

Authorised Signatory

5/2/19

Craig Tucker ***Date***

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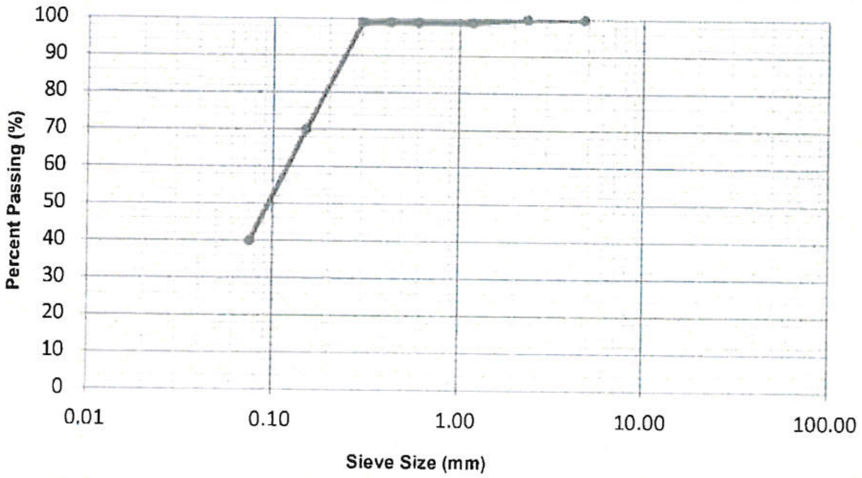
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Procedure: AS1289.3.6.1	✓	*Test Procedure: Q103A*	☐
Test Procedure: AS1289.2.1.1	✓	*Test Procedure: Q103B*	☐

Client:	Economic Development Queensland	Tested by:	NJ	Date:	5/10/2018
Project:	Broadscale Slope Stability Assessment	Checked by:	CT	Date:	8/10/2018
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Report No.:**	**018-118B_PSD_T1810-12**		
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample No.:	T1810-12
Sampling Method:	AS1289.1.2.1 Cl.6.5.3
Sample Moisture Content (%):	10.0
Bore:	19
Depth (m):	4.5 - 4.95

AS SIEVE SIZE (mm)	PERCENT PASSING
4.75	100
2.36	100
1.18	99
0.600	99
0.425	99
0.300	99
0.150	70
0.075	40



Comments:

Authorised Signatory

Chris Luxton

Date 30.10.18

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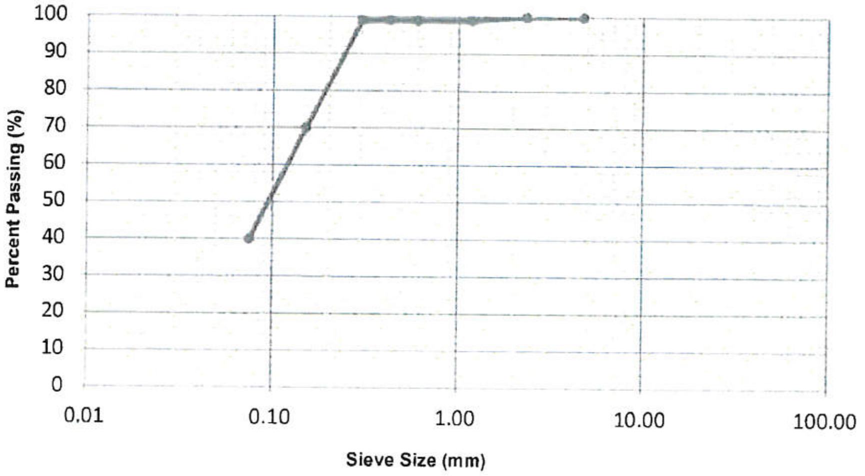
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Procedure: AS1289.3.6.1	✓	*Test Procedure: Q103A*	
Test Procedure: AS1289.2.1.1	✓	*Test Procedure: Q103B*	

Client:	Economic Development Queensland	Tested by:	NJ	Date:	5/10/2018
Project:	Broadscale Slope Stability Assessment	Checked by:	CT	Date:	8/10/2018
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Report No.:**	**018-118B_PSD_T1810-12**		
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample No.:	T1810-12
Sampling Method:	AS1289.1.2.1 Cl.6.5.3
Sample Moisture Content (%):	10.0
Bore:	19
Depth (m):	4.5 - 4.95

AS SIEVE SIZE (mm)	PERCENT PASSING
4.75	100
2.36	100
1.18	99
0.600	99
0.425	99
0.300	99
0.150	70
0.075	40



Comments:

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Chris Luxton ***Date*** 30.10.18

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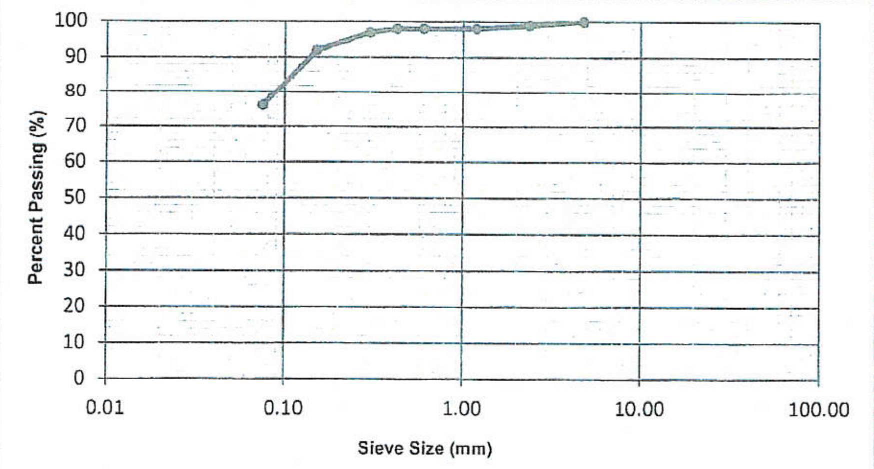
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Procedure: AS1289.3.6.1	✓	*Test Procedure: Q103A*	☐
Test Procedure: AS1289.2.1.1	✓	*Test Procedure: Q103B*	☐

Client:	Economic Development Queensland	Tested by:	KH	Date:	4/02/2019
Project:	Broadscale Slope Stability Assessment	Checked by:	CT	Date:	5/02/2019
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Report No.:**	**018-118B_PSD_T1901-207**		
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample No.:	T1901-207
Sampling Method:	AS1289.1.2.1 Cl.6.5.3
Sample Moisture Content (%):	12.4
Bore:	27
Depth (m):	0.5-0.95

AS SIEVE SIZE (mm)	PERCENT PASSING
4.75	100
2.36	99
1.18	98
0.600	98
0.425	98
0.300	97
0.150	92
0.075	76



Comments:

Authorised Signatory

5/2/19

Craig Tucker ***Date***

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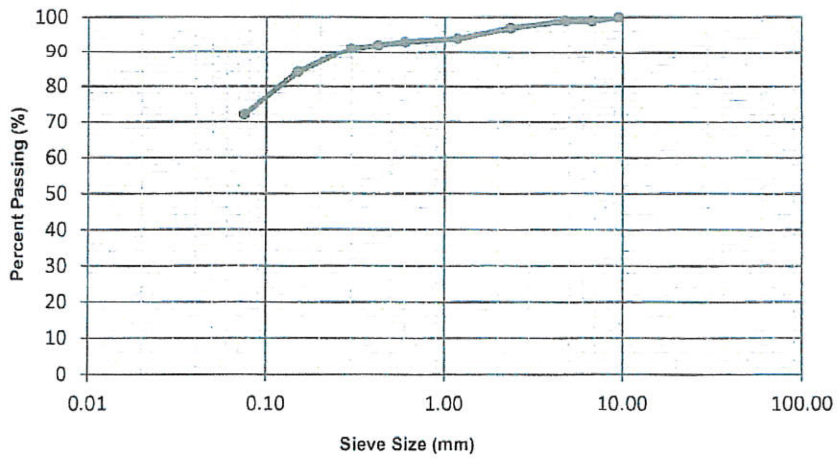
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Procedure: AS1289.3.6.1	☑	*Test Procedure: Q103A*	☐
Test Procedure: AS1289.2.1.1	☑	*Test Procedure: Q103B*	☐

Client:	Economic Development Queensland	Tested by:	KH	Date:	4/02/2019
Project:	Broadscale Slope Stability Assessment	Checked by:	CT	Date:	5/02/2019
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Report No.:**	**018-118B_PSD_T1901-209**		
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample No.:	T1901-209
Sampling Method:	AS1289.1.2.1 Cl.6.5.3
Sample Moisture Content (%):	10.4
Bore:	28
Depth (m):	0.5-0.95

AS SIEVE SIZE (mm)	PERCENT PASSING
9.5	100
6.7	99
4.75	99
2.36	97
1.18	94
0.600	93
0.425	92
0.300	91
0.150	84
0.075	72



Comments:

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Craig Tucker

5/2/19
Date

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Atterberg Limits Test Report

Test Procedure: AS1289.2.1.1
Test Procedure: AS1289.3.1.2
Test Procedure: AS1289.3.2.1
Test Procedure: AS1289.3.3.1
Test Procedure: AS1289.3.4.1

Client:	Economic Development Queensland	**Report No.:**	**018-118B_ATL_T1810-09**		
Project:	Broadscale Slope Stability Assessment	Tested by:	NJ	Date:	5/10/2018
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Checked by:	CT	Date:	9/10/2018
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample Number:	T1810-09	T1810-17	T1810-04	T1810-07	T1810-06
Sampling Method: AS1289.1.2.1	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3
Sample Location:	16	16	17	18	18
Sample Location:	3.0 - 3.45	4.5-4.95	4.5 - 4.95	4.5 - 4.95	7.5 - 7.95
Liquid Limit (%)	58	64	42	52	32
Plastic Limit (%)	14	18	15	23	15
Plasticity Index (%)	44	46	27	29	17
Linear Shrinkage (%)	14.5	17.0	12.0	12.0	6.0
Sample Moisture Content (%)	18.3	20.1	14.8	28.5	29.3
Shrinkage Mould Length (mm)	*125.00*	*250.00*	*125.00*	*125.00*	*125.00*
Sample History	*Air Dried*	*Air Dried*	*Air Dried*	*Air Dried*	*Air Dried*
Sample Preparation	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*
Cracking of Linear Shrinkage Sample	*None*	*None*	*None*	*None*	*None*
Crumbling of Linear Shrinkage Sample	*None*	*None*	*None*	*None*	*None*
Curling of Linear Shrinkage Sample	*Slight*	*None*	*None*	*Slight*	*None*

Comments

Authorised Signatory

Chris Luxton

Date 30.10.18

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Accreditation No. 18820

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Atterberg Limits Test Report

Test Procedure: AS1289.2.1.1
Test Procedure: AS1289.3.1.1
Test Procedure: AS1289.3.2.1
Test Procedure: AS1289.3.3.1
Test Procedure: AS1289.3.4.1

Client:	Economic Development Queensland	**Report No.:**	**018-118B_ATL_G1810-126**		
Project:	Broadscale Slope Stability Assessment	Tested by:	HO/CL	Date:	18/10/2018
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Checked by:	CL	Date:	19/10/2018
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample Number:	G1810-126
Sampling Method:	AS1289.1.2.1 Cl.6.5.3
Bore:	18
Depth (m):	7.5 - 7.95

Liquid Limit (%)	54
Plastic Limit (%)	21
Plasticity Index (%)	33
Linear Shrinkage (%)	11.0
Sample Moisture Content (%)	31.3

Shrinkage Mould Length (mm)	*125.00*
Sample History	*Oven Dried*
Sample Preparation	*Dry Sieved*
Cracking of Linear Shrinkage Sample	*None*
Crumbling of Linear Shrinkage Sample	*None*
Curling of Linear Shrinkage Sample	*None*

Comments

Authorised Signatory

Christopher Luxton

Date 30.10.18

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Atterberg Limits Test Report

Test Procedure: AS1289.2.1.1
Test Procedure: AS1289.3.1.2
Test Procedure: AS1289.3.2.1
Test Procedure: AS1289.3.3.1
Test Procedure: AS1289.3.4.1

Client:	Economic Development Queensland	**Report No.:**	**018-118B_ATL_T1810-11**		
Project:	Broadscale Slope Stability Assessment	Tested by:	NJ	Date:	5/10/2018
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Checked by:	CT	Date:	9/10/2018
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample Number:	T1810-11	T1810-14	T1810-15	T1810-16	T1810-01
Sampling Method: AS1289.1.2.1	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3
Sample Location:	19	20	20	20	21
Sample Location:	3.0 - 3.45	1.5 - 1.95	3.0 - 3.45	10.5 - 10.95	1.5 - 1.95
Liquid Limit (%)	51	69	73	73	95
Plastic Limit (%)	21	15	20	24	24
Plasticity Index (%)	30	54	53	49	71
Linear Shrinkage (%)	12.0	18.0	20.0	19.0	24.5
Sample Moisture Content (%)	11.3	20.9	26.4	31.8	36.4
Shrinkage Mould Length (mm)	*125.00*	*125.00*	*125.00*	*125.00*	*125.00*
Sample History	*Air Dried*	*Air Dried*	*Air Dried*	*Air Dried*	*Air Dried*
Sample Preparation	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*
Cracking of Linear Shrinkage Sample	*None*	*None*	*None*	*None*	*None*
Crumbling of Linear Shrinkage Sample	*None*	*None*	*None*	*None*	*None*
Curling of Linear Shrinkage Sample	*None*	*Slight*	*Slight*	*Slight*	*Moderate*

Comments

Authorised Signatory

Chris Luxton **Date** 30.10.18

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Atterberg Limits Test Report

Test Procedure: AS1289.2.1.1
Test Procedure: AS1289.3.1.1
Test Procedure: AS1289.3.2.1
Test Procedure: AS1289.3.3.1
Test Procedure: AS1289.3.4.1

Client:	Economic Development Queensland	**Report No.:**	**018-118B_ATL_T1901-208**		
Project:	Broadscale Slope Stability Assessment	Tested by:	CL	Date:	4/02/2019
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Checked by:	CT	Date:	5/02/2019
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample Number:	T1901-208
Sampling Method:	AS1289.1.2.1 Cl.6.5.3
Bore:	27
Depth (m):	1.5-1.95

Liquid Limit (%)	52
Plastic Limit (%)	15
Plasticity Index (%)	37
Linear Shrinkage (%)	7.0
Sample Moisture Content (%)	15.1

Shrinkage Mould Length (mm)	*250.00*
Sample History	*Oven Dried*
Sample Preparation	*Dry Sieved*
Cracking of Linear Shrinkage Sample	*None*
Crumbling of Linear Shrinkage Sample	*None*
Curling of Linear Shrinkage Sample	*None*

Comments

Authorised Signatory

5/2/19

Craig Tucker ***Date***

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Atterberg Limits Test Report

Test Procedure: AS1289.2.1.1
Test Procedure: AS1289.3.1.2
Test Procedure: AS1289.3.2.1
Test Procedure: AS1289.3.3.1
Test Procedure: AS1289.3.4.1

Client:	Economic Development Queensland	**Report No.:**	**018-118B_ATL_T1903-90**		
Project:	Broadscale Slope Stability Assessment	Tested by:	FL	Date:	8/03/2019
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	Checked by:	CT	Date:	11/03/2019
Project No:	018-118B	THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL			

Sample Number:	T1903-90	T1903-91	T1903-92		
Sampling Method: AS1289.1.2.1	Cl.6.5.3	Cl.6.5.3	Cl.6.5.3		
Bore:	29	29	29		
Depth (m):	4.5-4.95	7.5-7.95	12.0-12.45		

Liquid Limit (%)	47	49	43		
Plastic Limit (%)	22	17	18		
Plasticity Index (%)	25	32	25		
Linear Shrinkage (%)	10.0	15.0	10.5		
Sample Moisture Content (%)	22.8	24.2	18.4		

Shrinkage Mould Length (mm)	*125.00*	*125.00*	*125.00*		
Sample History	*Oven Dried*	*Oven Dried*	*Oven Dried*		
Sample Preparation	*Dry Sieved*	*Dry Sieved*	*Dry Sieved*		
Cracking of Linear Shrinkage Sample	*None*	*None*	*None*		
Crumbling of Linear Shrinkage Sample	*None*	*None*	*None*		
Curling of Linear Shrinkage Sample	*Moderate*	*Slight*	*None*		

Comments

Authorised Signatory

Craig Tucker

11/3/19
Date

Material Test Report

Report Number: **018-118B-1**
Issue Number: 3 - *This version supersedes all previous issues*
Date Issued: 12/03/2019
Client: Economic Development Queensland
Level 14, 1 William Street, Brisbane QLD 4000
Project Number: 018-118B
Project Name: Broadscale Slope Stability Assessment
Project Location: Former Oxley Secondary College, Blackheath Road, Oxley
Work Request: 70
Sample Number: G19-70A
Date Sampled: 23/01/2019
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **Bore 25 (4.5 - 4.95m)**

Ground Testing Services Pty Ltd
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Email: cluxton@groundtestingservices.com.au

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Approved Signatory: Chris Luxton
Laboratory Manager
NATA Accredited Laboratory Number: 18820

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	43		
Plastic Limit (%)	14		
Plasticity Index (%)	**29**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	11.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	16.2

Material Test Report

Report Number: 018-118B-1
Issue Number: 3 - *This version supersedes all previous issues*
Date Issued: 12/03/2019
Client: Economic Development Queensland
Level 14, 1 William Street, Brisbane QLD 4000
Project Number: 018-118B
Project Name: Broadscale Slope Stability Assessment
Project Location: Former Oxley Secondary College, Blackheath Road, Oxley
Work Request: 70
Sample Number: G19-70B
Date Sampled: 24/01/2019
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **Bore 26 (7.5 - 7.95m)**

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Approved Signatory: Chris Luxton
Laboratory Manager
NATA Accredited Laboratory Number: 18820

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	87		
Plastic Limit (%)	28		
Plasticity Index (%)	**59**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	21.0		
Cracking Crumbling Curling	Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	27.1

Material Test Report

Report Number: **018-118B-1**
Issue Number: 3 - *This version supersedes all previous issues*
Date Issued: 12/03/2019
Client: Economic Development Queensland
Level 14, 1 William Street, Brisbane QLD 4000
Project Number: 018-118B
Project Name: Broadscale Slope Stability Assessment
Project Location: Former Oxley Secondary College, Blackheath Road, Oxley
Work Request: 70
Sample Number: G19-70C
Date Sampled: 25/01/2019
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **Bore 27 (6.0 - 6.45m)**

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Approved Signatory: Chris Luxton
Laboratory Manager
NATA Accredited Laboratory Number: 18820

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	47		
Plastic Limit (%)	14		
Plasticity Index (%)	**33**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	11.0		
Cracking Crumbling Curling	None		

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

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Consolidated Undrained Triaxial Test Summary

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CUS_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

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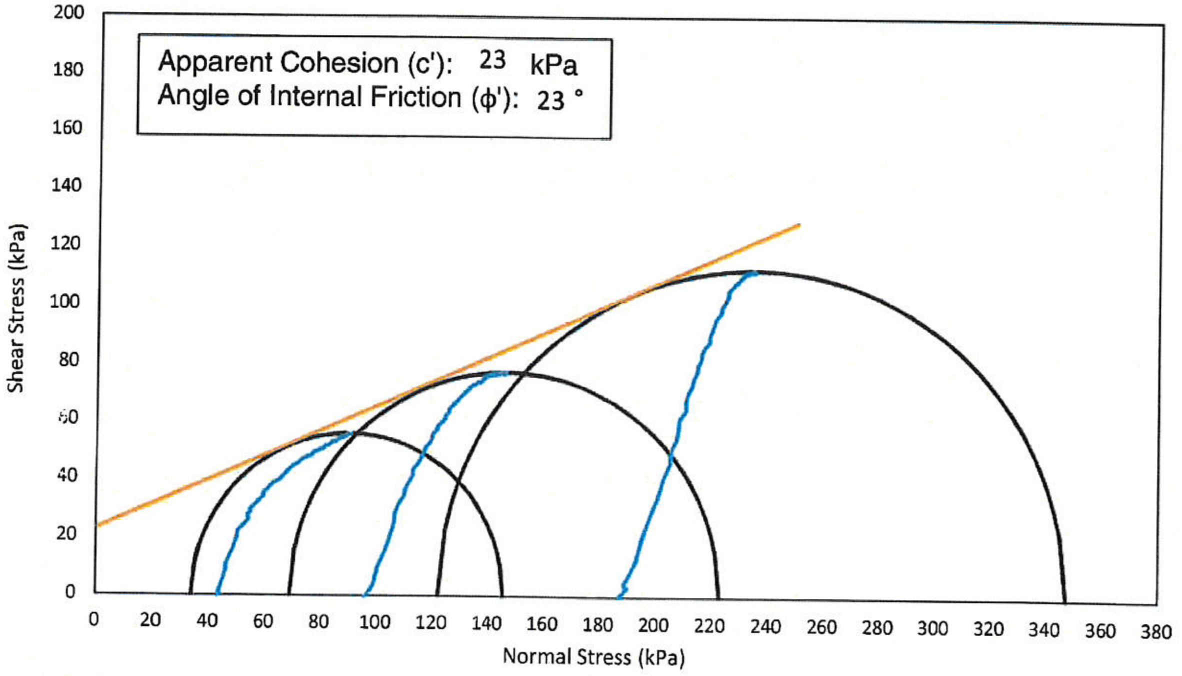
Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018
Initial Height (mm):	92.0	**Initial Diameter (mm):**	47.0
Initial Moisture Content (%):	31.3	**Wet Density (t/m^3):**	1.85
Final Moisture Content (%):	33.7	**Dry Density (t/m^3):**	1.41
Length to Diameter Ratio:	2.0	**Failure Type:**	Shear

Mohr Circle Diagram (with stress paths)



Stage	**Initial Effective Stress (kPa)**	**σ'_{1f} - σ'_{3f} (kPa)**	**σ'_{1f} (kPa)**	**σ'_{3f} (kPa)**	**u_f (kPa)**
1	50	111.4	145.4	34.0	16.0
2	100	154.1	223.1	69.0	31.0
3	200	225.2	347.2	122.0	78.0
		at 20% strain	308.4	146.0	54.0

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Consolidated Undrained Triaxial Test Report

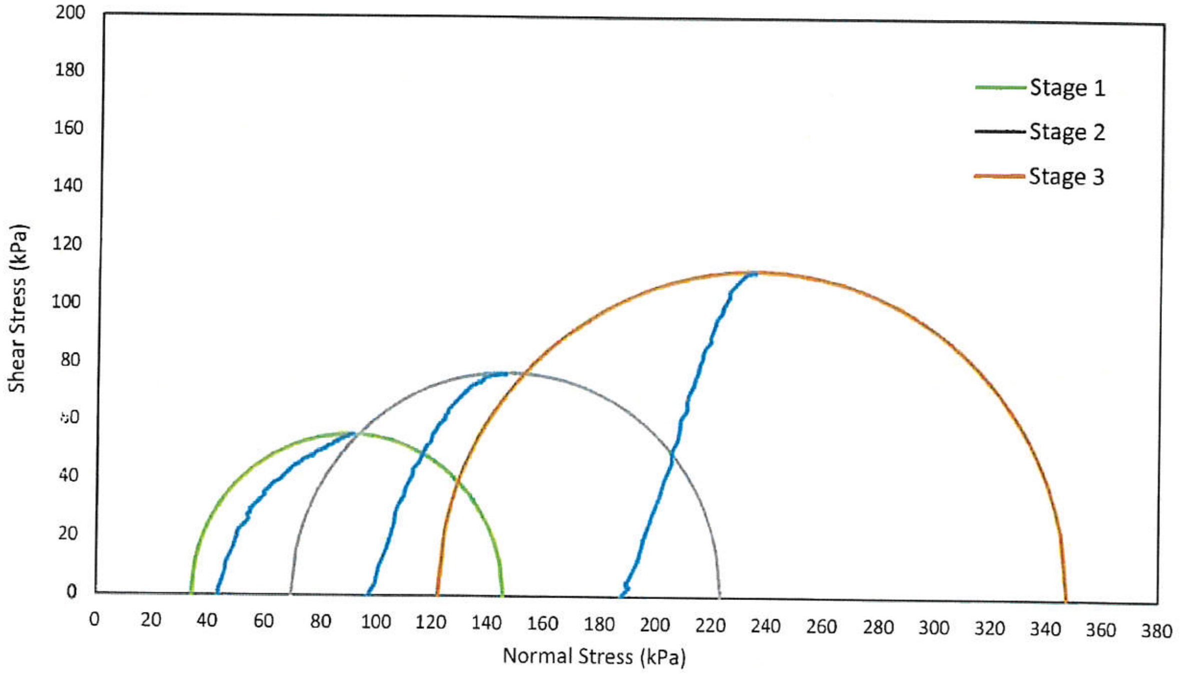
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018
Initial Height (mm):	92.0	**Initial Diameter (mm):**	47.0
Initial Moisture Content (%):	31.3	**Wet Density (t/m^3):**	1.85
Final Moisture Content (%):	33.7	**Dry Density (t/m^3):**	1.41
Length to Diameter Ratio:	2.0	**Failure Type:**	Shear

Mohr Circle Diagram (with stress paths)



Stage	**Initial Effective Stress (kPa)**	**σ'_{1f} . σ'_{3f} (kPa)**	**σ'_{1f} (kPa)**	**σ'_{3f} (kPa)**	**u_f (kPa)**
1	50	111.4	145.4	34.0	16.0
2	100	154.1	223.1	69.0	31.0
3	200	225.2	347.2	122.0	78.0
		at 20% strain	308.4	146.0	54.0

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Consolidated Undrained Triaxial Test Report

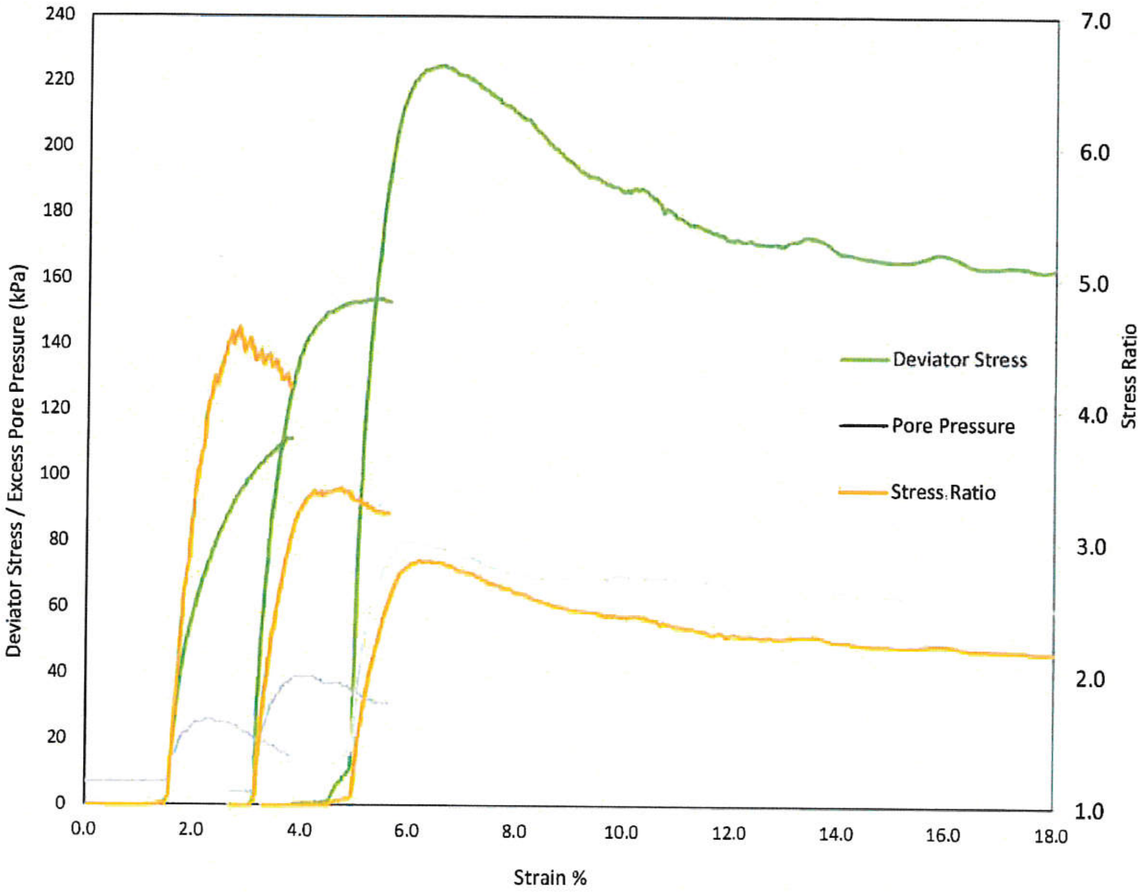
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Stress / Strain Plot



Stage	Strain Rate (mm/hr)	Maximum Deviator Stress (kPa)	Strain at Maximum Deviator Stress (%)
1	0.005	111.4	3.68
2	0.086	154.1	5.32
3	0.058	225.2	6.52

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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

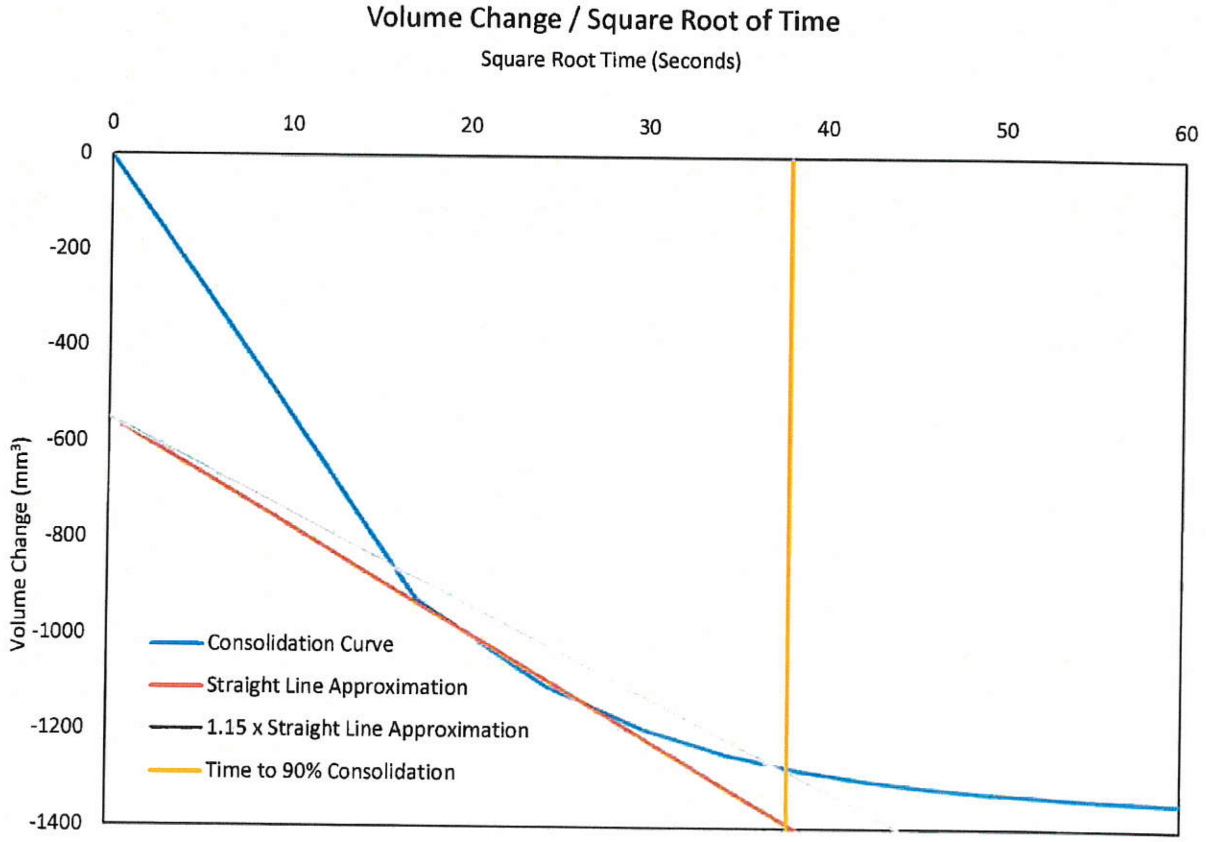
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Consolidation Stage 1

Cell Pressure (kPa):	550	**Back Pressure (kPa):**	500	**Effective Stress σ' (kPa):**	50



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

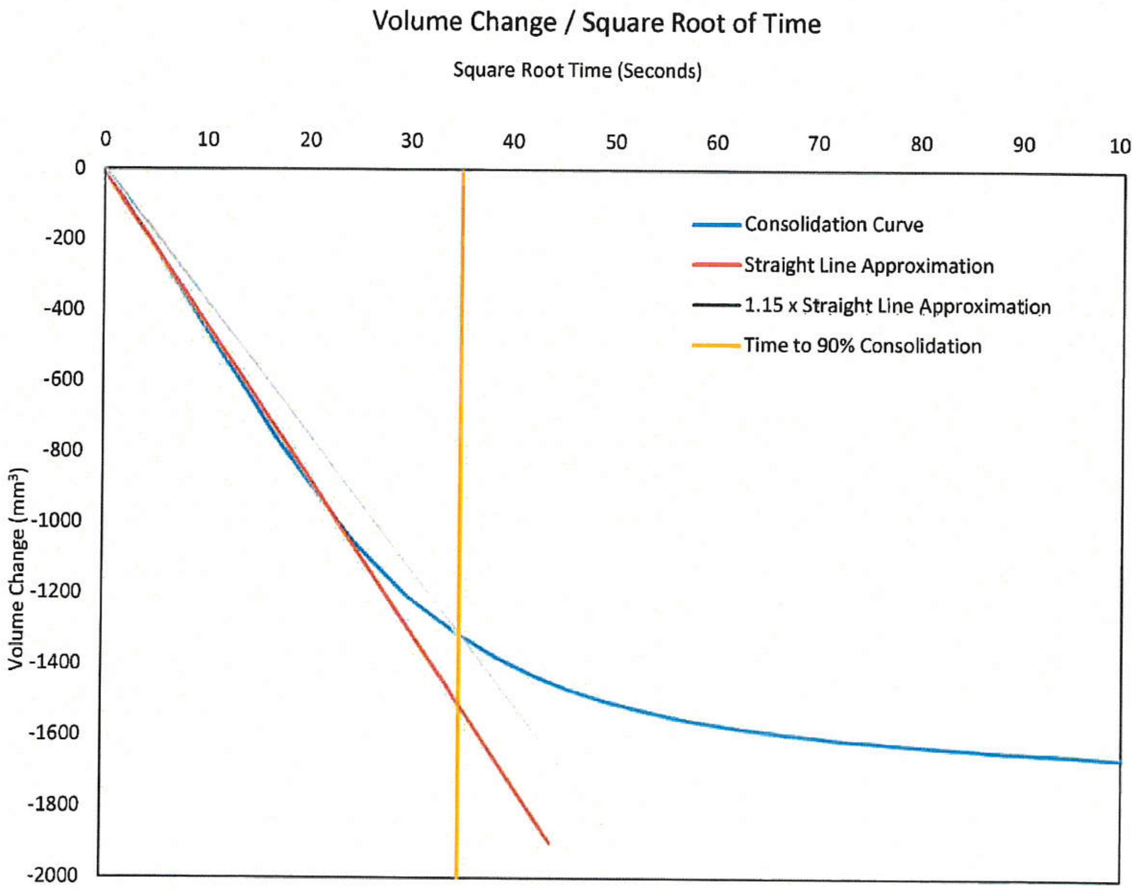
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Consoilidation Stage 2

Cell Pressure (kPa):	600	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	100



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

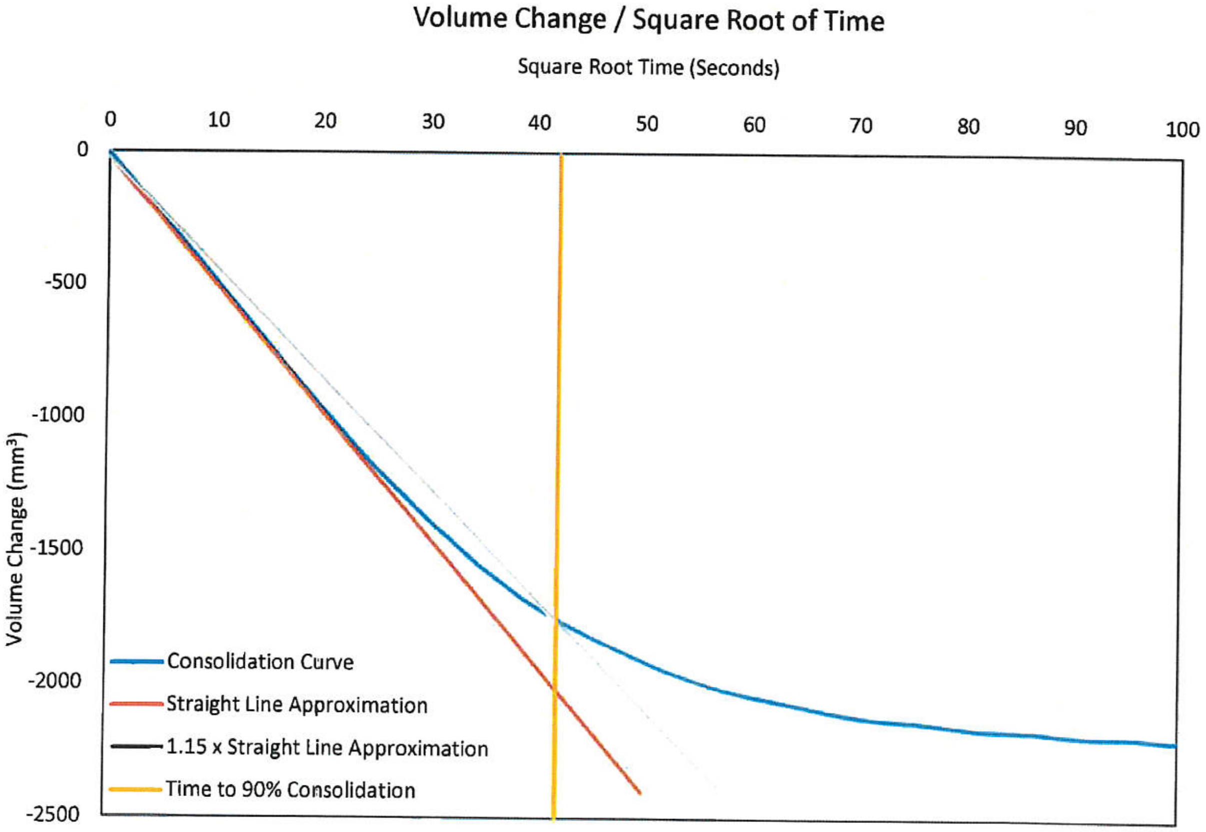
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Consolidation Stage 3

Cell Pressure (kPa):	700	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	200



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-126
Project:	Broadscale Slope Stability Assessment	**Tested by:**	WR
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	10/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	16/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-126
Bore:	18	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018
Saturation Phase - ΔH (mm):	0.1	**Initial Cell Pressure (kPa):**	0

Sample Before Test

Sample After Test

Sample Description (Clause 10(e))

No natural layers, stones, or calcerous matter.

Comments:

Authorised Signatory:

Michael Neighbour

Date: 16.10.18

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Accreditation No. 18820

Consolidated Undrained Triaxial Test Summary

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CUS_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

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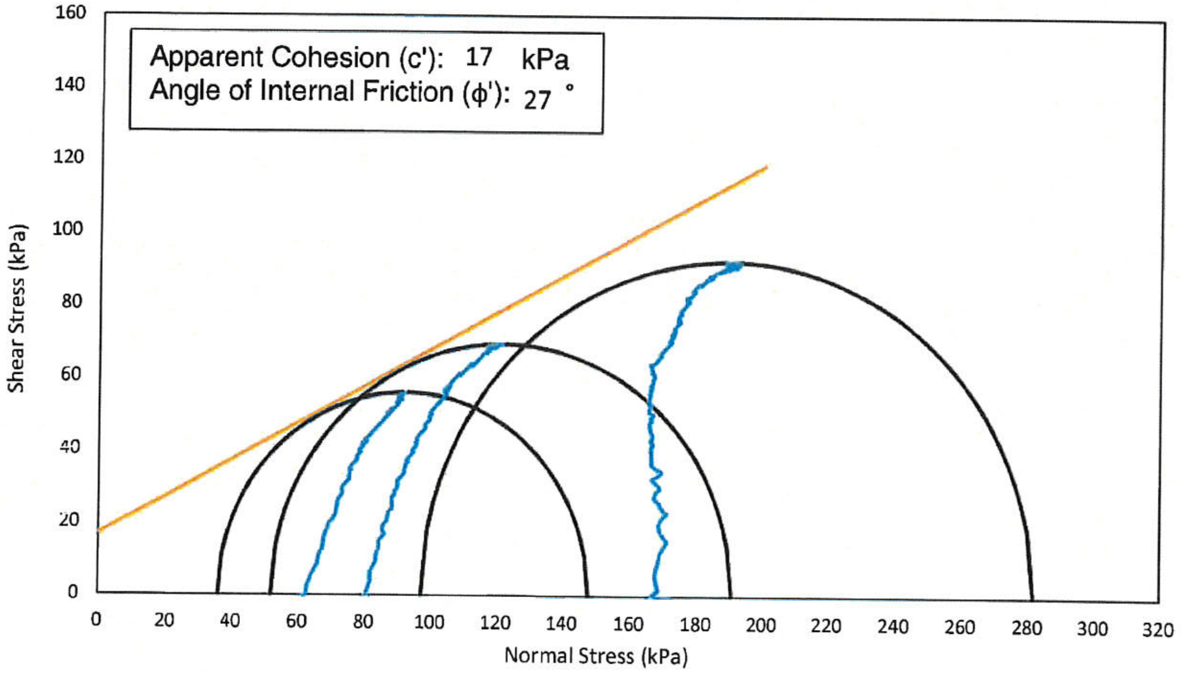
Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018
Initial Height (mm):	100.2	**Initial Diameter (mm):**	47.8
Initial Moisture Content (%):	19.1	**Wet Density (t/m^3):**	2.05
Final Moisture Content (%):	24.1	**Dry Density (t/m^3):**	1.72
Length to Diameter Ratio:	2.1	**Failure Type:**	Shear

Mohr Circle Diagram (with stress paths)



Stage	**Initial Effective Stress (kPa)**	**$\sigma'_{1f} - \sigma'_{3f}$ (kPa)**	**σ'_{1f} (kPa)**	**σ'_{3f} (kPa)**	**u_f (kPa)**
1	50	111.7	147.7	36.0	14.0
2	100	138.6	190.6	52.0	48.0
3	200	184.5	281.5	97.0	103.0
		at 20% strain	264.4	124.0	76.0

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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

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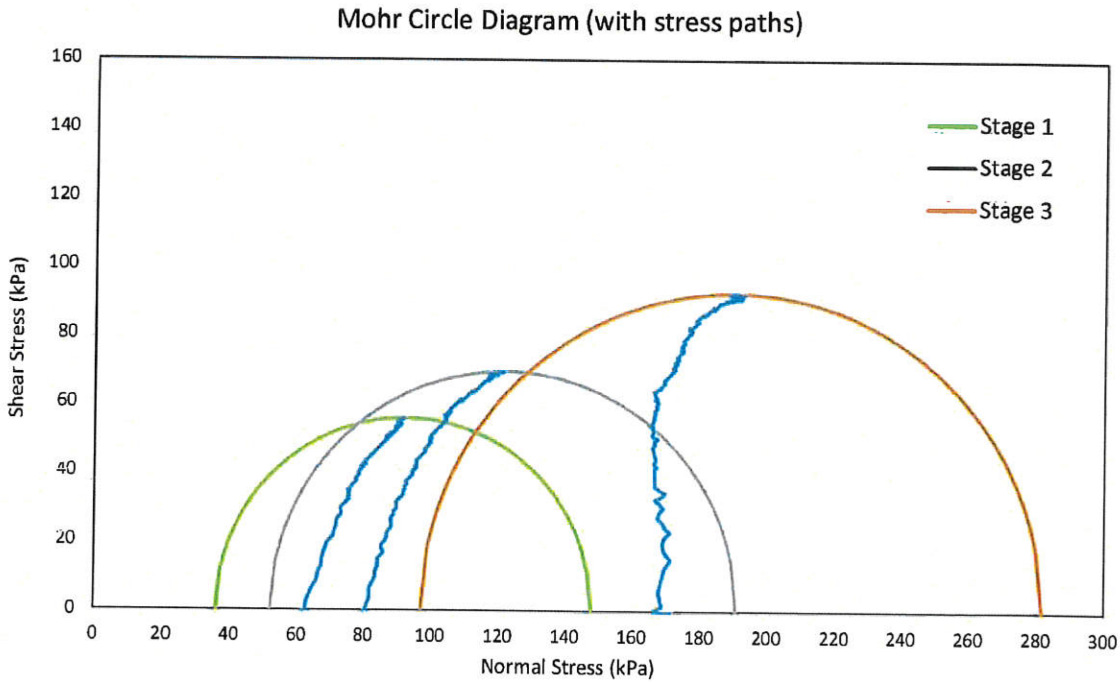
Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018
Initial Height (mm):	100.2	**Initial Diameter (mm):**	47.8
Initial Moisture Content (%):	19.1	**Wet Density (t/m^3):**	2.05
Final Moisture Content (%):	24.1	**Dry Density (t/m^3):**	1.72
Length to Diameter Ratio:	2.1	**Failure Type:**	Shear



Stage	Initial Effective Stress (kPa)	$\sigma'_{1f} - \sigma'_{3f}$ (kPa)	σ'_{1f} (kPa)	σ'_{3f} (kPa)	u_f (kPa)
1	50	111.7	147.7	36.0	14.0
2	100	138.6	190.6	52.0	48.0
3	200	184.5	281.5	97.0	103.0
		at 20% strain	264.4	124.0	76.0

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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289 6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

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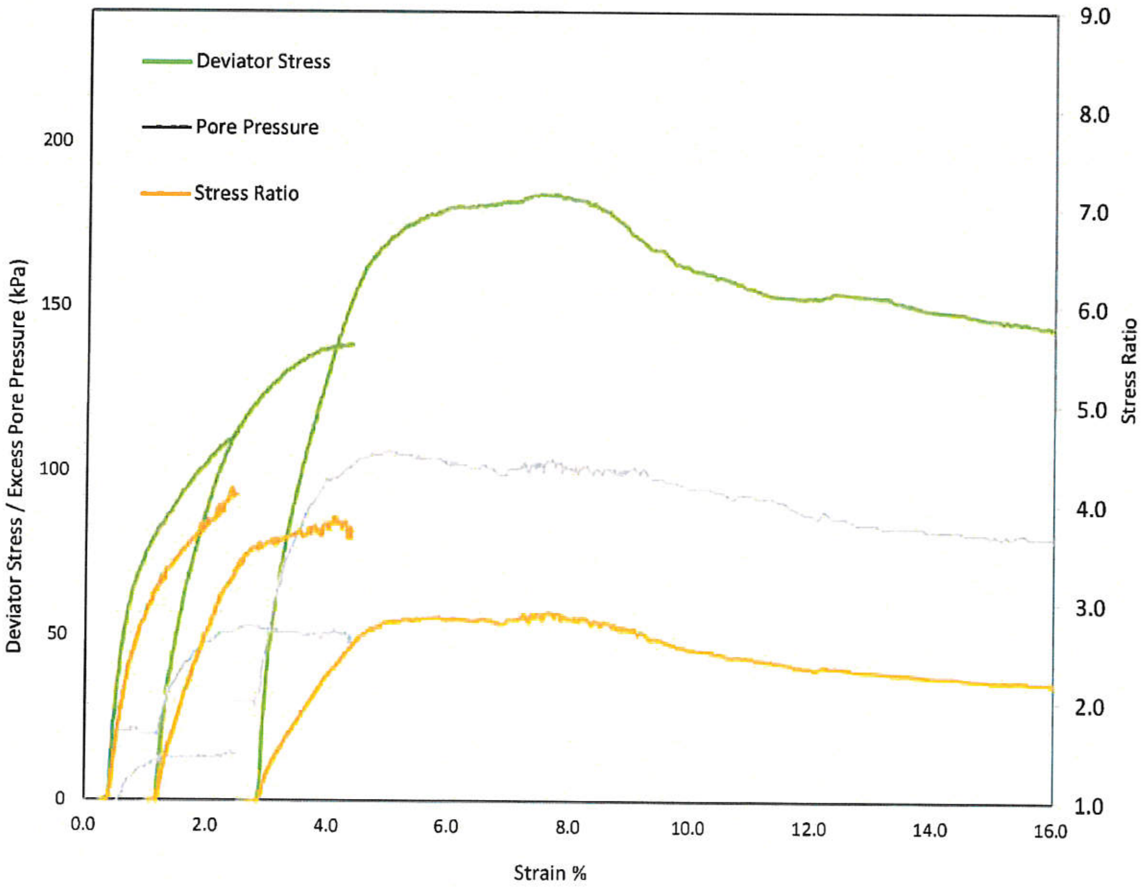
Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Stress / Strain Plot



Stage	Strain Rate (mm/hr)	Maximum Deviator Stress (kPa)	Strain at Maximum Deviator Stress (%)
1	0.001	111.7	2.44
2	0.001	138.6	4.31
3	0.000	184.5	7.71

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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

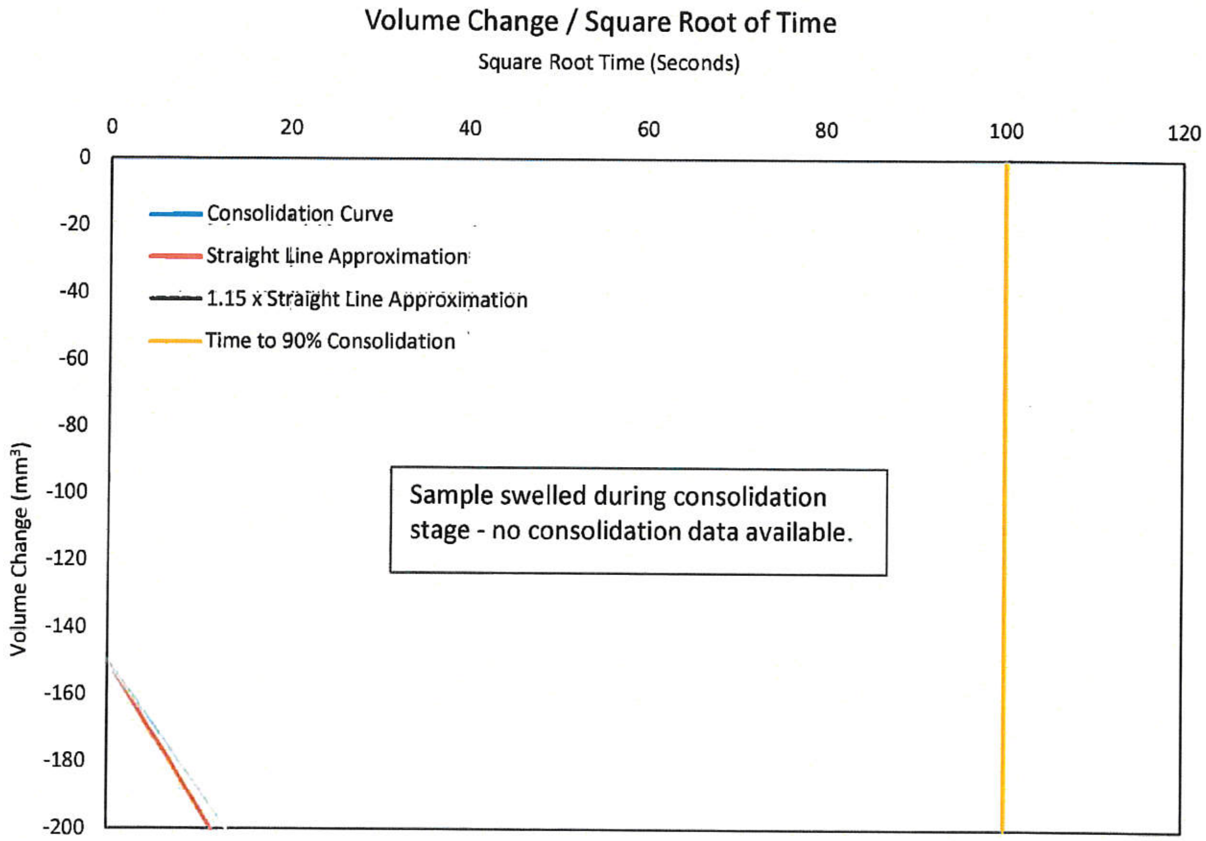
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Consolidation Stage 1

Cell Pressure (kPa):	550	**Back Pressure (kPa):**	500	**Effective Stress σ' (kPa):**	50



Sample swelled during consolidation stage - no consolidation data available.

Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

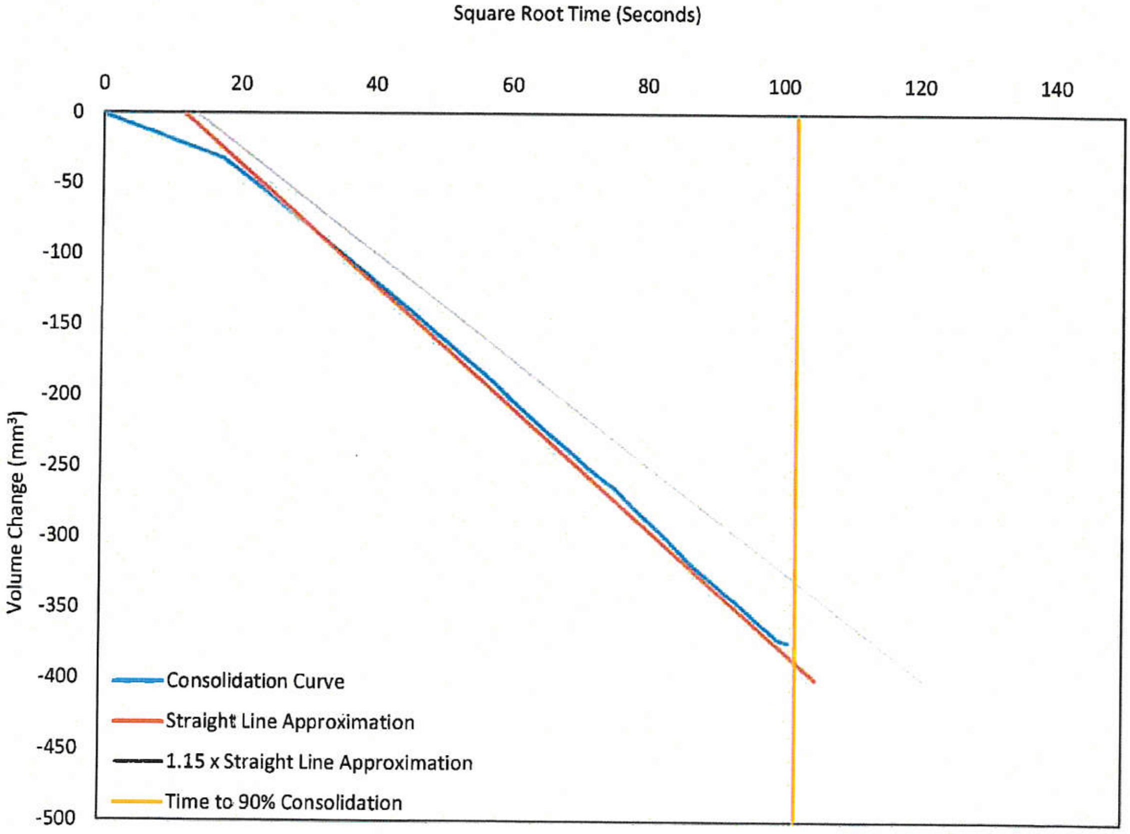
THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Consoilidation Stage 2

Cell Pressure (kPa):	600	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	100

Volume Change / Square Root of Time



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

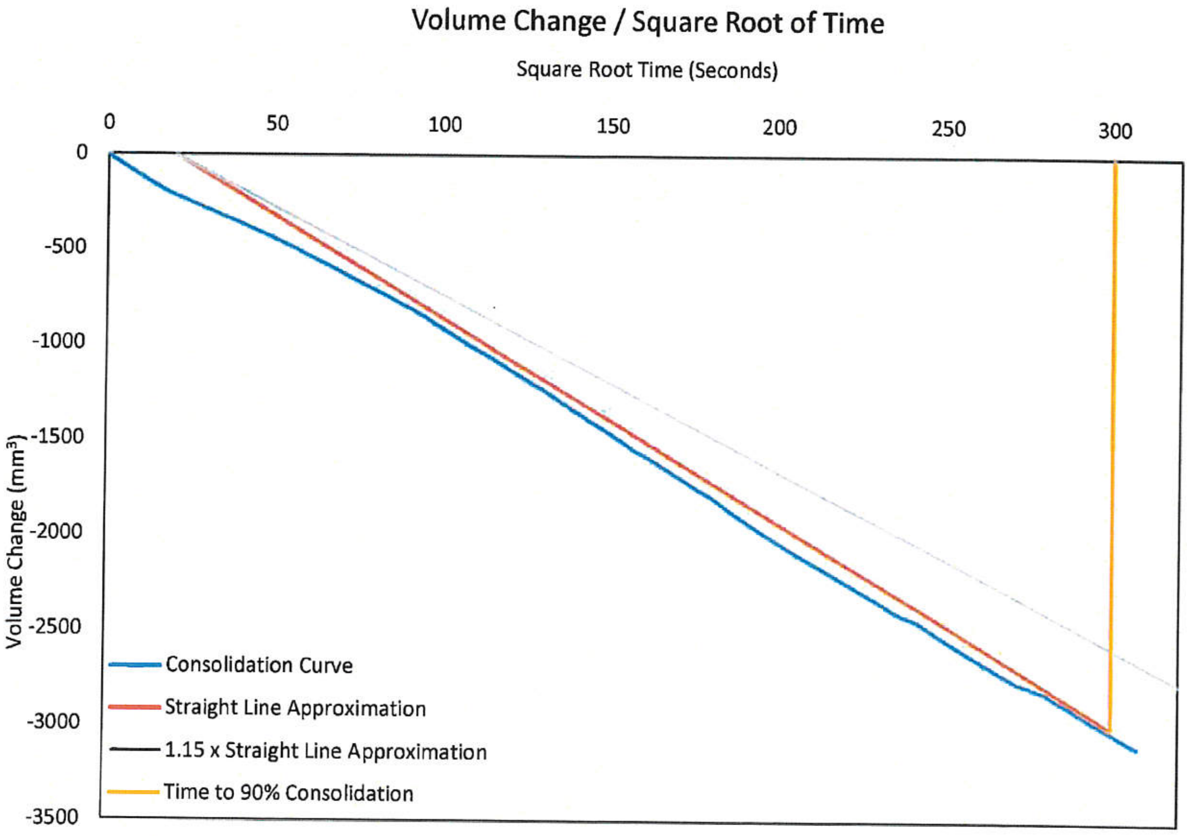
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018

Consolidation Stage 3

Cell Pressure (kPa):	700	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	200



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Consolidated Undrained Triaxial Test Report

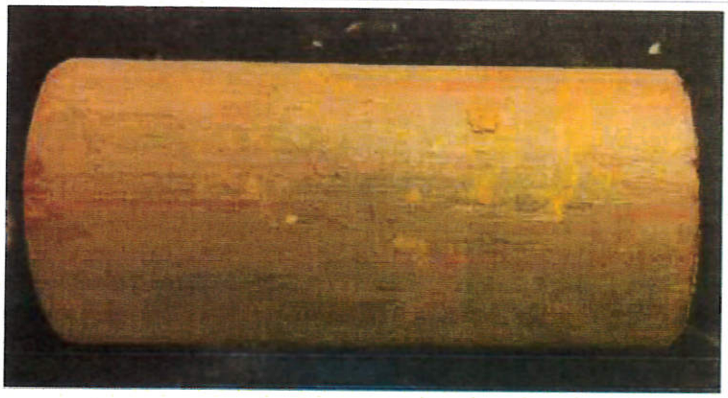
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G1810-124
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College, Blackheath Road, Oxley	**Date:**	17/10/2018
		Checked by:	WR
Project No:	018-118B	**Date:**	26/10/2018

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G1810-124
Bore:	20	**Depth (m):**	1.5 - 1.95
Sample Type:	Undisturbed	**Date Sampled:**	25/09/2018
Saturation Phase - ΔH (mm):	0.3	**Initial Cell Pressure (kPa):**	0

Sample Before Test



Sample After Test

Sample Description (Clause 10(e))

Trace of fine angular gravel found in sample upon post test inspection.

Comments:

Authorised Signatory:

Michael Neighbour

Date: 26.10.18

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Consolidated Undrained Triaxial Test Summary

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

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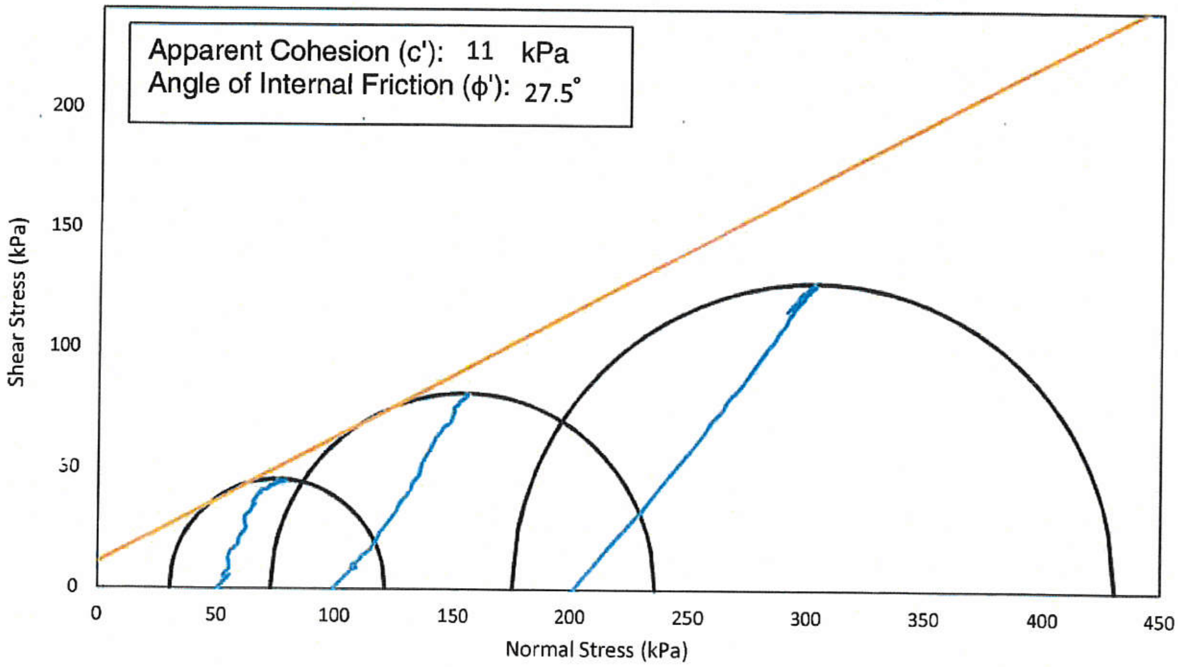
Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019
Initial Height (mm):	97.9	**Initial Diameter (mm):**	47.6
Initial Moisture Content (%):	16.3	**Wet Density (t/m^3):**	2.13
Final Moisture Content (%):	18.0	**Dry Density (t/m^3):**	1.83
Length to Diameter Ratio:	2.0	**Failure Type:**	Shear

Mohr Circle Diagram (with stress paths)



Stage	Initial Effective Stress (kPa)	$\sigma'_{1f} - \sigma'_{3f}$ (kPa)	σ'_{1f} (kPa)	σ'_{3f} (kPa)	u_f (kPa)
1	50	90.9	120.9	30.0	20.0
2	100	162.9	235.9	73.0	27.0
3	200	255.4	430.4	175.0	25.0
		at 20% strain	407.5	175.0	25.0

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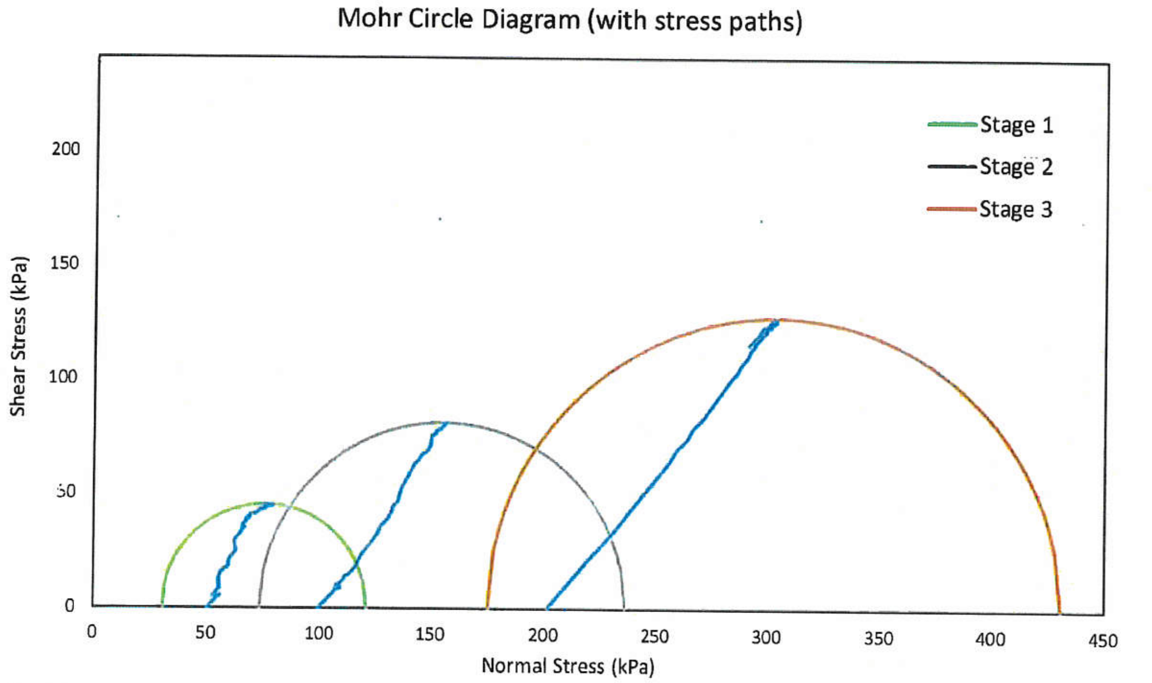
Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019
Initial Height (mm):	97.9	**Initial Diameter (mm):**	47.6
Initial Moisture Content (%):	16.3	**Wet Density (t/m^3):**	2.13
Final Moisture Content (%):	18.0	**Dry Density (t/m^3):**	1.83
Length to Diameter Ratio:	2.0	**Failure Type:**	Shear



Stage	**Initial Effective Stress (kPa)**	**$\sigma'_{1f} - \sigma'_{3f}$ (kPa)**	**σ'_{1f} (kPa)**	**σ'_{3f} (kPa)**	**u_f (kPa)**
1	50	90.9	120.9	30.0	20.0
2	100	162.9	235.9	73.0	27.0
3	200	255.4	430.4	175.0	25.0
		at 20% strain	407.5	175.0	25.0

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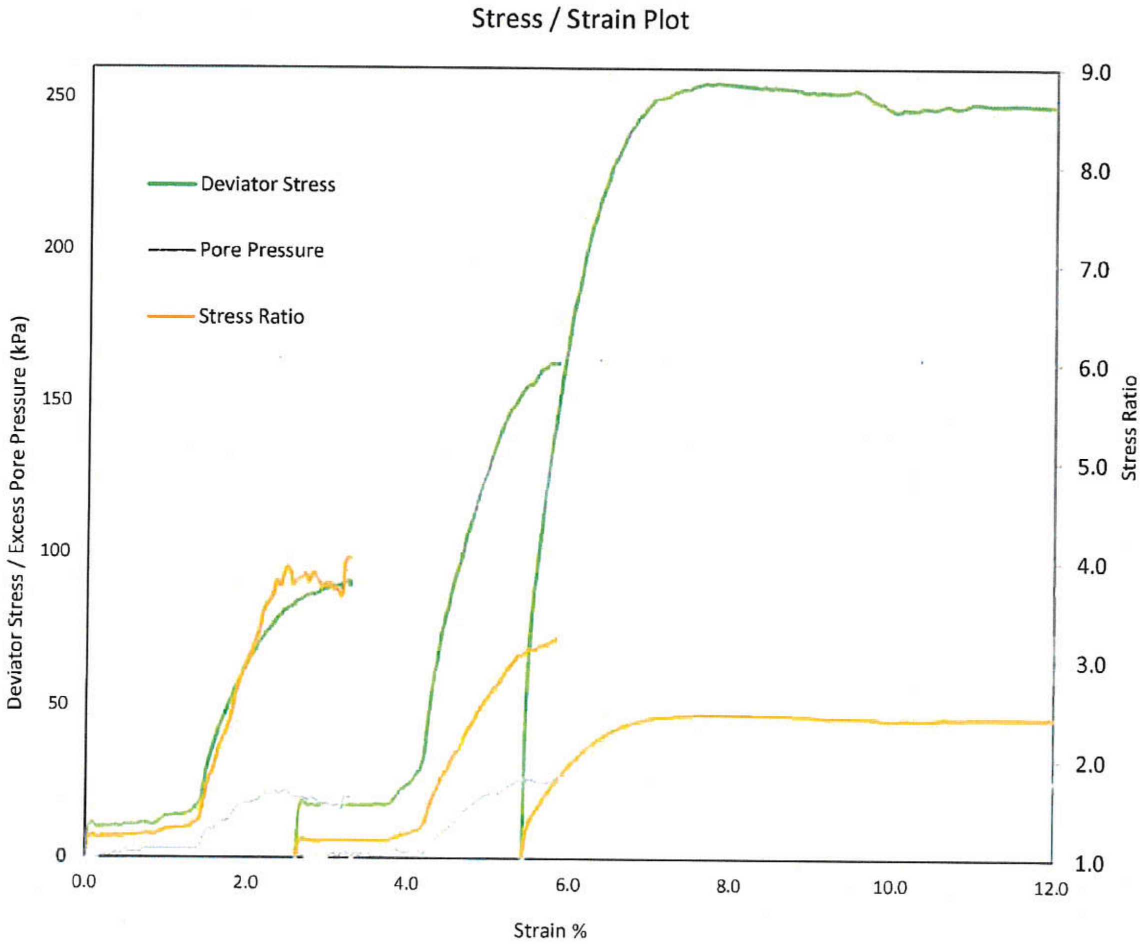
Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019



Stage	Strain Rate (mm/hr)	Maximum Deviator Stress (kPa)	Strain at Maximum Deviator Stress (%)
1	0.011	90.9	3.25
2	0.008	162.9	5.84
3	0.005	255.4	7.78

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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

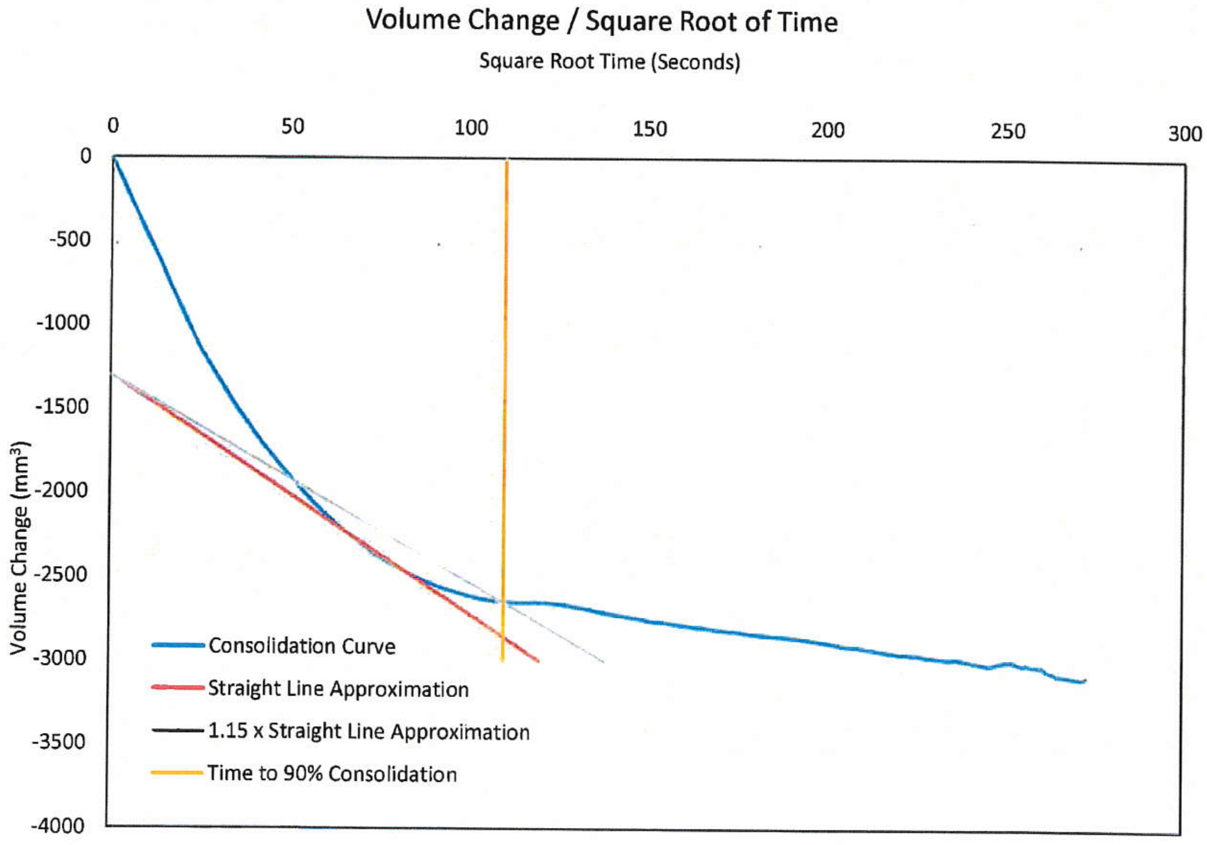
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019

Consolidation Stage 1

Cell Pressure (kPa):	551	**Back Pressure (kPa):**	501	**Effective Stress σ' (kPa):**	50



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

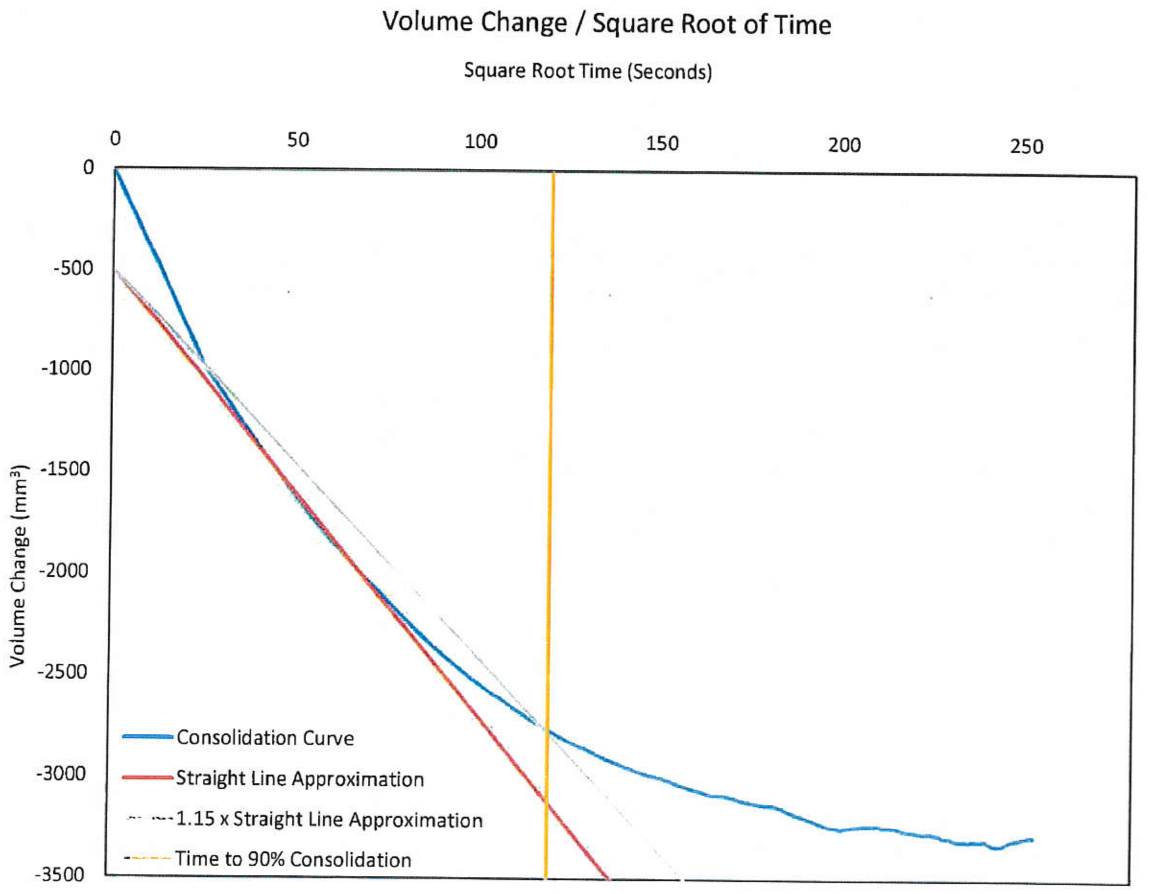
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019

Consoilidation Stage 2

Cell Pressure (kPa):	600	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	100



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

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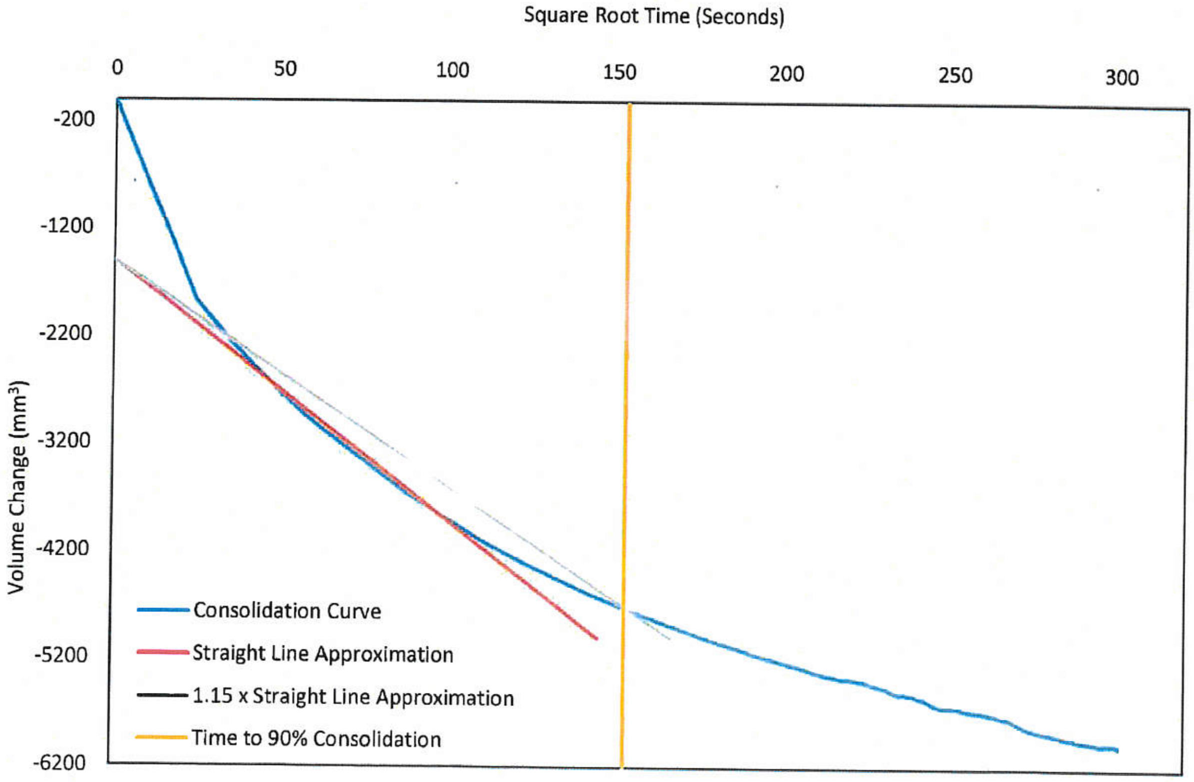
Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019

Consolidation Stage 3

Cell Pressure (kPa):	701	**Back Pressure (kPa):**	501	**Effective Stress s' (kPa):**	200

Volume Change / Square Root of Time



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70A
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	6/02/2019
	Blackheath Road, Oxley	**Checked by:**	MN
Project No:	018-118B	**Date:**	13/02/2019

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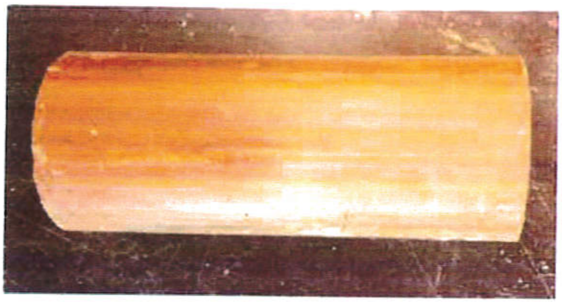
Sample Description:	Silty Clay	**Sample Number:**	G19-70A
Bore:	25	**Depth (m):**	4.5 - 4.95
Sample Type:	Undisturbed	**Date Sampled:**	23/01/2019
Saturation Phase - ΔH (mm):	0.7	**Initial Cell Pressure (kPa):**	0

Sample Before Test



Sample After Test

Sample Description (Clause 10(e))

No natural layers, stones, or calcerous matter.

Comments:

Authorised Signatory:

Michael Neighbour

14-2-19
Date:

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Consolidated Undrained Triaxial Test Summary

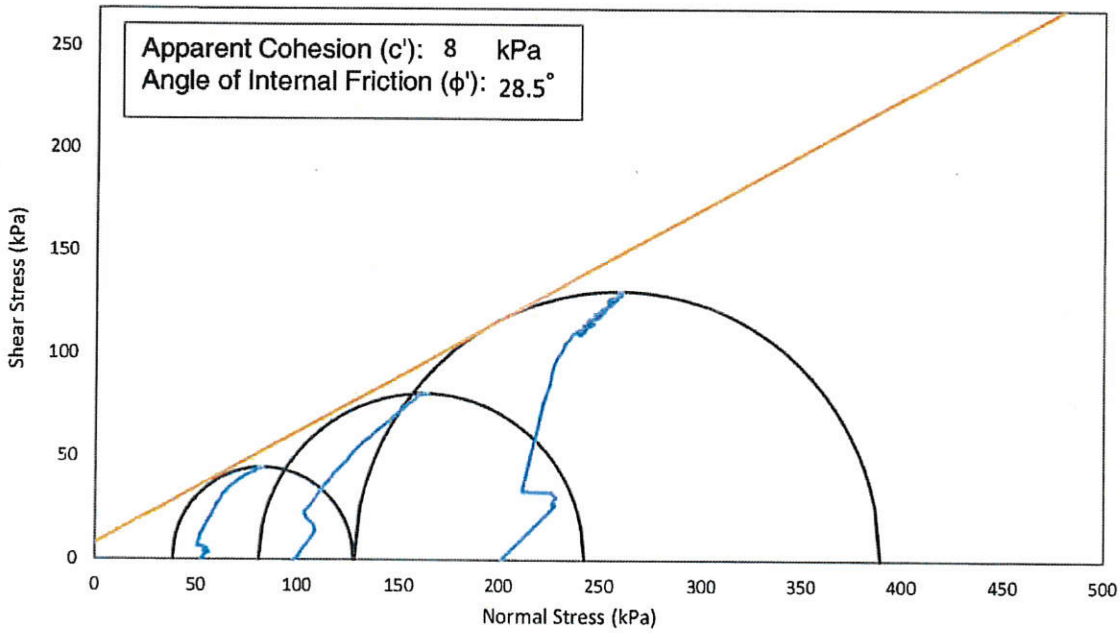
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019
Initial Height (mm):	94.3	**Initial Diameter (mm):**	47.7
Initial Moisture Content (%):	27.0	**Wet Density (t/m^3):**	1.83
Final Moisture Content (%):	34.9	Dry Density (t/m^3):	1.44
Length to Diameter Ratio:	2.0	**Failure Type:**	Shear

Mohr Circle Diagram (with stress paths)



Stage	Initial Effective Stress (kPa)	$\sigma'_{1f} - \sigma'_{3f}$ (kPa)	σ'_{1f} (kPa)	σ'_{3f} (kPa)	u_f (kPa)
1	50	89.5	127.5	38.0	12.0
2	100	161.4	242.4	81.0	19.0
3	200	261.2	389.2	128.0	72.0
		at 20% strain	354.2	130.0	70.0

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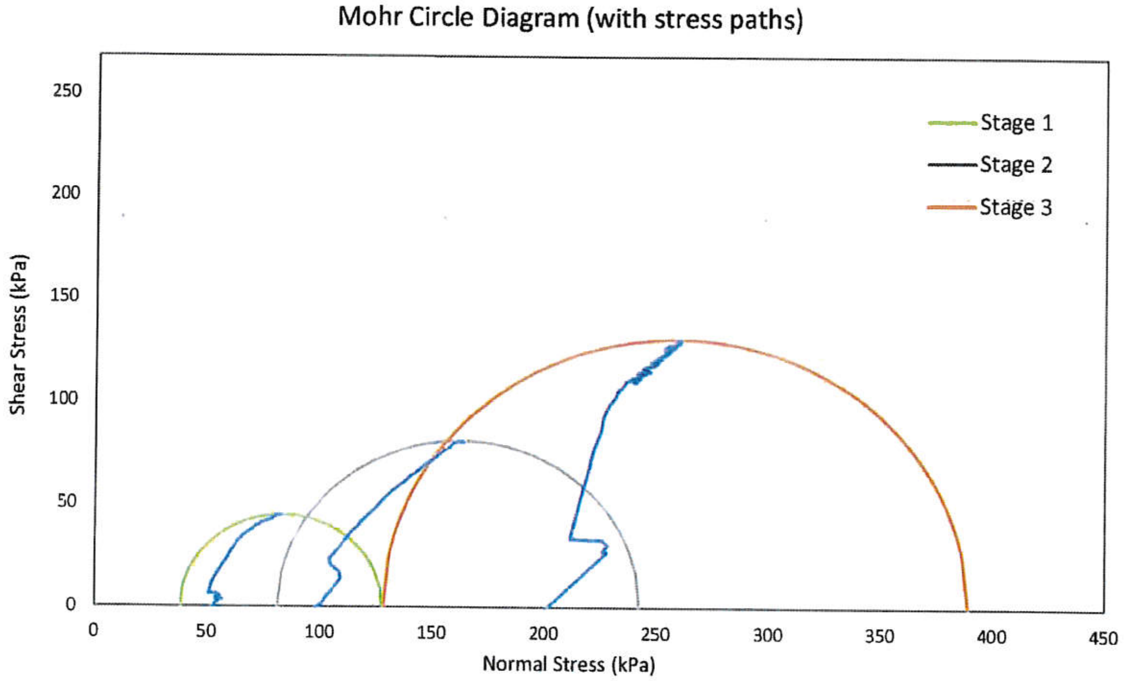
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019
Initial Height (mm):	94.3	**Initial Diameter (mm):**	47.7
Initial Moisture Content (%):	27.0	**Wet Density (t/m^3):**	1.83
Final Moisture Content (%):	34.9	**Dry Density (t/m^3):**	1.44
Length to Diameter Ratio:	2.0	**Failure Type:**	Shear



Stage	**Initial Effective Stress (kPa)**	**$\sigma'_{1f} - \sigma'_{3f}$ (kPa)**	**σ'_{1f} (kPa)**	**σ'_{3f} (kPa)**	**u_f (kPa)**
1	50	89.5	127.5	38.0	12.0
2	100	161.4	242.4	81.0	19.0
3	200	261.2	389.2	128.0	72.0
		at 20% strain	354.2	130.0	70.0

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Consolidated Undrained Triaxial Test Report

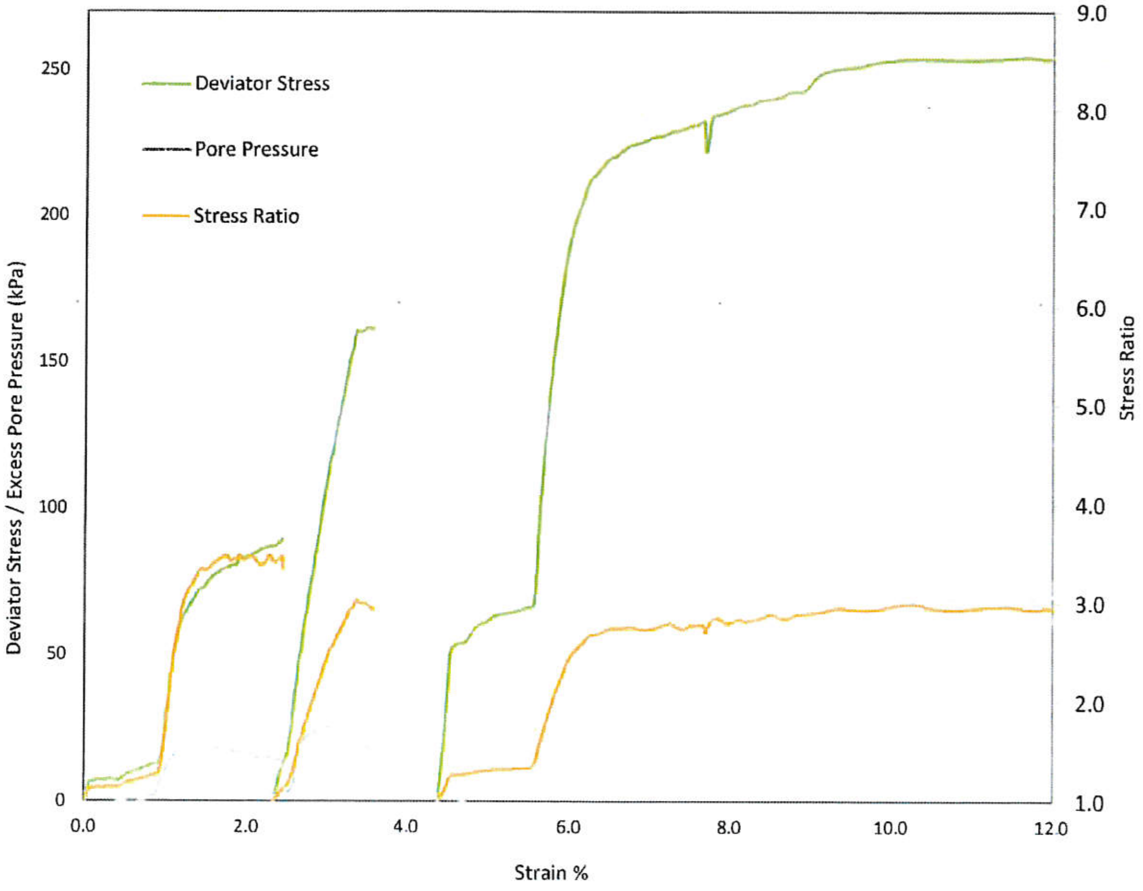
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019

Stress / Strain Plot



Stage	Strain Rate (mm/hr)	Maximum Deviator Stress (kPa)	Strain at Maximum Deviator Stress (%)
1	0.053	89.5	2.43
2	0.023	161.4	3.49
3	0.010	261.2	14.99

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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

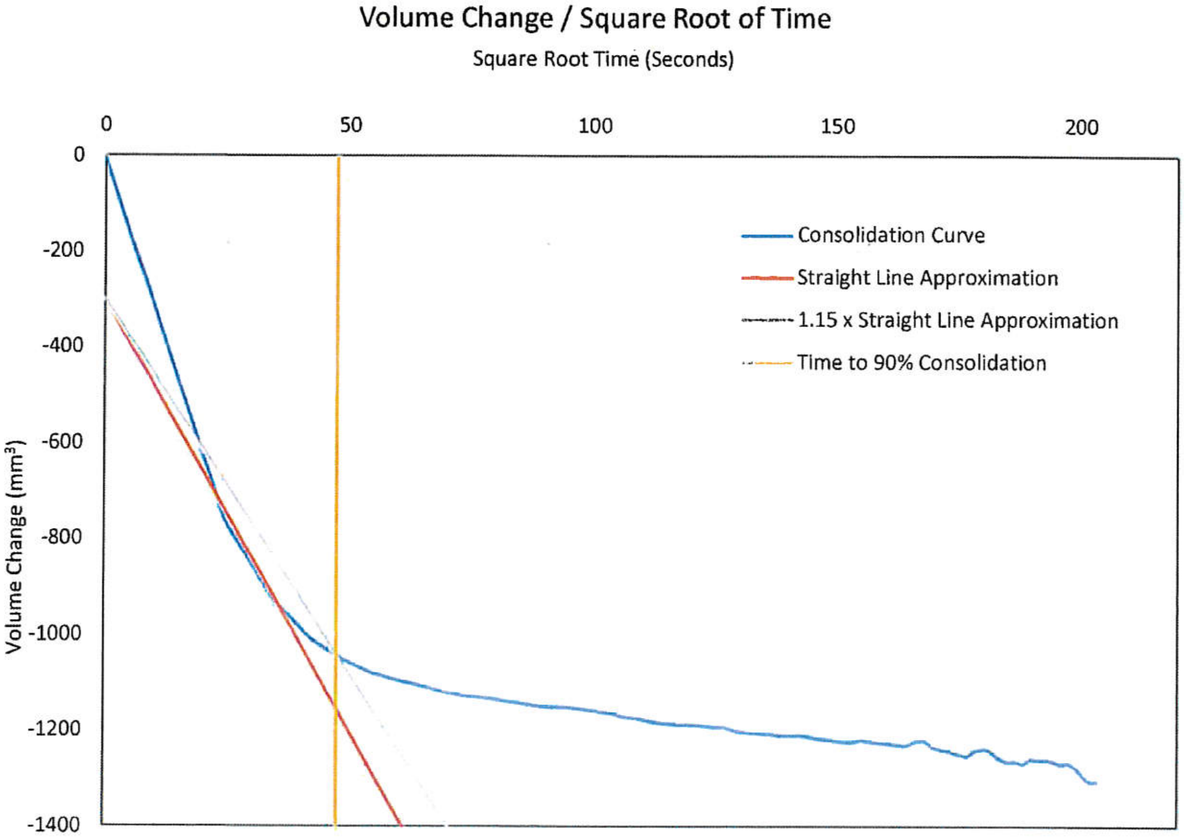
Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019

Consolidation Stage 1

Cell Pressure (kPa):	550	**Back Pressure (kPa):**	500	**Effective Stress σ' (kPa):**	50



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Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

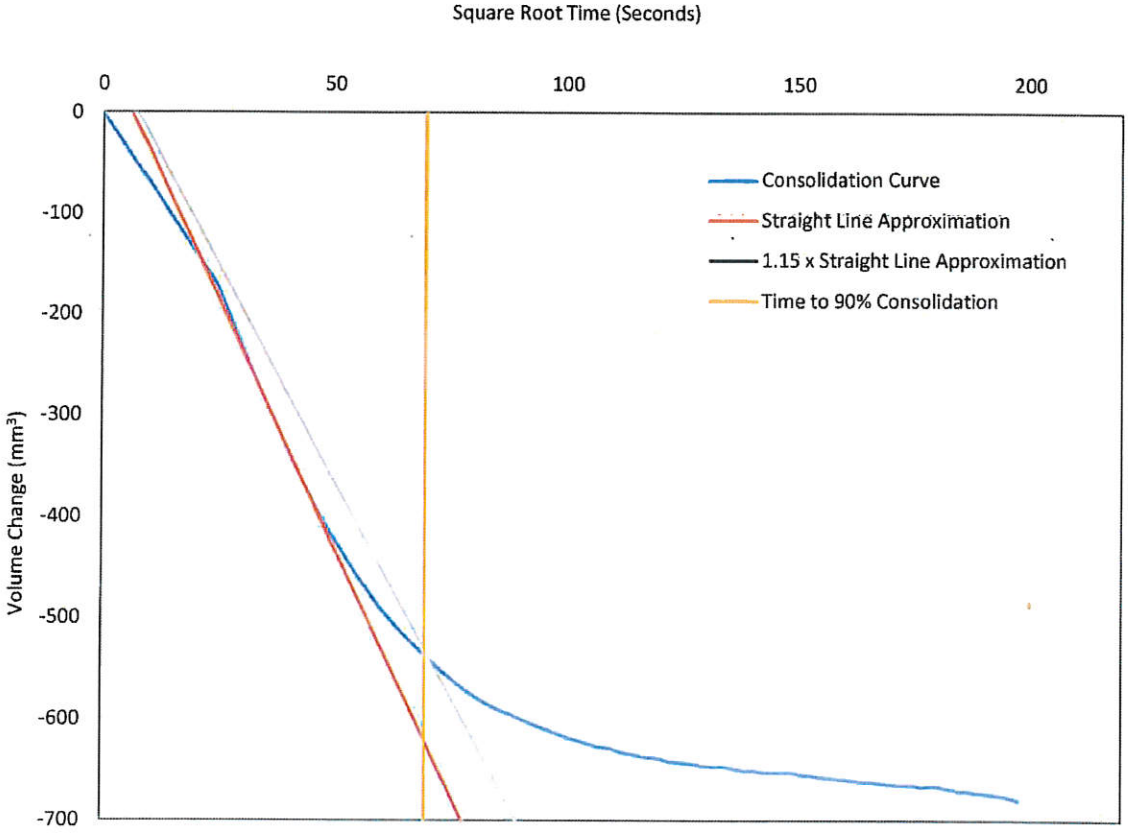
THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019

Consoilidation Stage 2

Cell Pressure (kPa):	600	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	100

Volume Change / Square Root of Time



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Consolidated Undrained Triaxial Test Report

Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

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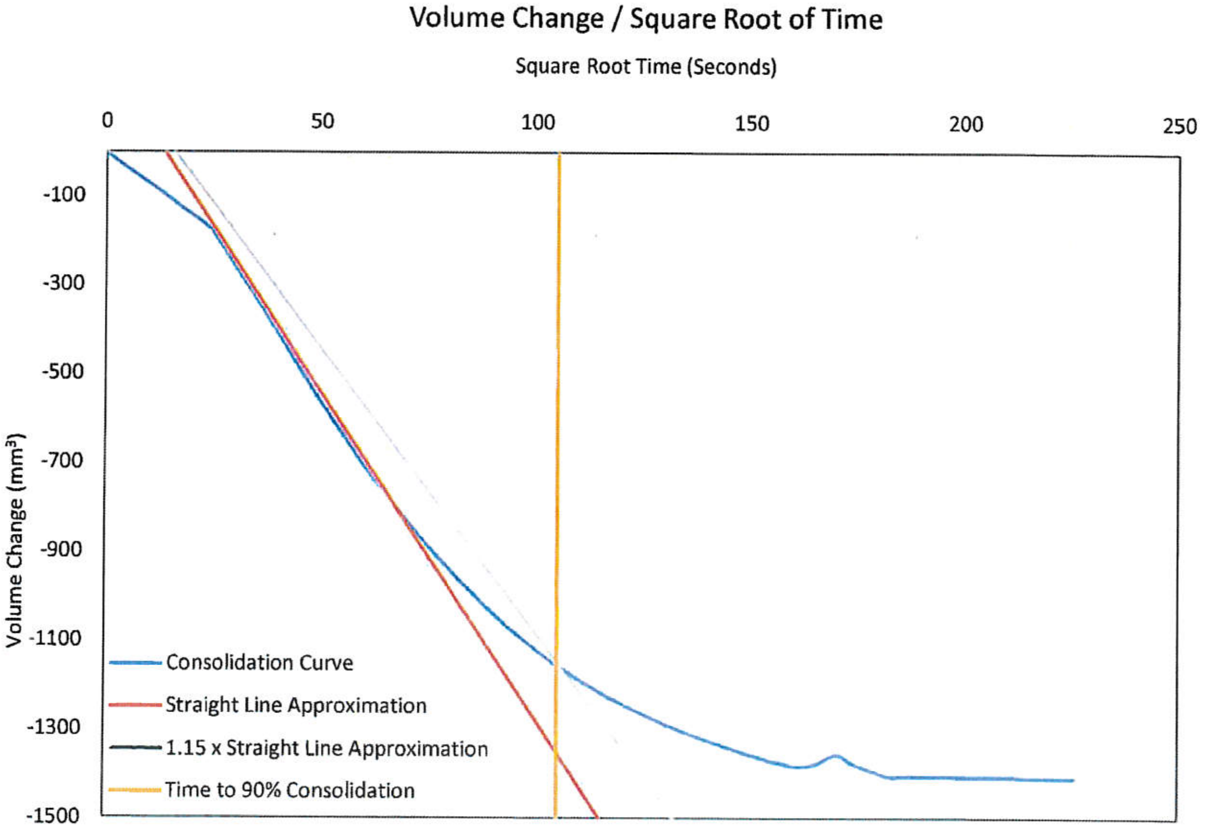
Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019

Consolidation Stage 3

Cell Pressure (kPa):	700	**Back Pressure (kPa):**	500	**Effective Stress s' (kPa):**	200



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Consolidated Undrained Triaxial Test Report

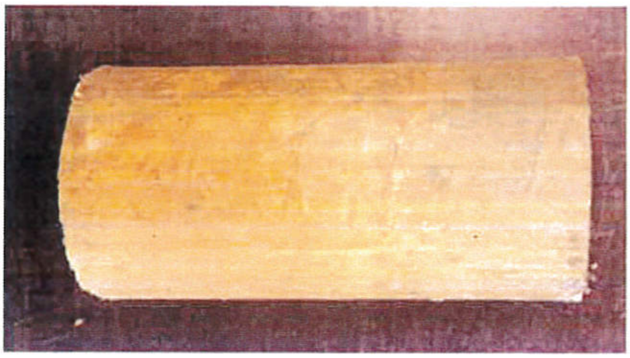
Test Procedure: AS1289.6.4.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_CU_G19-70B
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	30/01/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	14/02/2019

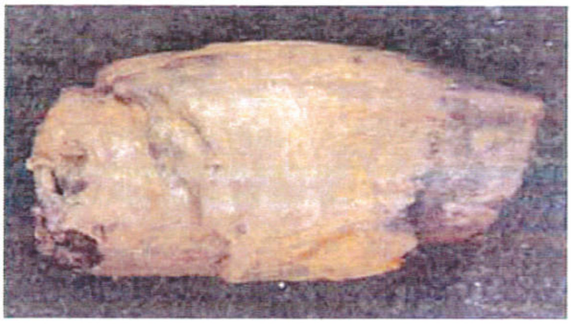
THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Description:	Silty Clay	**Sample Number:**	G19-70B
Bore:	26	**Depth (m):**	7.5 - 7.95
Sample Type:	Undisturbed	**Date Sampled:**	24/01/2019
Saturation Phase - ΔH (mm):	0.7	**Initial Cell Pressure (kPa):**	0

Sample Before Test



Sample After Test



Sample Description (Clause 10(e))

No natural layers, stones, or calcerous matter.

Comments:

Authorised Signatory:

Michael Neighbour

Date: 15.02.19

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DIRECT SHEAR STRENGTH OF A SOIL (SHEAR BOX) TEST REPORT

Test Procedure: AS1289.6.6.2 AS1289.2.1.1

Client:	Economic Development Queensland	**Report No.:**	018-118B_SBT_G1810-125
Project:	Broadscale Slope Stability Assesment	**Tested by:**	WR
Location:	Former Oxley Secondary College,	**Date:**	11/10/2018
	Blackheath Road, Oxley	**Checked by:**	WR
Project No:	018-118B	**Date:**	30/10/2018

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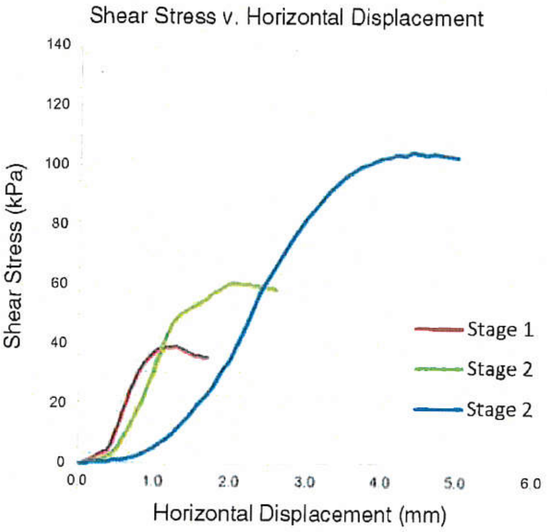
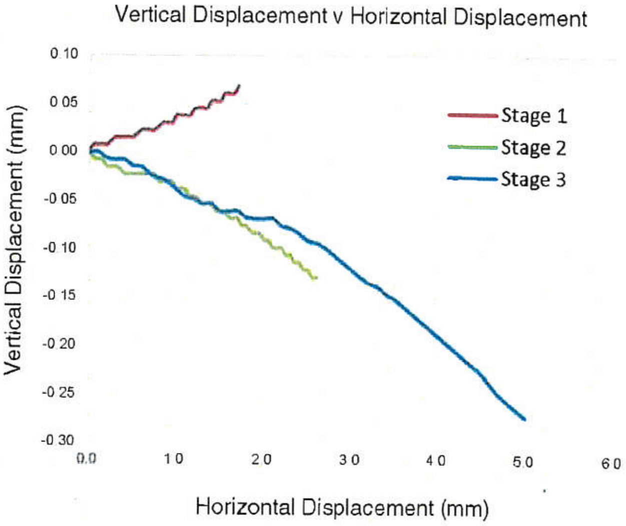
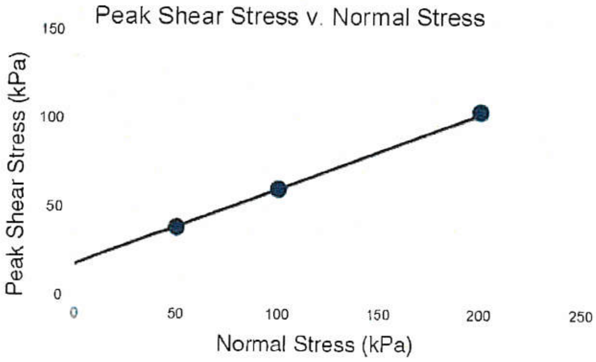
Stage	**Moisture Content (%)**		**Initial Dry Density (t/m^3)**	**Shearing Rate (mm/min)**	**Normal Stress (kPa)**	**Peak Shear Stress (kPa)**
	Initial	**Final**				
1	17.9	26.9	1.73	0.003	50.0	39.0
2	17.9	26.9	1.73	0.005	100.0	60.6
3	17.9	26.9	1.73	0.005	200.0	104.4

Type of Specimen	Undisturbed	**Size of Shear Box (mm)**	45
Conditions	Submerged	**Sample Shape**	Circle







Sample No.:	G1810-125
Bore:	16
Depth (m):	4.5 - 4.95
Sample Description:	Silty Clay
Apparent Cohesion (kPa)	**Friction Angle (degrees)**
18	**23**

Values for cohesion and friction angle are interpetations only

Comments

Authorised Signatory

Michael Neighbour

Date: 30.10.18

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DIRECT SHEAR STRENGTH OF A SOIL (SHEAR BOX) TEST REPORT

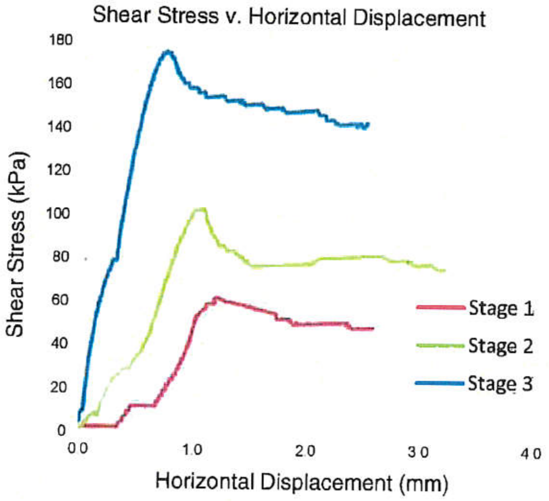
Test Procedure: AS1289.6.6.2 AS1289.2.1.1

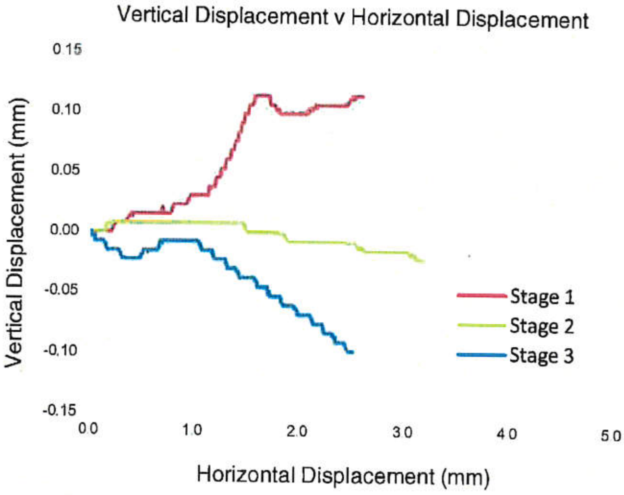
Client:	Economic Development Queensland	**Report No.:**	018-118B_SBT_G19-70C
Project:	Broadscale Slope Stability Assessment	**Tested by:**	CL
Location:	Former Oxley Secondary College	**Date:**	7/02/2019
	Blackheath Road, Oxley	**Checked by:**	CL
Project No:	018-118B	**Date:**	13/02/2019

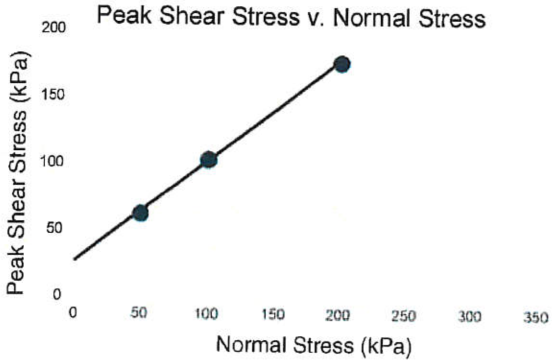
THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Stage	**Moisture Content (%)**		**Initial Dry Density (t/m^3)**	**Shearing Rate (mm/min)**	**Normal Stress (kPa)**	**Peak Shear Stress (kPa)**
	Initial	**Final**				
1	14.5	19.9	1.81	0.050	50.0	62.0
2	13.2	19.2	1.83	0.050	100.0	102.7
3	12.7	19.4	1.82	0.050	200.0	175.5

Type of Specimen	Undisturbed	**Size of Shear Box (mm)**	45
Conditions	Submerged	**Sample Shape**	Circle







Sample No.:	G19-70C
Sampling Method:	AS1289.1.2.1
	Clause 6.5.3
Bore:	27
Depth (m):	6.0 - 6.45
Sample Description:	Silty Clay
Apparent Cohesion (kPa)	**Friction Angle (degrees)**
27	**37**

Values for cohesion and friction angle are interpetations only

Comments

Authorised Signatory

Michael Neighbour

Date: 14.2.19

APPENDIX D

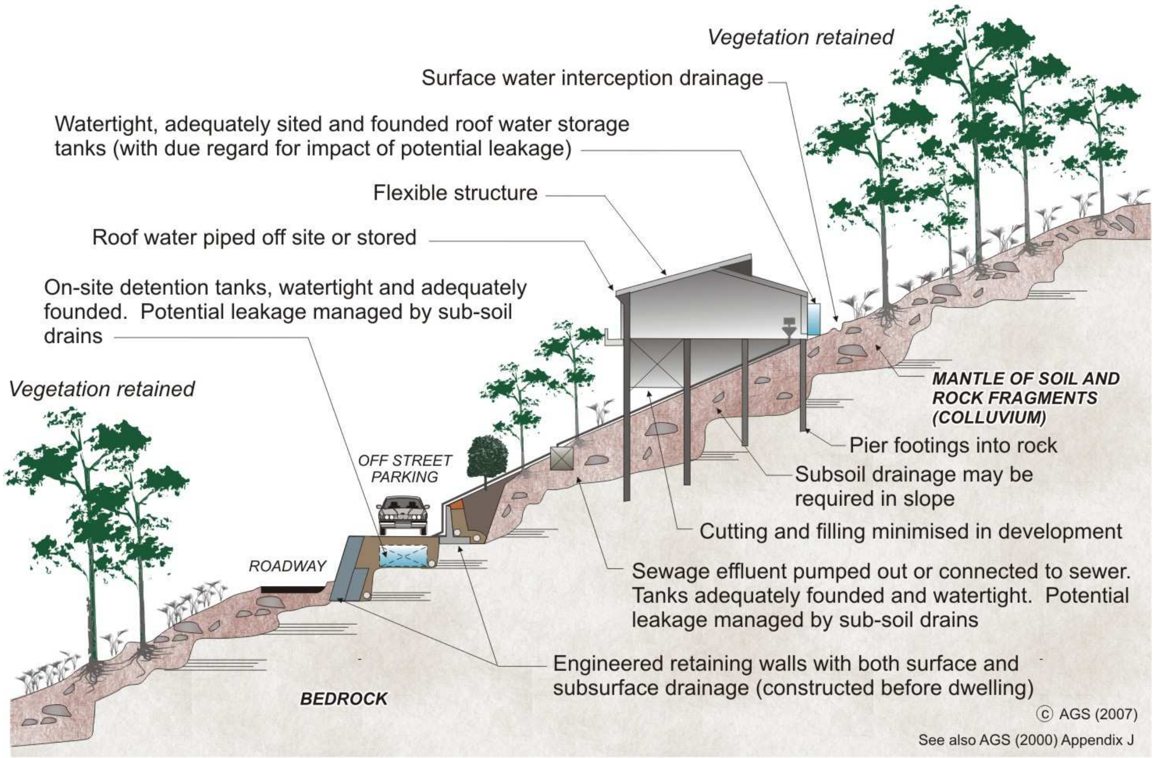
AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.

EXAMPLES OF **GOOD** HILLSIDE CONSTRUCTION PRACTICE



© AGS (2007)

See also AGS (2000) Appendix J

WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

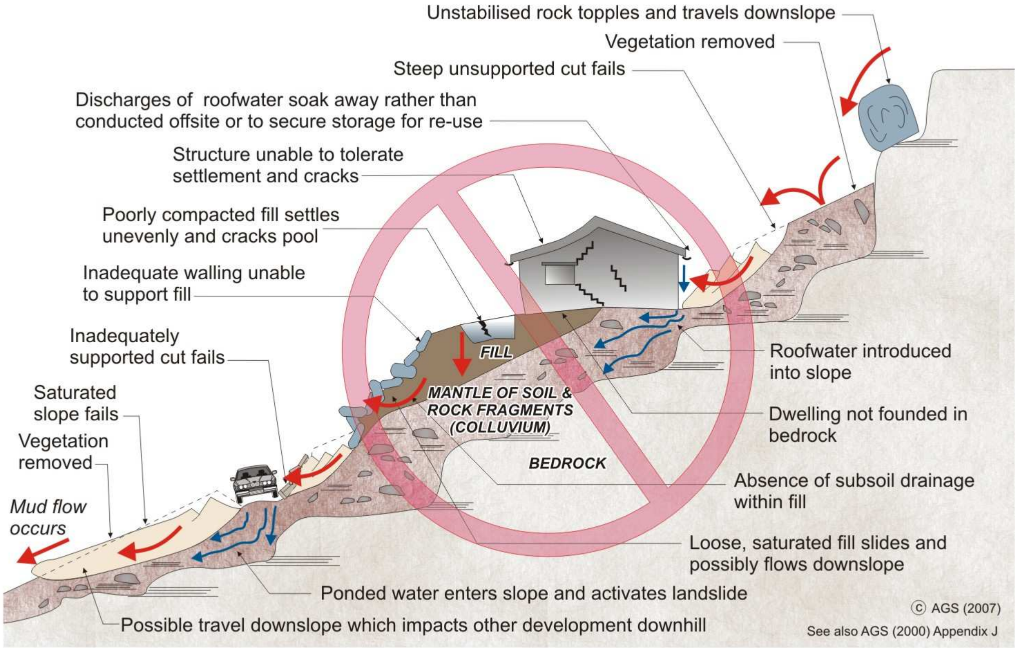
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal

GeoGuide LR10 - Coastal Landslides

- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.