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Report on Geotechnical Investigation

Proposed Residential Aged Care Facility Upgrade
2B West Street, Lewisham

Prepared for
Catholic Healthcare Ltd

Project 85469.01
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Douglas Partners
Geotechnics | Environment | Groundwater

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

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Author	S. Balian	30/7/2018
Reviewer	F MacGregor	30/7/2018.

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

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Report on Geotechnical Investigation
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1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the proposed residential aged care facility upgrade at 2B West Street, Lewisham. The investigation was commissioned in an email dated 13 June 2018 by Connor Martin of Artazan Property Group on behalf of Catholic Healthcare Ltd and was undertaken in accordance with DP's proposal SYD160190 dated 12 December 2016.

The proposed development involves the construction of a multi-storey residential aged care facility with a two level basement carpark on the southern half of the site, as well as some modifications to the existing facilities in the northern half of the site. The approximate bulk excavation level for the new building (RL 19.0 m) will require excavations to depths of approximately 9.5 m.

The investigation included the drilling of seven rock cored bores, installation of three groundwater monitoring wells and drilling of three shallow augered bores. The details of the field work are presented in this report, together with comments on excavation conditions, shoring, groundwater, pavements and footings.

2. Site Description

The site (DP111695) is an irregular shape, covers an area of approximately 12,000 m^2 and is currently occupied by three buildings as well as various car parking and garden areas. It is bound by West Street to the east / south east, the main western railway line to the south, Charles O'Neill Way to the west / south west and a neighbouring property to the north. The ground surface slopes from the south west to the north east and surface levels range between RL 28.5 m and RL 19.5 m AHD.

The proposed new building (with the basement carpark) is located in the southern half of the site and covers an area of approximately 4,500 m^2. The ground level within the building footprint ranges between RL 28.5 m and RL 24.0 m AHD.

The main western railway line is separated from the site by a public pathway. The level of the railway track adjacent to the site is between RL 24.0 m to 24.5 m AHD, which is approximately 4 – 4.5 m below the ground level (RL 28.0 m to RL 28.5 m) on the site boundary. The cutting is supported by a sub-vertical brick retaining wall.

3. Geology and Acid Sulphate Soils

Reference to the *Sydney 1:100 000 Geological Series Sheet* indicates that the site is underlain by the Ashfield Shale Formation. Ashfield Shale typically comprises black to dark grey shale and laminite (interbedded shale, siltstone and fine grained sandstone) and typically weathers to form clays of medium to high plasticity. The geological mapping was consistent with the investigation which encountered shale, siltstone and laminite.

Reference to Acid Sulphate Soil mapping for the area indicates that the site is in an area of no known occurrence.

4. Field Work Methods

The field work comprised:

- Drilling of seven (7) cored bores (BH1 to BH7). The bores were initially drilled using solid flight augers then rotary methods through the soils to the approximate top of rock at depths between 1.0 m to 3.2 m. Standard penetration tests (SPT) were undertaken at regular depth intervals in the soils. The bores were then extended into the bedrock to a depth of 9 m (BH6 and BH7) or 12 m (BH1 – BH5) using NMLC size diamond coring equipment to obtain core samples;
- Drilling of three (3) shallow augered bores (BH8 to BH10). Two of the bores (BH8 and BH9) were drilled with solid flight augers using the same rig used to drill the cored bores, with dynamic cone penetrometer tests (DCPs) to a depth of 1.4 m. BH10 was drilled using hand tools due to access issues;
- Installation, development and sampling of three (3) groundwater monitoring wells in BH1, BH5 and BH7 to allow for the measurement of groundwater levels;
- Supervision of the drilling and logging of the bores by an experienced engineer; and
- Core photography and point load testing of the rock cores.

The bore levels were estimated from the Plan of 2B West Street, Lewisham, prepared by Project Surveyors (Drawing No B1974-1, Rev F, dated 8/12/17) which is understood to be relative to Australian Height Datum (AHD). The bore locations were measured from known site features and are shown on Drawing 1 in Appendix B.

5. Field Work Results

The detailed bore logs, together with core photographs, notes defining classification methods and terms used to describe the soils and rocks, are included in Appendix C. Interpreted geological cross sections through the site, based on the bore logs, are shown on Drawings 2, 3 and 4 in Appendix B.

The investigations indicate that the sub-surface profile includes:

Pavements A thin layer of asphalt (0.02 m to 0.08 m) overlying roadbase gravel in BH3, BH4, BH8 and BH9. Roadbase gravel was exposed at the surface in BH5 and BH6.

Filling Unit 1	In all bores between 0.3 m to 1.7 m depth. The filling generally included clayey soils with varying proportions of sand and gravel. In BH2, terracotta tile fragments were also present. In BH3 topsoil filling to a depth of 0.3 m was directly underlain by natural clay.
Residual Soil Unit 2	Residual soils typically comprising firm to stiff clays to depths of 1.0 m to 2.7 m below the filling in all bores apart from BH5 and BH6. In BH5 and BH6 the filling was directly overlying weathered shale / laminite.
Shale / Laminite Units 3 to 5	Typically extremely to highly weathered, fragmented to fractured and variable strength shale / laminite was encountered in all bores apart from BH9 which was terminated at a depth of 2.7 m in residual soil. The shale / laminite typically increased in strength with depth. In some bores, the upper weathered profile included medium to high strength material with very low strength bands.

No groundwater was observed during auger drilling of the bores to depths of up to 2.8 m. A summary of the measured groundwater levels within the three monitoring wells is provided in Table 1.

Table 1: Summary of Groundwater Measurements

Location	Surface Level (m AHD)	2 July 2018 (Depth m)	2 July 2018 (RL, m AHD)
BH1	28.2	6.1	22.1
BH5	26.7	5.1	21.6
BH7	23.1	7.9	15.2

6. Laboratory Testing

Selected samples of the rock core were tested in the laboratory to determine the Point Load Strength Index (Is_{50}) values to assist with the rock strength classification. The results of the testing are shown on the bore logs at the appropriate depth. The Is_{50} values for the rock ranged from 0.2 MPa to 3.5 MPa, indicating that the rock samples tested ranged from very low strength to very high strength.

7. Geotechnical Model

Three geotechnical cross-sections (Sections A-A', B-B' and C-C'), showing the interpreted subsurface profile between selected bores, are presented as Drawings 2 to 4 in Appendix B. The sections show interpreted geotechnical units of soil and rock, together with the proposed basement level. It should be noted that the interpreted boundaries shown on the sections are accurate only at the bore locations and layers shown diagrammatically on the drawings are inferred only. Bands of lower and higher strength rock should be expected within the generalised layers. The interpreted depth and Reduced Level (RL) at the top of the interpreted geotechnical units are shown in Tables 2A and 2B.

The rock units have been classified in accordance with the procedures given in Reference 1, which use a combination of rock strength and fracture spacing to divide the rock into five classes ranging from Class I (high strength and very few defects) to Class V (extremely low to very low strength and/or highly fractured). In some cases the classification for the stronger rock has been downgraded due to fracture spacing and the presence of weaker seams.

Table 2A: Summary of Depths to Top of Various Strata

Bore	Surface Level (RL, m AHD)	Unit 1: Filling	Unit 2: Residual Soil	Unit 3: Class V/IV Shale	Unit 4: Class III/II Shale	Unit 5: Class I Shale
BH1	28.2	0	1.7	2.0	6.5	7.8
BH2	28.4	0	1.3	1.9	5.6	6.8
BH3	28.5	0.1	1.2	1.5	4.5	5.0
BH4	26.9	0.15	0.6	1.4	5.7	10.5
BH5	26.7	0.05	-	0.3	4.0	4.5*
BH6	26.9	0.05	-	1.2	4.0	7.6
BH7	23.1	0	0.15	1.0	5.3	-
BH8	24.5	0.2	0.8	1.4	-	-
BH9	21.9	0.2	1.0	-	-	-
BH10	20	0	0.3	1.04	-	-

Note: Lower strength bands were encountered below

Table 2B: Summary of RL (AHD) to Top of Various Strata

Bore	Surface Level (RL, m AHD)	Unit 1: Filling	Unit 2: Residual Soil	Unit 3: Class V/IV Shale	Unit 4: Class III/II Shale	Unit 5: Class I Shale
BH1	28.2	28.2	26.5	26.2	21.7	20.4
BH2	28.4	28.4	27.1	26.5	22.8	21.6
BH3	28.5	28.4	27.3	27	24	23.5
BH4	26.9	26.75	26.3	25.5	21.2	16.4
BH5	26.7	26.65	-	26.4	22.7	22.2
BH6	26.9	26.85	-	25.7	22.9	19.3
BH7	23.1	23.1	22.95	22.1	17.8	-
BH8	24.5	24.3	23.7	23.1	-	-
BH9	21.9	21.7	20.9	-	-	-
BH10	20	20	19.7	18.96	-	-

8. Proposed Development

The proposed development involves the construction of a multi-storey residential aged care facility with a two level basement carpark on the southern half of the site, as well as some modifications to the existing facilities in the northern half of the site. The approximate bulk excavation level for the new building (RL 19.0 m) will require excavations to depths of approximately 9.5 m.

9. Comments

9.1 Excavation Conditions

Excavation for the two level basement is expected to be approximately 9.5 m deep in the south western portion of the site. Excavation is expected mainly through Units 1 to 4. However, the deeper parts of the excavation especially to the south west of the site will encounter Unit 5.

Excavation of Unit 1 and Unit 2 (filling and soils) should be achievable using conventional earthmoving equipment. Unit 3 (class V/IV shale) should be mainly achievable using conventional earthmoving equipment, however this unit includes some medium to high strength shale with very low strength bands which may require rock hammering or ripping for effective removal. Excavation of Unit 4 (class III/II shale) is likely to require medium to heavy ripping. Excavation of Unit 5 (class I shale) may require heavy ripping with large bulldozers together with the use of hydraulic rock breakers for effective removal.

9.2 Vibrations

During excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. Excavation of Unit 1 and Unit 2 (filling and soils) are not expected to generate excessive vibrations. The use of ripping and rock hammers to excavate the rock units may generate vibrations which could potentially damage adjacent buildings.

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

Based on the experience of DP and with reference to AS2670, it is suggested that a maximum PPVi of 8 mm/s (applicable at the foundation level of existing buildings/structures) be employed at this site for both architectural and human comfort considerations, although this vibration limit may need to be reduced if there are sensitive buildings, structures or equipment in the area.

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

9.3 Dilapidation Surveys

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

9.4 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014). This includes filling and natural materials that may be removed from the site. Accordingly, environmental testing will need to be carried out to classify spoil prior to transport from the site. Reference should be made to DP's "Report on Preliminary Site (Contamination) Investigation" for the site (Project 85469.00, dated May 2016) for details on the current contamination status of the soils.

9.5 Excavation Support

Vertical excavations within the filling, soils and shale/laminite will require both temporary and permanent lateral support during and after excavation. Excavations in shale and laminite will also need to consider jointing and potential wedges that may be formed along joints within the rock, although this is unlikely to govern the design for the two level basement excavation.

9.5.1 Batter Slopes and Vertical Rock Faces

Suggested temporary and permanent batter slopes for unsupported excavations up to a maximum height of 2 m in soils (Unit 1 and Unit 2) and 4 m in rock (Units 3 to 5) are shown in Table 3. If surcharge loads are applied near the crest of the slope then further specific geotechnical review and flatter batters or stabilisation using rock bolts or soil nails may be required.

Table 3: Recommended Maximum Batter Slopes for Exposed Material

Unit	Exposed Material	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
1 and 2	Filling and Residual Soil	1 : 1	2 : 1**
3	Class V/IV Shale	1 : 1	1.5 : 1*
4	Class III/II Shale	0.75 : 1*	1 : 1*
5	Class I Shale	0.5 : 1*	1 : 1*

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

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

9.5.2 Retaining Walls

Where there is not sufficient space for the batter slopes, shoring walls will be required to support the filling, soils and rock. Anchored soldier pile walls are often used to provide temporary retaining support to residual clay soils and weathered rock.

The soldier piles are usually spaced at approximately 2 m to 2.5 m centres, and should be founded at least two pile diameters below the lowest excavation level (including detailed excavation). More closely spaced piles may be required to reduce wall movements, or prevent collapse of infill materials, particularly where pavements, structures or services are located in close proximity to the excavation.

At the completion of each 1.5 m to 2.0 m drop in excavation level, reinforced shotcrete infill panels should be constructed. At no stage should progressive vertical excavation proceed beyond 2 m without infill panel support being constructed. Regular inspections by a geotechnical professional should be carried out following each progressive drop in excavation level to confirm that the conditions encountered are consistent with the design assumptions.

It is suggested that preliminary design of cantilevered shoring systems (or shoring with one row of anchors or propping) be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 4.

Table 4: Recommended Design Parameters for Shoring Systems

Unit	Material	Unit Weight (kN/m^3)	Earth Pressure Coefficient	
			Active (K_a)	At Rest (K_o)
1 and 2	Filling and Soils	20	0.4	0.6
3 and 4	Class V – II Shale	22	0.25	0.3
5	Class I Shale	24	10 kPa uniform	10 kPa uniform

'Active' earth pressure coefficient (K_a) values may be used for a flexible wall where some wall movement is acceptable, and 'at rest' earth pressure (K_o) values should be used where the wall movement needs to be reduced (i.e. adjacent to existing structures or utilities). A uniform pressure of 10 kPa should be adopted for the support of medium strength or stronger laminite/shale between soldier piles and/or anchors to account for minor joint wedges that may become mobilised.

Where multiple rows of anchors or propping are used it is suggested that preliminary design of shoring walls could be based a trapezoidal earth pressure distribution with a maximum pressure calculated based on 4H kPa where H is equal to the retained height of soil and extremely low to low strength rock. The maximum pressure should be increased to 6H where wall movement needs to be reduced. In each case the maximum pressure generally acts over the central 60% of the wall, reducing to zero at the top and base.

The design of temporary and permanent support will also need to consider the possibility that steeply dipping joints in the shale and laminite will daylight near the base of the excavation leading to wedges of rock requiring support by the temporary and permanent retaining structures. As a guide, an anchor force equal to $4.2H^2$ kN per m length of wall would be required for a continuous 45 degree joint daylighting at the toe of the excavation.

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

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

9.5.3 Passive Resistance

Passive resistance for piles founded in rock below the base of the bulk excavation (including allowance for services and/or footings) may be based on the ultimate passive restraint values provided in Table 5. The ultimate values represent the pressure mobilised at high displacements and therefore it will be necessary to incorporate a factor of safety of at least 2 to limit wall movement. The top 0.5 m of the socket should be ignored due to possible disturbance and over-excavation.

Table 5: Recommended Passive Resistance Values

Unit	Foundation Material	Ultimate Passive Pressure (kPa)
3	Class V/IV Shale	400
4	Class III/II Shale	2,000
5	Class I Shale	6,000

9.5.4 Ground Anchors

The design of temporary and permanent ground anchors/rock bolts for the support of excavations and/or shoring systems may be carried out on the basis of the bond stresses given in Table 6.

Table 6: Recommended Bond Stresses for Rock Anchor Design

Unit	Material Description	Maximum Allowable Bond Stress (kPa)	Maximum Ultimate Bond Stress (kPa)
Unit 3	Class V/IV Shale	50	100
Unit 4	Class III/II Shale	200	400
Unit 5	Class I Shale	500	1000

The parameters given in Table 6 assume that the drilled holes are clean and adequately flushed. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the shoring and "lift-off" tests should be carried out to confirm the anchor capacities. It is suggested that ground anchors should be proof loaded to 125% of the design Working load and locked-off at no higher than 80% of the Working load.

9.6 In-situ Stress Relief

Based on previous experience in the Sydney area it is estimated that at the midpoint of the crest of a deep excavated face, stress relief may cause a horizontal movement of approximately 0.5 mm/m to 1.5 mm/m depth of excavation in Class III or better Ashfield Shale (Units 4 and 5). The amount of horizontal movement may diminish along the crest away from the midpoint, down the excavated face away from the crest and back from the face. The movement would be expected to occur progressively during the excavation with only minor creep expected after completion of the excavation.

The effect of the stress relief on the shallow foundations of the adjacent structures and infrastructure needs to be considered. It is estimated that there could be up to 15 mm of additional lateral movement due to stress relief (in addition to earth pressure induced deflections) at the ground level around basement perimeter.

9.7 Groundwater

Based on groundwater measurement to date, the proposed bulk excavation level is below the water table on the western side of the excavation. However, due to the expected very low permeability of the soils and shale the seepage inflow to the basement is expected to be minor. Some inflow due to seepage of surface water through the filling is expected after rainfall.

During construction and in the long term, it is anticipated that seepage into the excavation could be controlled by perimeter and subfloor drainage connected to a sump-and-pump system. On this basis, it is technically feasible to construct drained basement for this site without any significant adverse impacts to surrounding groundwater systems. Approval of a drained basement may however be subject to review by Council and relevant authorities. Generally, water collected from dewatering operations should be suitable for disposal by pumping to stormwater drains subject to confirmation testing of groundwater quality and approval from the local council.

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

It is not possible to provide an estimate of the seepage quantity that may be expected within the basement based on the available data. This would require large scale packer/permeability testing of the rock and pumping tests over a period of several weeks together with further analysis which would probably include numerical modelling. A more usual approach is to monitor the seepage rates during the excavation to confirm and/or re-assess the proposed sump and pump system capacity over the longer term.

9.8 Foundations

It is expected that Unit 4 (Class III/II shale) or Unit 5 (Class I shale) will be exposed close to the bulk excavation level over most of the site. However, in the north corner of the excavation Unit 3 (Class V/IV shale) will be exposed.

Preferably all foundations should be uniformly founded in the same material to limit potential for differential settlement. Due to variations in levels of the different units across the excavation site this would require a mixture of pad footings at the south western corner and bored piles to reach stronger rock in areas where weaker rock is exposed at the bulk excavation level. Alternatively pad footings proportioned using lower bearing pressures may be used.

If bored piles are used, the selection of piling rigs will need to consider the presence of high and very high strength rock if rock sockets are required to be drilled in these materials. Seepage should be expected within the open piles and therefore allowance for pumping to remove water or the use of tremmie methods to place concrete should be considered. Relatively high seepage flows can sometimes occur within the fractured shale/laminite.

Any footings near the rail line should be founded below a 45 degree line extending up from the base of the existing retaining wall along the railway cutting. The base of the wall is expected to be close to the rail track level (approximate RL 24.0 m to RL 24.5 m AHD).

Design of footings may be based on the parameters provided in Table 7. For bored piles, if required, shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the shaft adhesion values for compression in Table 7.

Table 7: Design Parameters for Foundation Design

Unit	Foundation Stratum	Maximum Allowable Pressure		Maximum Ultimate Pressure	
		End Bearing (kPa)	Shaft Adhesion (Compression)* (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression)* (kPa)
2	Residual Soil	100	5	250	15
3	Class V/IV Shale	700	50	3,000	100
4	Class III/II Shale	3,500	350	30,000	600
5	Class I Shale	6,000	1,000	120,000	2,000

Note: *shaft adhesion parameters in rock (Units 3 to 5) assume adequately clean and rough sockets of category "R2", or better.

Foundations proportioned on the basis of the allowable bearing pressures in Table 8 would be expected to experience total settlements of less than 1% of the footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value.

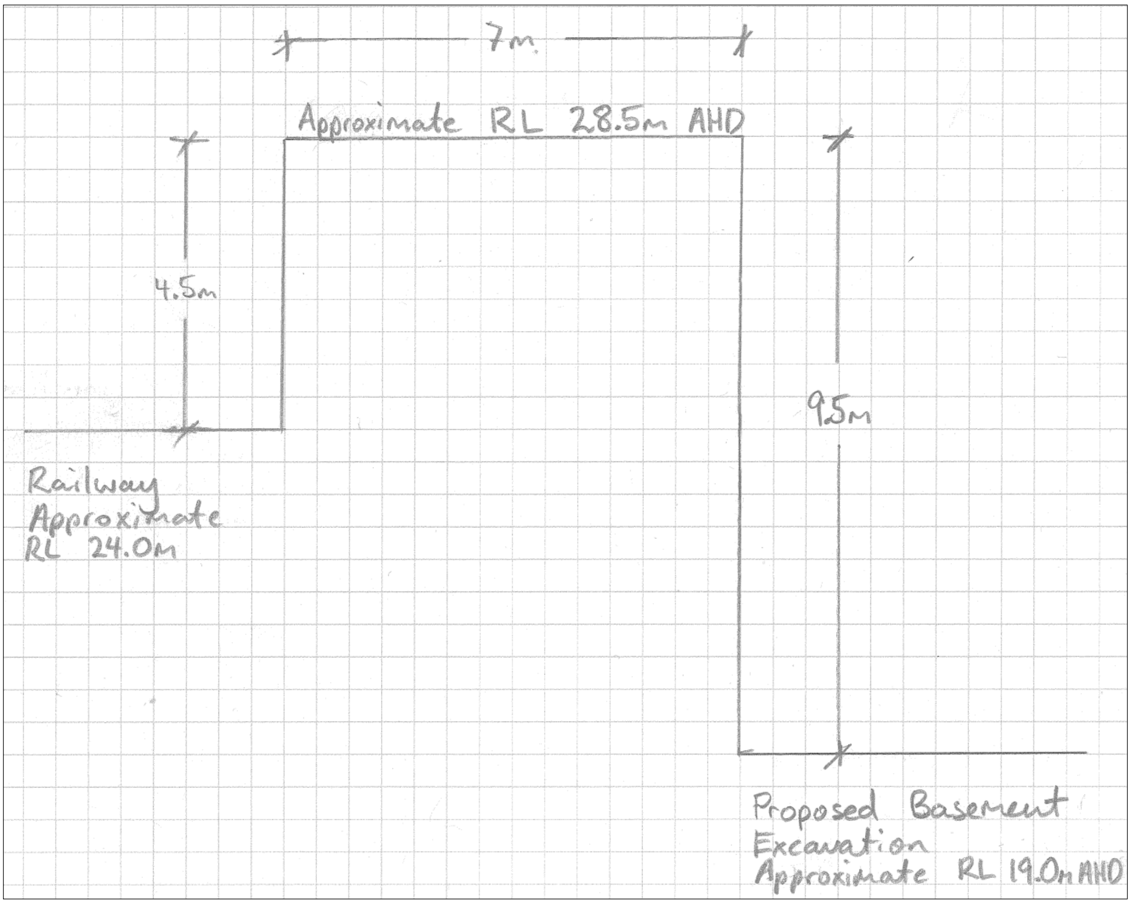
Spoon testing will be required in about 50% of pad footings that are designed for an allowable end bearing pressure of 6,000 kPa in Unit 5 (Class I Shale). An allowable end bearing pressure of 8,000 kPa may be possible in this unit, however would require cored bores in 50% of the footings and spoon testing in the remainder.

All footings should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters.

9.9 Effects on Rail Infrastructure

The main western rail line is on the south western side of the proposed development. The rail line is located within a cutting which is supported by a brick retaining wall. Reference to the survey plan prepared by Project Surveyors (Rev F, dated 8/12/2018) indicates that the crest of the cutting is approximately 7 m from the proposed basement carpark, the track level is between RL 24.0 m to RL 24.5 m and the ground level at the adjacent site boundary is approximately RL 28.0 m to RL 28.5 m. A section through the railway line and proposed basement carpark excavation showing approximate dimensions is presented in Figure 1.

Figure 1: Section Through Railway and Proposed Basement Excavation



The footings of the proposed structure (assuming they are founded at or below the bulk excavation level of RL 19.0m) are below the rail track level adjacent to the site.

Based on previous experience, the lateral stress relief movements due to excavation of the rock are expected to be less than 5 mm at the track level and less than 10 mm at the top of the brick retaining wall (due to distance from the excavation and relative levels of the tracks and excavation). Numerical modelling would be required to assess the effect of stress relief on the railway corridor more accurately.

Ground anchors into the rail corridor are usually not accepted by Sydney Trains and alternative support systems such as internal propping or a cantilever wall will be required along this boundary.

9.10 Pavements and Floor Slabs

The earthworks required for slabs on ground will depend on the loading conditions and settlement tolerances. Most of the basement floor slab will be underlain by rock

Preparation for lightly trafficked pavements at existing ground levels should be carried out as described below.

9.10.1 Subgrade Preparation and Engineered Filling

Following stripping of topsoil it is suggested that site preparation and engineered filling for lightly loaded pavements and/or raising of site levels should incorporate the following:

- stripping of vegetation, organic topsoil and obvious unsuitable material;
- rolling of the exposed subgrade with at least 8 passes of a vibrating smooth drum roller with a minimum static weight of 10 tonnes. The final pass (proof roll) of the subgrade should be inspected by a geotechnical engineer to detect any soft or heaving areas. Any soft spots detected during proof rolling would generally need to be stripped to a stiff base or depth of approximately 0.5 m, subject to confirmation by a geotechnical engineer, and replaced with engineered filling;
- engineered filling for replacing soft spots or raising site levels should be placed in layers of 300 mm maximum loose thickness and compacted to a dry density ratio of between 98% and 102% relative to Standard compaction with moisture contents strictly within 2% of Standard optimum moisture content (OMC). The density ratio should be increased to between 100% and 102% Standard compaction within 0.3 m of the finished surface. The existing filling and clayey soils on site should generally be suitable for re-use as engineered filling provided it has a maximum particle size of 150 mm and moisture content within 2% of Standard OMC. Reuse of material should also consider the contamination status of the soil, which may require further assessment;
- density testing of each layer of filling should be undertaken in accordance with AS 3798-2007 “Guidelines for Earthworks for Commercial and Residential Developments” to verify that specified density ratios have been achieved.

9.10.2 CBR Value

Based on DP’s experience, preliminary design of pavements on clayey subgrade could be based on a design California bearing ratio (CBR) of 3%. Further inspection and possibly laboratory testing of the exposed subgrade soils should be carried out by an experienced geotechnical engineer during the earthworks.

10. References

1. Pells, P.J., Mostyn, G. and Walker, B.F. “Foundations on Sandstone and Shale in the Sydney Region”. Australian Geomechanics Journal, Vol. No. 33 Part 3, Dec. 1998.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at 2B West Street in accordance with DP’s proposal dated 12 December 2016 and acceptance received from Artazan Property Group on behalf of Catholic Healthcare Ltd dated 13 June 2018. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report

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

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

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

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

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

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

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

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

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

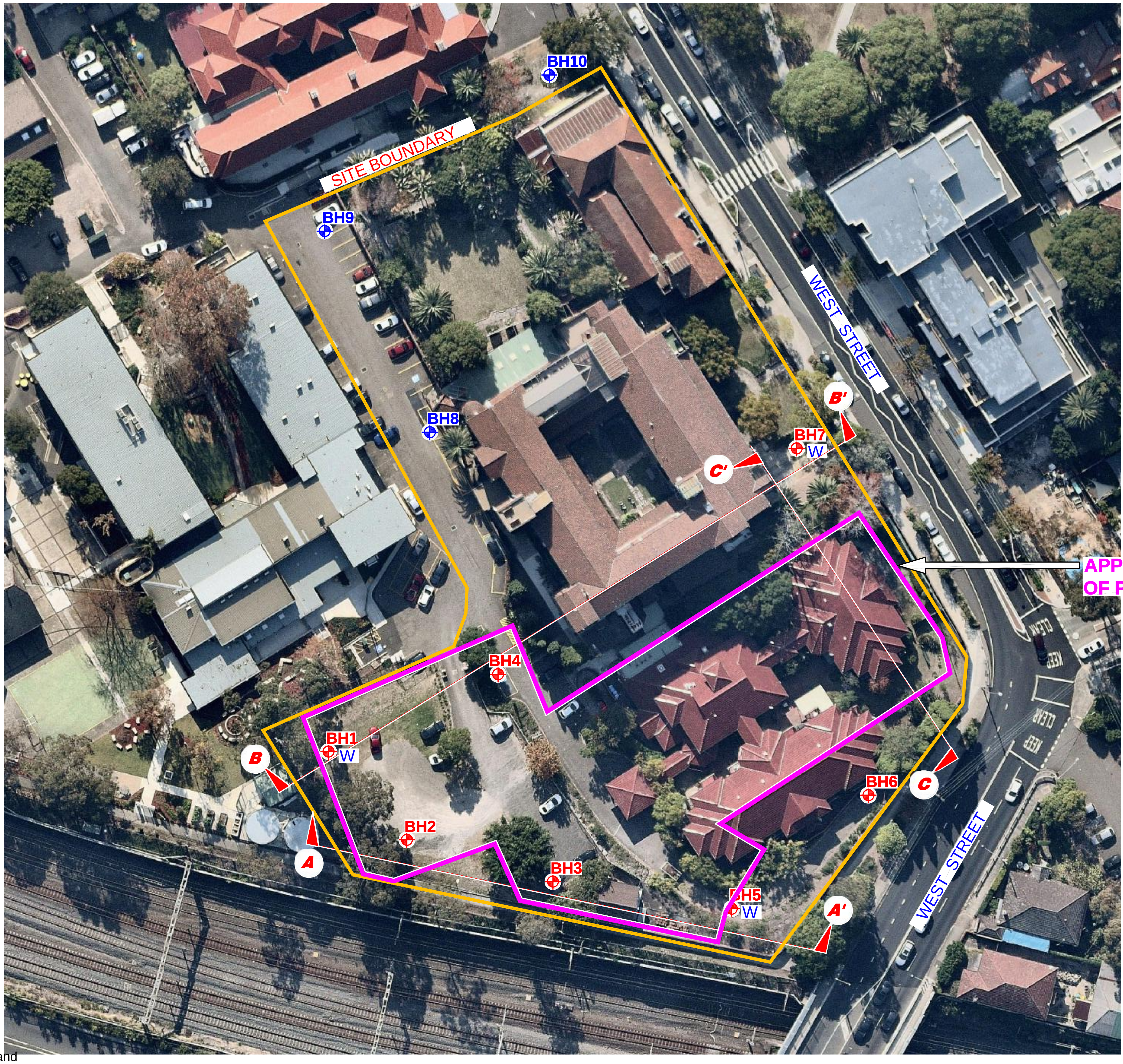
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

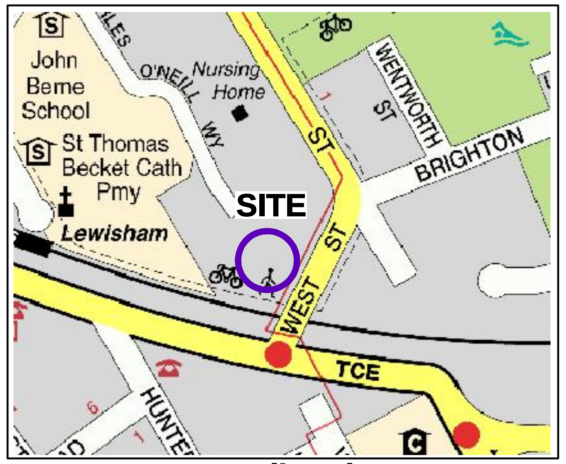
Site Inspection

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

Appendix B

Drawings





Locality Plan

NOTE:
1: Base drawing from Nearmap.com (Dated 27.5.2018)
2: Test locations are approximate only and are shown with reference to existing features.

0 5 10 15 20 30 40 60 80m

1:800 @ A3

LEGEND

- Rock cored bore
- Augered bore
- W Groundwater well
- A A' Geotechnical Cross Section A-A'

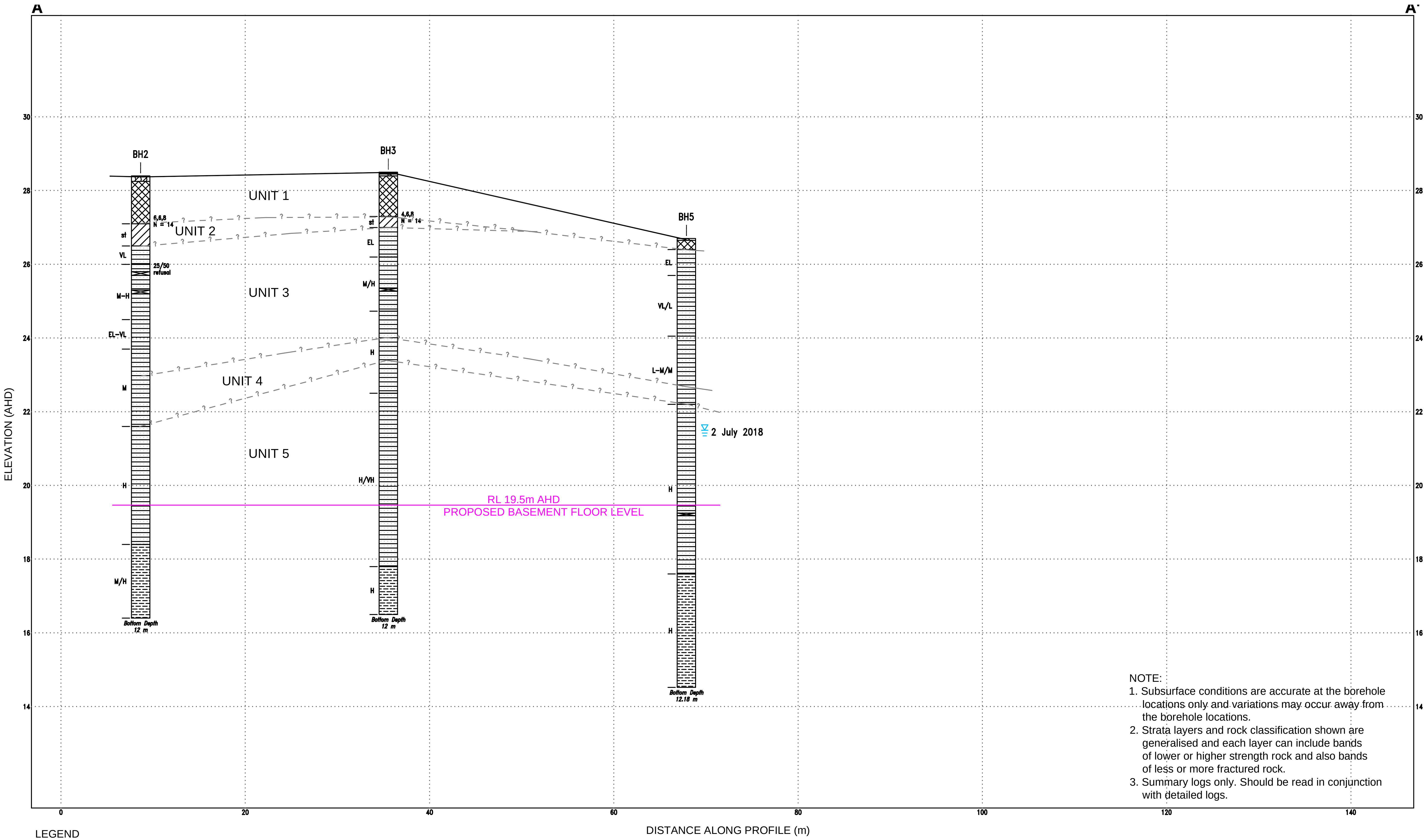
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Catholic Healthcare Ltd		
OFFICE: Sydney	DRAWN BY: PSCH	
SCALE: 1:800 @ A3	DATE: 13.7.2018	

TITLE: **Test Location Plan**
Proposed Residential Aged Care Facility Upgrade
2B West Street, LEWISHAM

N

PROJECT No:	85469.01
DRAWING No:	1
REVISION:	0



NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Filling
- Laminite
- Roadbase
- Shale
- Topsoil

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

SOIL CONSISTENCY
f - firm
st - stiff

UNIT 1: Filling
UNIT 2: Residual soil
UNIT 3: Class V/ IV shale
UNIT 4: Class III/ II shale
UNIT 5: Class I shale

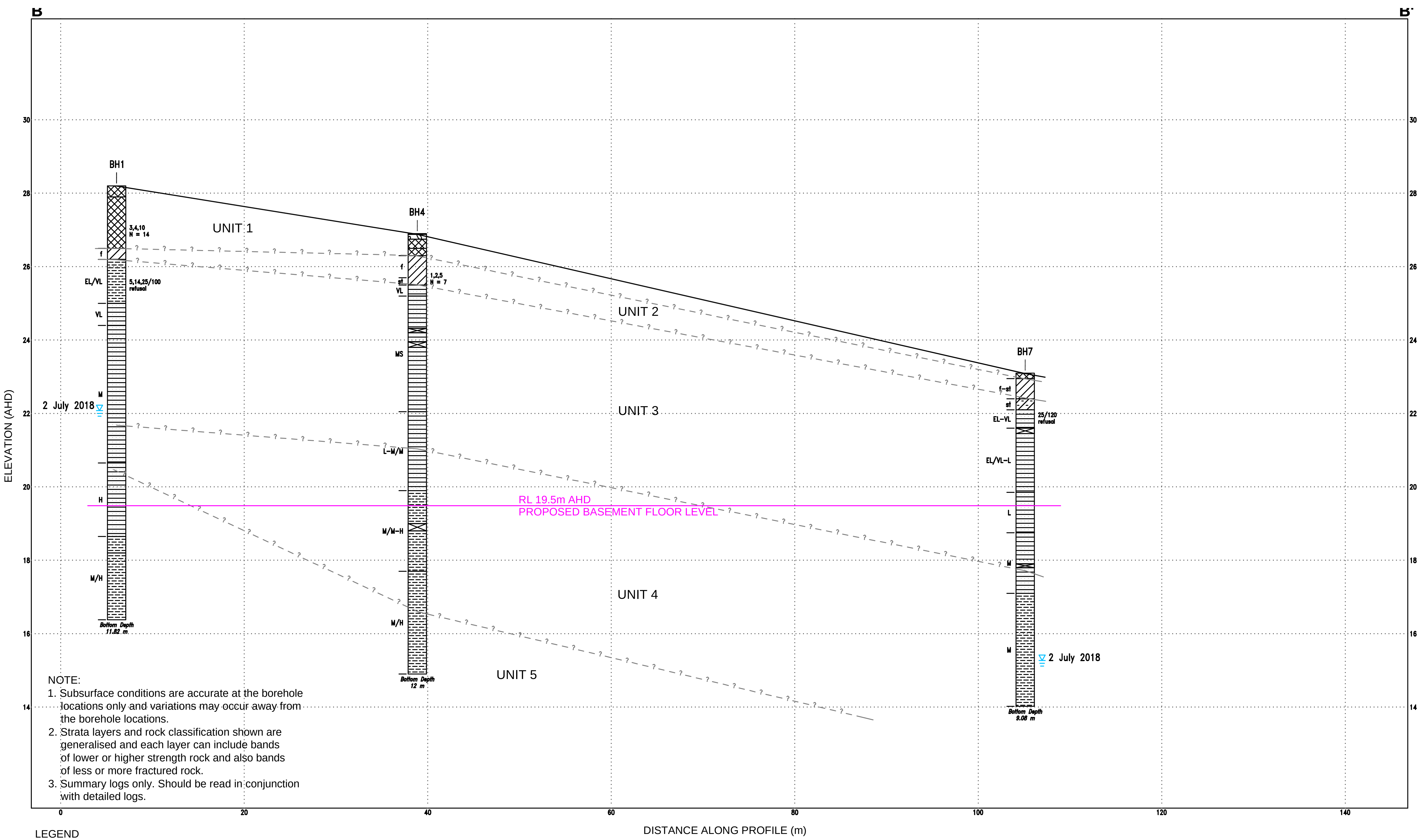
TESTS / OTHER
N - Standard penetration test value
- Water level
PP- Pocket penetrometer test value

0 8
Horizontal Scale (metres)

Vertical Exaggeration = 4.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Catholic Healthcare Ltd		TITLE: **Cross-section A-A'**	PROJECT No: 85469.01
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Residential Aged Care Facility Upgrade**	DRAWING No: 2
SCALE: 1:400 (H) 1:100 (V) @ A3	DATE: 13.07.2018	**2B West Street, LEWISHAM**	REVISION: 0



NOTE:

1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Filling
- Laminite
- Roadbase
- Sandy Clay
- Shale
- Shaly Clay

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

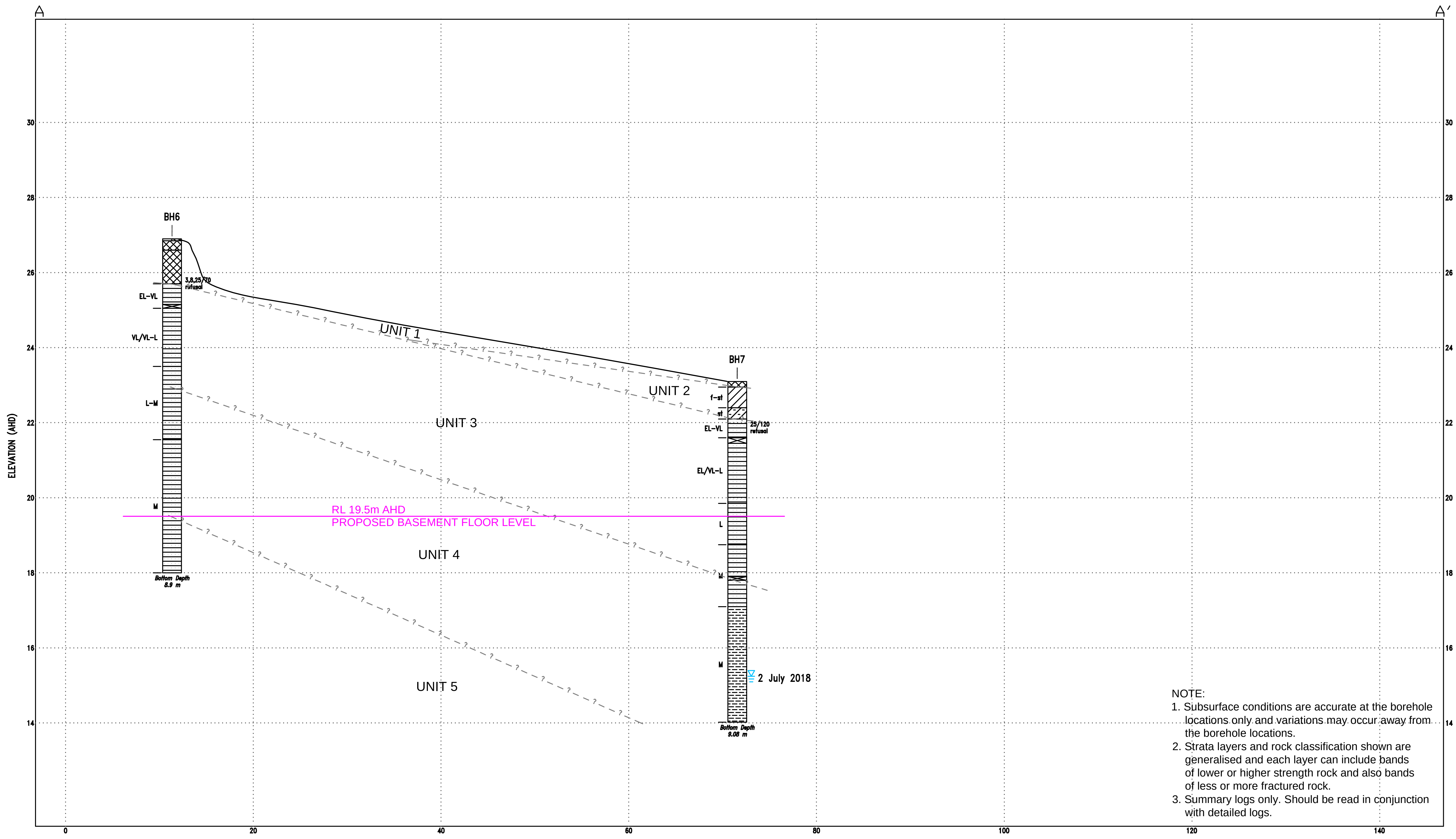
SOIL CONSISTENCY
f - firm
st - stiff

UNIT 1: Filling
UNIT 2: Residual soil
UNIT 3: Class V/ IV shale
UNIT 4: Class III/ II shale
UNIT 5: Class I shale

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

0 8
Horizontal Scale (metres)
Vertical Exaggeration = 4.0

Douglas Partners — Geotechnics / Environment / Groundwater	CLIENT: Catholic Healthcare Ltd	TITLE: **Cross-section B-B'**	PROJECT No: 85469.01
	OFFICE: Sydney — DRAWN BY: PSCH	**Proposed Residential Aged Care Facility Upgrade**	DRAWING No: 3
	SCALE: 1:400 (H) 1:100 (V) @ A3 — DATE: 13.07.2018	**2B West Street, LEWISHAM**	REVISION: 0



NOTE:
1. Subsurface conditions are accurate at the borehole locations only and variations may occur away from the borehole locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

- Core Loss
- Clay
- Filling
- Laminite
- Roadbase
- Shale
- Shaly Clay

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

SOIL CONSISTENCY
f - firm
st - stiff

UNIT 1: Filling
UNIT 2: Residual soil
UNIT 3: Class V/ IV shale
UNIT 4: Class III/ II shale
UNIT 5: Class I shale

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

0 8
Horizontal Scale (metres)
Vertical Exaggeration = 4.0

Douglas Partners — Geotechnics | Environment | Groundwater	CLIENT: Catholic Healthcare Ltd	TITLE: **Cross-section C-C'**
	OFFICE: Sydney / DRAWN BY: PSCH	**Proposed Residential Aged Care Facility Upgrade**
	SCALE: 1:400 (H) 1:100 (V) @ A3 / DATE: 13.07.2018	**2B West Street, LEWISHAM**
PROJECT No: 85469.01	DRAWING No: 4	REVISION: 0

Appendix C

Field Work Results

Sampling

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

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

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

Test Pits

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

Large Diameter Augers

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

Continuous Spiral Flight Augers

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

Non-core Rotary Drilling

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

Continuous Core Drilling

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

Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

Soil Descriptions

Douglas Partners

Description and Classification Methods

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

Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Descriptions

Soil Origin

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

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

Transported soils may be further subdivided into:

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

Rock Descriptions

Douglas Partners

Rock Strength

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

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Degree of Fracturing

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

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

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General

- Asphalt
- Road base
- Concrete
- Filling

Soils

- Topsoil
- Peat
- Clay
- Silty clay
- Sandy clay
- Gravelly clay
- Shaly clay
- Silt
- Clayey silt
- Sandy silt
- Sand
- Clayey sand
- Silty sand
- Gravel
- Sandy gravel
- Cobbles, boulders
- Talus

Sedimentary Rocks

- Boulder conglomerate
- Conglomerate
- Conglomeratic sandstone
- Sandstone
- Siltstone
- Laminite
- Mudstone, claystone, shale
- Coal
- Limestone

Metamorphic Rocks

- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks

- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 28.2 AHD
EASTING: 328842
NORTHING: 6248131
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 85469.01
DATE: 20/6/2018
SHEET 1 OF 2

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.3	FILLING: dark brown clayey gravel filling, medium to coarse and some fine to medium sand, moist.		A			
1.7	FILLING: dark brown clay filling with some fine to medium sand and fine to medium gravel, moist.		A, A, S			3,4,10 N = 14
2.0	SANDY CLAY: firm, orange-grey fine sandy clay with some fine to medium gravel, damp.					
3.2	SHALE: extremely low strength, extremely weathered, light grey mottled orange shale.	Unless otherwise stated, rock is fractured along planar, rough bedding, dipping at 0-10°.	A, S			5,14,25/100 refusal
3.8	LAMINITE: very low strength, highly weathered, fragmented, pale grey laminite with some medium strength, iron-cemented bands.	3.20-3.80m: fg, fe	C	100	0	
7.55	LAMINITE: medium strength, highly weathered then moderately weathered, fragmented to fractured, grey-brown laminite with approximately 40% fine grained sandstone laminations and some very low strength bands.	3.80-4.00m: B's, 0°, fe, cly co 4.00-4.30m: B(x6), 0°, fe, cly co 1-5mm 4.3m: J70°, pl, ro, fe 4.42-4.50m: Ds 4.62m: B0°, cly 5mm 4.63-4.80m: fg 4.95m: J, 30° and 70°, st, ro, cln 5.04-5.54m: B(x6), 0°, cly co 5.66-5.8m: J(x2), 60°, un,ro, fe, cly 6.02-6.50m: fg, fe 6.6m: B0°, fe, cly 20mm 6.65-7.55m: B's, 0°, fe, fg 10mm 7.05m: J45°, pl, ro, fe 7.2m: J45°, pl, ro, fe 7.42m: J40°, pl, ro, fe, fg 10mm	C (contd); C; C	100; 100	30; 75	PL(A) = 0.53 PL(A) = 0.66 PL(A) = 0.53 PL(A) = 0.69
9.55	LAMINITE: high strength, fresh, slightly fractured and unbroken, pale grey to grey laminite with approximately 20% fine grained sandstone laminations.	7.70-7.80m: J(x2), 45°, pl, ro, fe	C	100	97	PL(A) = 1.7 PL(A) = 2.3 PL(A) = 2.9
10.0	SHALE: (see next page)	9.45m: J,30-45°, cu, sm, cln 9.5m: J30°, pl, sm, fe 9.55m: J30°, pl, sm, cly				

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 3.2m
TYPE OF BORING: Solid flight auger to 2.5m, washbore to 3.2m, NMLC-coring to 11.82m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS: Well Installed: blank 0.1 - 3.0m, screen 3.0 - 11.8m, gravel 2.5 - 11.8m, bentonite 1.5 - 2.5m, backfill to 0.1m, flush gatic cover

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 28.2 AHD
EASTING: 328842
NORTHING: 6248131
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 85469.01
DATE: 20/6/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
18, 17	11	SHALE: high then medium to high strength, fresh, unbroken, grey shale with approximately 5% fine grained sandstone laminations.	FR		High then Medium to High		>1.00	9.65m: J45°, pl, ro, cln	C	100	97	PL(A) = 2.7 PL(A) = 1
16	11.82 12	Bore discontinued at 11.82m Target depth reached										
15	13											
14	14											
13	15											
12	16											
11	17											
10	18											
9	19											

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 3.2m

TYPE OF BORING: Solid flight auger to 2.5m, washbore to 3.2m, NMLC-coring to 11.82m

WATER OBSERVATIONS: No free ground water observed whilst augering

REMARKS: Well Installed: blank 0.1 - 3.0m, screen 3.0 - 11.8m, gravel 2.5 - 11.8m, bentonite 1.5 - 2.5m, backfill to 0.1m, flush gatic cover

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: 1 PROJECT: LEWISHAM JUNE 2018

3.2 – 8.0m

BORE: 1 PROJECT: LEWISHAM JUNE 2018

8.0 – 11.82m

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 28.4 AHD
EASTING: 328856
NORTHING: 6248115
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 85469.01
DATE: 19/6/2018
SHEET 1 OF 2

Column headings: RL | Depth (m) | Description of Strata | Degree of Weathering (EW, HW, MW, SW, FS, FR) | Graphic Log | Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High) | Water | Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00) | Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault) | Sampling & In Situ Testing (Type, Core Rec. %, RQD %, Test Results & Comments)

RL scale: 28, 27, 26, 25, 24, 23, 22, 21, 20, 19. Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.0

Depth (m)	Description of Strata
0.15	TOPSOIL: dark brown, fine to medium sand filling with clay and some fine to medium gravel, trace of tile fragments (15mm), moist
	FILLING: brown gravelly clay filling with trace terracotta tile fragments (25mm), damp
1.3	CLAY: stiff, orange-brown, slightly silty clay, with a trace of fine sand, humid
1.9	LAMINITE: very low strength, light grey mottled orange laminite
2.4	LAMINITE: medium to high strength, highly weathered, fragmented and fractured, pale grey laminite with very low strength bands.
2.7	
3.2	
3.9	LAMINITE: extremely to very low strength, extremely to highly weathered, slightly fractured, pale grey laminite with some medium strength, iron-cemented bands.
4.7	LAMINITE: medium strength, slightly weathered, fragmented to fractured then slightly fractured, grey-brown laminite with approximately 20% fine grained sandstone laminations.
6.8	LAMINITE: high strength, fresh, unbroken, pale grey to grey laminite with approximately 20% fine grained sandstone laminations.
10.0	

Discontinuities:

Unless otherwise stated, rock is fractured along planar, rough bedding, dipping at 0-10°.

2.6m: CORE LOSS: 100mm
2.70-3.10m: fg, fe
3.1m: CORE LOSS: 100mm
3.20-3.57m: fg, cly
3.67m: J85°, pl, ro, cln
3.90-4.25m: Ds
4.30-4.40m: Ds
4.50-4.60m: Cs
5.12-5.55m: fg, fe
5.55-5.95m: B's, 0°, fe
6.25m: J85°, pl, sm, cln
6.75m: J, 30° and 80°, st ro, cln
7.20-7.40m: J,70-90°, cu, ro, cln

Sampling & In Situ Testing:

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			6,6,8 N = 14
A			
S			25/50 refusal
C	90	45	PL(A) = 1.4; PL(A) = 1.2
C	100	35	PL(A) = 0.36; PL(A) = 0.59
C	100	100	PL(A) = 0.57; PL(A) = 2.6; PL(A) = 2.7
C	100	99	PL(A) = 2

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m, washbore to 2.6m, NMLC-coring to 12.05m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS: 10% water loss whilst coring

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 28.4 AHD
EASTING: 328856
NORTHING: 6248115
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 85469.01
DATE: 19/6/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
18		SHALE: high then medium to high strength, fresh, unbroken, grey shale with trace fine grained sandstone laminations.										PL(A) = 1.7
	11								C	100	99	
17								11.26m: J(x2), 30°, pl, sm, cln 11.4m: J30°, pl, sm, cln 11.44-11.55m: J, 60-70°, cu, ro, cln 11.86m: J60°, un, ro, cln				PL(A) = 0.98
	12 12.0	Bore discontinued at 12.0m Target depth reached										
16												
	13											
15												
	14											
14												
	15											
13												
	16											
12												
	17											
11												
	18											
10												
	19											
9												

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 2.5m
TYPE OF BORING: Solid flight auger to 2.5m, washbore to 2.6m, NMLC-coring to 12.05m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS: 10% water loss whilst coring

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: 2 PROJECT: LEWISHAM JUNE 2018

2.6 – 7.0m

BORE: 2 PROJECT: LEWISHAM JUNE 2018

7.0 – 12.0m

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 28.5 AHD
EASTING: 328882
NORTHING: 6248108
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 85469.01
DATE: 22 - 25/6/2018
SHEET 1 OF 2

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.05	ASPHALTIC CONCRETE		A			
0.1	ROADBASE		A			
	FILLING: dark brown fine to medium sand and fine to medium gravel filling, humid.		A			
1.2	CLAY: stiff, orange mottled red clay, trace of fine gravel and fine to medium sand.		S			4,6,8 N = 14
1.5	LAMINITE: extremely low strength, light grey and orange laminite.	Unless otherwise stated, rock is fractured along planar, rough bedding, dipping at 0-10°.				
2.3	LAMINITE: medium and high strength, highly weathered, fragmented to fractured, pale grey-brown laminite.	2.45-2.55m: fg 2.65m: B0°, cly 2.9m: J60°, un, ro, ti	C	100	50	PL(A) = 2.5
3.23		3.15m: CORE LOSS: 80mm 3.37-3.54m: fg 3.62-3.65m: fg, Ds				
3.77	LAMINITE: high strength, moderately to slightly weathered then fresh stained, fractured and slightly fractured, grey-brown laminite with approximately 30% fine grained sandstone laminations.	3.77-4.05m: B(x4), 0°, fe 4.00-4.10m: fg, cly 4.35-4.50m: B0°, fe 5.33-5.80m: B(x2), 0°, fe	C	97	65	PL(A) = 1.9 PL(A) = 1.2 PL(A) = 1.5
6.0	LAMINITE: high and very high strength, fresh, slightly fractured and unbroken, light grey to grey laminite with approximately 25% fine grained sandstone laminations.	>>	C	100	100	PL(A) = 3.2 PL(A) = 2.4 PL(A) = 3.5
		9.75m: J65°, pl, ro, cln	C	100	100	PL(A) = 2.8

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 2.2m
TYPE OF BORING: Solid flight auger to 2.2m, washbore to 2.3m, NMLC-coring to 12.1m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 28.5 AHD
EASTING: 328882
NORTHING: 6248108
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 85469.01
DATE: 22 - 25/6/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01 0.05 0.10 0.50 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
18		LAMINITE: (continued)						10.3m: J70°, pl, ro, cln 10.50-10.75m: J80°, un, ro, cln				PL(A) = 2.4
	10.7 11	SHALE: high strength, fresh, unbroken, grey shale with trace fine grained sandstone laminations.							C	100	100	
17												PL(A) = 1.7
	12 12.0	Bore discontinued at 12.0m Target depth reached										
16	13											
15	14											
14	15											
13	16											
12	17											
11	18											
10	19											
9												

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 2.2m

TYPE OF BORING: Solid flight auger to 2.2m, washbore to 2.3m, NMLC-coring to 12.1m

WATER OBSERVATIONS: No free ground water observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: 3 PROJECT: LEWISHAM JUNE 2018

2.3 – 7.0m

BORE: 3 PROJECT: LEWISHAM JUNE 2018

7.0 – 12.0m

BOREHOLE LOG

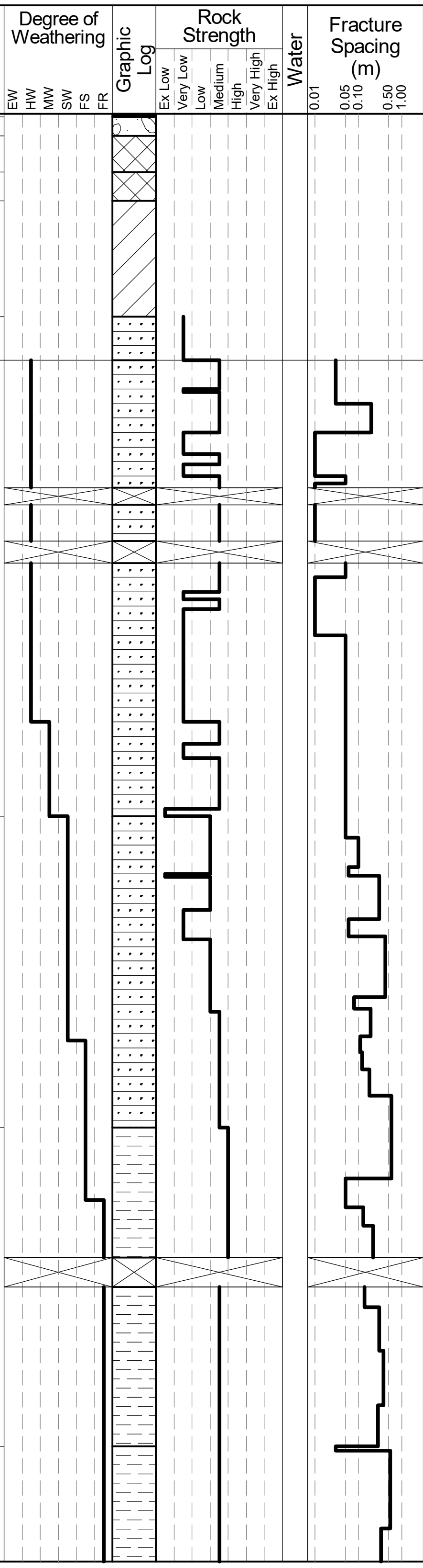
CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 26.9 AHD
EASTING: 328872
NORTHING: 6248145
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 85469.01
DATE: 21/6/2018
SHEET 1 OF 2

Depth (m)	Description of Strata
0.02	ASPHALTIC CONCRETE
0.15	ROADBASE
0.4	FILLING: light yellow-brown fine to medium sand with fine to medium gravel, damp
0.6	FILLING: dark brown, sandy clay with trace fine gravel, sand is fine to medium, damp
1.4	CLAY: firm, orange mottled grey clay, some fine to medium ironstone gravel, moist 1.2m: becoming stiff
1.7	LAMINITE: very low strength, grey-orange laminite with some clay
2.7	LAMINITE: medium strength, highly then moderately weathered, fragmented to fractured, pale grey and brown laminite
3.1	
4.85	LAMINITE: low to medium then medium strength, slightly weathered then fresh stained, fractured and slightly fractured, grey-brown laminite with approximately 20% fine grained sandstone laminations.
7.0	SHALE: medium to high and medium strength, fresh, fractured and slightly fractured, grey shale with some fine grained sandstone laminations.
8.1	
9.2	SHALE: medium then high strength, fresh, slightly fractured, grey shale.

RL scale: 26, 25, 24, 23, 22, 21, 20, 19, 18, 17. Depth scale: 1 to 9 m.



Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)

Unless otherwise stated, rock is fractured along planar, rough bedding, dipping at 0-10°.

- 1.80-1.85m: J(x2), 30-35°, pl, sm, cln
- 2.20-2.50m: fg
- 2.58m: CORE LOSS: 120mm
- 2.70-2.95m: fg, fe
- 2.95m: CORE LOSS: 150mm
- 3.20-3.60m: fg, fe
- 3.55m: J, sv, un, ro, fe
- 3.72m: J70°, pl, sm, ti
- 3.88m: J45°, pl, sm, fe
- 3.95-4.00m: Cs
- 4.05m: J60°, pl, sm, cly
- 4.12-4.18m: Ds
- 4.25m: J, 85°, un, ro, fe
- 4.35-4.40m: Cs
- 4.62m: J70°, pl, sm, fe
- 4.80-4.83m: Ds
- 5.2m: J45°, un, ro, fe
- 5.25m: B0°, cly 10mm
- 5.56m: J, sv, un, ro, cly
- 5.68-5.70m: Cs
- 6.48m: J, 45°, pl, ro, cln
- 6.6m: J, 45°, pl, ro, cln
- 6.78m: J, 45°, pl, ro, cln
- 7.35-7.40m: J(x2), 30°, pl, ro, cln
- 7.45-7.48m: sz, 30mm; J35°, pl, ro, cln
- 7.55m: J,45° and 85°, st, ro, fe
- 7.68m: J60°, pl, ro, fe, fg 25mm
- 7.9m: CORE LOSS: 200mm
- 8.24m: J45°, pl, sm, cln
- 8.54m: J45°, pl, sm, cln
- 8.92m: J45°, pl, sm, cln
- 9.20 & 9.23m: J(x2), 45°, pl, sm, cln
- 9.72m: J30°, pl, sm, cln

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			1,2,5 N = 7
C	90	7	PL(A) = 0.69; PL(A) = 0.72
C	100	38	PL(A) = 0.48; PL(A) = 0.27
C	91	79	PL(A) = 0.94; PL(A) = 1.3
C	100	99	PL(A) = 0.81; PL(A) = 0.87

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 1.6m
TYPE OF BORING: Solid flight auger to 1.6m, washbore to 1.7m, NMLC-coring to 12.0m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 26.9 AHD
EASTING: 328872
NORTHING: 6248145
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 85469.01
DATE: 21/6/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
16	11	SHALE: medium then high strength, fresh, slightly fractured, grey shale. *(continued)*	FR		Medium then High			10.1m: J45°, pl, sm, cln 10.8m: J45°, pl, sm, cln	C	100	99	PL(A) = 1.5
15									C	100	100	PL(A) = 1.2
	12 12.0	Bore discontinued at 12.0m Target depth reached										
14	13											
13	14											
12	15											
11	16											
10	17											
9	18											
8	19											
7												

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 1.6m
TYPE OF BORING: Solid flight auger to 1.6m, washbore to 1.7m, NMLC-coring to 12.0m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: 4 PROJECT: LEWISHAM JUNE 2018

1.7 – 6.0m

BORE: 4 PROJECT: LEWISHAM JUNE 2018

6.0 – 11.0m

BORE: 4 PROJECT: LEWISHAM JUNE 2018

11.0 – 12.0m

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 26.7 AHD
EASTING: 328914
NORTHING: 6248103
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 85469.01
DATE: 21/6/2018
SHEET 1 OF 2

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.05	ROADBASE					
0.3	FILLING: orange, clayey fine to medium sand filling with some fine to medium gravel, humid		A			
			A			
	LAMINITE: extremely low strength, orange and grey laminite.	Unless otherwise stated, rock is fractured along planar, rough bedding, dipping at 0-10°.				
1.0	LAMINITE: very low and low strength, highly and slightly weathered, fragmented and fractured, grey-brown laminite with approximately 20% fine grained sandstone laminations and some high strength band.	1.00-1.20: fg, fe 1.35-1.48m: Ds 1.78m: B0°, cly 5mm 1.85m: Cs, 20mm 1.92m: Cs, 20mm 2.25-2.40m: Ds 2.50-2.70m: J(x4), 45° and 85°, st, ro, fe, cz 50mm	C	100	8	PL(A) = 1.5 PL(A) = 0.32
2.65	LAMINITE: low to medium and medium strength and medium strength, highly and moderately weathered, fragmented and fractured, grey-brown laminite with approximately 40% fine grained sandstone laminations.	2.80-3.25m: fg, fe 3.1m: J70°, pl, ro, fe 3.35-4.00m: B(x12), 0°, fe 3.4m: B0°, fg, 20mm 3.5m: J45°, he, fe 3.75m: J30°, he, fe 4m: J85°, pl, ro, cln	C	100	35	PL(A) = 0.16
4.5	LAMINITE: high strength, fresh, slightly fractured and unbroken, light grey and grey laminite with approximately 20% fine grained sandstone laminations.	5.10-5.25m: B(x3), 0°, fe				PL(A) = 1.6 PL(A) = 1.7
		6.30-6.80m: J, 70-85°, cu, ro, cln 6.85m: J75°, pl, ro, cln 6.95-7.05m: fg 7.1m: J, 45° and 85°, st, ro, cln	C	100	88	PL(A) = 2.3
7.52		7.45m: CORE LOSS: 70mm 7.55m: J45°, pl, ro, cln 8.15m: J35°, pl, ro, cln	C	96	95	PL(A) = 2 PL(A) = 2
9.1	SHALE: high strength, fresh, slightly fractured and unbroken, grey shale with trace fine grained sandstone laminations.	9.20-9.45m: J, 70-85°, cu, ro, cln	C	100	100	PL(A) = 1.8

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 1.0m

TYPE OF BORING: Solid flight auger to 0.8m, washbore to 1.0m, NMLC-coring to 12.8m

WATER OBSERVATIONS: No free ground water observed whilst augering

REMARKS: 15% water loss whilst coring; Well installed: blank 0.1 - 1.5m, screen 1.5 - 12.1m, gravel 1.0 - 12.1m, bentonite 0.5 - 1.0m, backfill to 0.1m, flush gatic cover

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 26.7 AHD
EASTING: 328914
NORTHING: 6248103
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 85469.01
DATE: 21/6/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
16, 15	11, 12	SHALE: high strength, fresh, slightly fractured and unbroken, grey shale with trace fine grained sandstone laminations. *(continued)*	FR		High			11.22m: J45°, pl, sm, cln 11.45m: B0°, fe	C	100	100	PL(A) = 1.3 PL(A) = 1.9 PL(A) = 1.4
14–7	12.18	Bore discontinued at 12.18m Target depth reached										

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 1.0m

TYPE OF BORING: Solid flight auger to 0.8m, washbore to 1.0m, NMLC-coring to 12.8m

WATER OBSERVATIONS: No free ground water observed whilst augering

REMARKS: 15% water loss whilst coring; Well installed: blank 0.1 - 1.5m, screen 1.5 - 12.1m, gravel 1.0 - 12.1m, bentonite 0.5 - 1.0m, backfill to 0.1m, flush gatic cover

SAMPLING & IN SITU TESTING LEGEND

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

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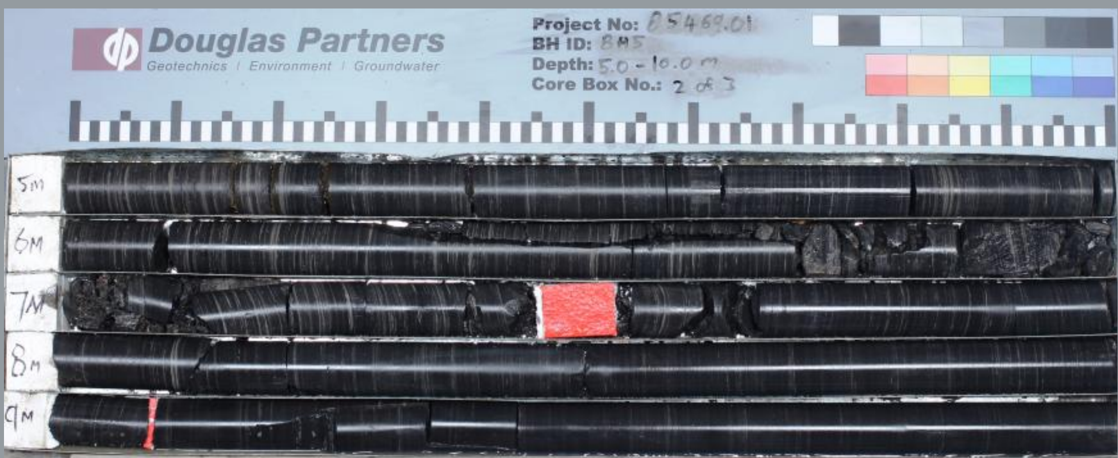
BORE: 5 PROJECT: LEWISHAM JUNE 2018

1.0 – 5.0m

BORE: 5 PROJECT: LEWISHAM JUNE 2018



5.0 – 10.0m

BORE: 5 PROJECT: LEWISHAM JUNE 2018

10.0 – 12.18m

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 26.9 AHD
EASTING: 328938
NORTHING: 6248123
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 85469.01
DATE: 22/6/2018
SHEET 1 OF 1

Column headings: RL; Depth (m); Description of Strata; Degree of Weathering (EW, HW, MW, SW, FS, FR); Graphic Log; Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High); Water; Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00); Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault); Sampling & In Situ Testing (Type, Core Rec. %, RQD %, Test Results & Comments)

Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
0.05	ROADBASE		A			
0.3	FILLING: orange, clayey fine to medium sand filling with some fine to medium gravel, humid		A			
	FILLING: orange-brown, clayey fine to medium sand filling with some fine to medium gravel and trace coarse gravel, humid		A			
1.2	LAMINITE: extremely low to very low strength, light grey and orange laminite.	Unless otherwise stated, rock is fractured along planar, rough bedding, dipping at 0-10°.	S			3,8,25/70 refusal
1.85	LAMINITE: very low and very low to low strength, highly weathered, fragmented to fractured, pale grey to grey-brown laminite with some medium strength, iron-cemented bands.	1.75m: CORE LOSS: 100mm 1.85-2.50m: fg 2.25m: J, sv (90°), un, ro, cln 2.4m: J, 45-90°, cu, ro, cln 2.5m: J85°, un, ro, fe 2.95m: J, 60° and 90°, st, ro, cln 3.20-3.25m: Ds 3.25-3.40m: fg, fe, cly	C	93	0	PL(A) = 0.69
3.4	LAMINITE: low to medium strength, slightly weathered, slightly fractured, grey-brown laminite with approximately 25% fine grained sandstone laminations.	3.50-3.98m: B's, 0°, fe 4.1m: J55°, pl, ro, cly 4.3m: B0°, fe 4.6m: B0°, fe 5.25-5.30m: fg, fe	C	100	81	PL(A) = 0.15 PL(A) = 0.38
5.35	LAMINITE: medium strength, fresh, slightly fractured, grey laminite with approximatey 20% fine grained sandstone laminations.	5.5m: J70°, pl, ro, ti 6.30-6.40m: J80°, un, ro, cln 6.85m: J45°, pl, sm, fe 7.08-7.48m: J(x5), 60-80°, pl, ro, fe 7.15m: J45°, pl, ro, cly 8.05m: J45°, pl, ro, cln 8.10-8.13m: fg 8.8m: J45°, pl, sm, cln	C	100	79	PL(A) = 0.59 PL(A) = 0.49 PL(A) = 1.1 PL(A) = 0.98
8.9	Bore discontinued at 8.9m Target depth reached					

RL scale: 26 (at ~1 m), 25, 24, 23, 22, 21, 20, 19, 18, 17

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 1.75m

TYPE OF BORING: Solid flight auger to 1.5m, washbore to 1.75m, NMLC-coring to 8.9m

WATER OBSERVATIONS: No free ground water observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: 6 PROJECT: LEWISHAM JUNE 2018

1.75 – 6.0m

BORE: 6 PROJECT: LEWISHAM JUNE 2018

6.0 – 8.9m

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 23.1 AHD
EASTING: 328925
NORTHING: 6248185
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 85469.01
DATE: 25/6/2018
SHEET 1 OF 1

Discontinuities legend: B - Bedding, J - Joint, S - Shear, F - Fault

Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
0.15	FILLING: dark brown sandy clay filling with trace coarse sandstone gravels, trace roots and rootlets, sand is fine to medium, damp.	Unless otherwise stated rock is fractured along rough planar bedding, dipping at 0°-10°	A, A			
0.7	CLAY: firm to stiff, orange mottled sandy clay with trace medium to coarse gravel, sand is fine, damp.		A			
1.0	SHALY CLAY: stiff, light grey and orange shaly clay.		S			25/120 refusal
1.5 / 1.65	LAMINITE: extremely low to very low strength, orange and light grey laminite.	1.5m: CORE LOSS: 150mm; 1.65-2.05m: fg, fe	C	90	0	
	LAMINITE: extremely and very low to low strength, extremely to highly weathered, fragmented, pale grey-brown laminite.	2.3m: B 0°, fe; 2.70-2.92m: Ds; 3.00-3.10m: Cs; 3.10-4.85m: B's, 0°, fe				PL(A) = 0.72
3.25	LAMINITE: low strength, moderately weathered, fractured, grey-brown laminite with approximately 20% fine sandstone laminations.	3.35m: J 45°, pl, ro, fe; 3.50-4.00m: J 80°, un, ro, fe; 3.60-3.70m: J (x2) 35°, pl, ro, fe; 4.15m: J 60°, un, ro, fe	C	100	0	PL(A) = 0.2
4.35	LAMINITE: medium strength, moderately and slightly weathered , fractured, grey laminite with approximately 20% fine sandstone laminations.	4.65m: J 35°, pl, ro, fe; 4.8m: J 45°, pl, ro, cly; 4.95-5.20m: fg				PL(A) = 0.61
5.3		5.2m: CORE LOSS: 100mm; 5.45-6.00m: B's 0°-5°, fe	C	95	25	PL(A) = 0.37
6.0	SHALE: medium strength, slightly weathered then fresh, fractured and slightly fractured grey shale.	6.20-6.30m: B (x3) 0°, fe; 6.42m: B 0°, pl, ro, cln; 7.16m: J 45°, pl, ro, cln; 7.6m: J sv, pl, ro, cln; 7.75-7.90m: J 80°, pl, sm, cln; 8.40-8.85m: J (x4) 45°, pl, sm, cln; 8.40-8.45m: Sz 50mm	C	100	85	PL(A) = 0.82; PL(A) = 0.74; PL(A) = 0.66
9.08	Bore discontinued at 9.08m Target depth reached					

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB/SI **CASING:** HW to 1.5m

TYPE OF BORING: Hand auger to 0.5m, solid flight auger to 1.0m, washbore to 1.5m, NMLC-coring to 9.08m

WATER OBSERVATIONS: No free ground water observed whilst augering

REMARKS: Well Installed: blank 0.5 - 2.0m, screen 2.0 - 9.1m, gravel 1.5 - 9.1m, bentonite 0.5 - 1.5m, backfill to 0.1m, flush gatic cover

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: 7 PROJECT: LEWISHAM JUNE 2018

1.5 – 6.0m

BORE: 7 PROJECT: LEWISHAM JUNE 2018

6.0 – 9.08m

BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 24.5 AHD
EASTING: 328860
NORTHING: 6248188
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 85469.01
DATE: 25/6/2018
SHEET 1 OF 1

Depth (m)	Description of Strata
0.05	ASPHALTIC CONCRETE
0.2	ROADBASE
0.4	FILLING: dark grey, sandy gravel filling, sand is medium, moist, generally in a dense condition
0.8	FILLING: dark grey and orange, clayey gravel filling, with medium sand, damp, generally in a medium dense to dense condition
1.4	CLAY: very stiff, light grey and orange clay with fine to medium gravel, humid 1.1m becoming hard
2.8	SHALE: extremely low and low strength, extremely weathered, fractured, light grey and orange shale
	Bore discontinued at 2.8m Auger refusal on shale

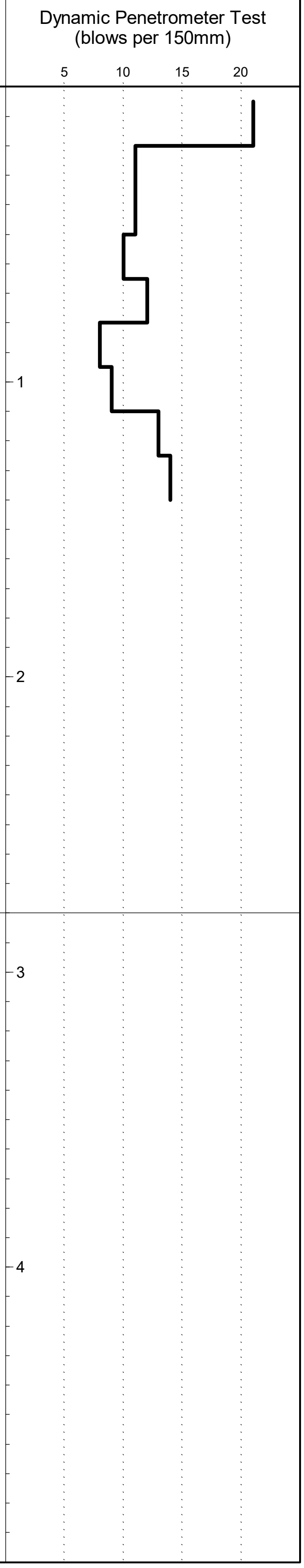
The depth given for each layer is the depth of its lower boundary.

Sampling & In Situ Testing

Type	Depth	Sample	Results & Comments
A	0.1–0.2		
A	0.3–0.4		
A	0.4–0.5		
A	2.0–2.1		

Water: –

RL scale: 24, 23, 22, 21, 20



RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB **CASING:** Uncased
TYPE OF BORING: Solid flight auger to 2.8m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS: Drilled in road

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

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 21.9 AHD
EASTING: 328841
NORTHING: 6248224
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 85469.01
DATE: 25/6/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water
0.08	ASPHALTIC CONCRETE	A	0.0–0.08			
0.2	ROADBASE	A	0.1–0.2			
1.0	FILLING: dark grey, gravelly clay filling, with fine to medium sand, gravel is fine to medium, moist, generally in a firm condition	A	0.4–0.5			
		A	0.8–0.9			
1.5	CLAY: firm, orange and brown clay with fine to medium sand and fine to medium gravel, damp, high plasticity	A	1.0–1.1			
1.8	CLAY: firm, dark red-brown clay with trace of fine to medium gravel, damp, high plasticity	A	1.5–1.6			
2.7	CLAY: stiff, orange clay with trace fine to medium sand and fine to medium gravel, damp, high plasticity	A	1.8–1.9			
		A	2.1–2.2			
	Bore discontinued at 2.7m Target depth reached					

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Scout 1 **DRILLER:** SS **LOGGED:** SLB **CASING:** Uncased
TYPE OF BORING: Solid flight auger to 2.7m
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS: Drilled in road

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

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Catholic Healthcare Ltd
PROJECT: Lewisham Redevelopment Project
LOCATION: 2B West Street, Lewisham

SURFACE LEVEL: 20.0 AHD
EASTING: 328881
NORTHING: 6248252
DIP/AZIMUTH: 90°/--

BORE No: BH10
PROJECT No: 85469.01
DATE: 25/6/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
20		TOPSOIL: dark brown, sandy clay filling with rootlets, fine to medium sand, moist		A	0.0–0.1				
	0.3	CLAY: firm, orange-brown motlled red clay, damp, trace of rootlets, mosit		A	0.4–0.5				
		0.8m becoming stiff		A	0.9–1.0				
19	1								1
	1.04	Bore discontinued at 1.04m Auger refusal on shale							

RIG: Hand Tools **DRILLER:** SLB **LOGGED:** SLB **CASING:** Uncased
TYPE OF BORING: Hand Auger
WATER OBSERVATIONS: No free ground water observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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