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Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Data Centre
1 Sirius Road, Lane Cove West

Prepared for
Greenbox Architecture Pty Ltd

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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.

	Signature	Date
Author		17 December 2018
Reviewer		17 December 2018

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Report on Geotechnical Investigation
Proposed Data Centre
1 Sirius Road, Lane Cove

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed data centre to be constructed at 1 Sirius Road, Lane Cove. The investigation was commissioned in an email dated 9 November 2018 by Mr Justin Smith of AW Edwards Pty Ltd on behalf of Greenbox Architecture Pty Ltd and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal SYD181146 dated 9 November 2018.

It is understood that the project involves site preparation and earthworks, including excavation to about 13 m, filling to 6 m, followed by construction of 3-4 level data halls, a substation, retaining walls and associated pavements.

Further, the proposed excavation footprint will cover most of the western and central parts of the site, to within a few metres of the eastern property boundary. From the provided preliminary architectural drawings, the proposed vehicular entry point to the site is from Sirius Road at about RL28 m AHD. Investigation was carried out to provide information on the subsurface conditions for the design of excavation, site preparation and earthworks, shoring systems and foundations.

The investigation comprised borehole drilling, installation of standpipe piezometers and laboratory testing of selected samples. Details of the field work and laboratory testing are given in this report together with comments relevant to design and construction practice.

2. Site Description and Geology

The site, known as Lot 1 in DP 1151370, has approximate plan dimensions of 270 m by 120 m and an area of 39453 m^2. It is located on the eastern side of the Lane Cove River and the southern side of Stringybark Creek, close to the Lane Cove West Business Park. The central part of the site is a broad and slightly sloped area (oriented approximately north-west to south-east: refer Photo 1 in Appendix B), the eastern part of the site slopes down to the north-east (refer Photo 2), whilst the western part of the proposed site slopes down to the south-west, and to the north from the industrial developments at the western end of Apollo Road (refer Photo 3). The central part of the site is accessed via a gravel-surfaced track leading from Sirius Road to the east. Neighbouring developments to the south-west of the site include multi-storey industrial developments (refer Photo 4).

A north-east trending cliff line on the south and south-eastern parts of the site (including adjacent to the main access track: refer Photo 5) has exposed rock outcrops and overhangs / caves, with rock also exposed within the access track near the northern property boundary. There are boulders in the soil slopes and below rock outcrops on both the south-eastern and south-western parts of the site (refer Photo 6). There were multiple stockpiles of soil and excavation rubble on the central part of the site, and near the northern property boundary on the lower level of the site (refer Photos 7 and 8).

There was seepage of groundwater on the western, uphill and winding section of the access track, at an elevation of about RL11 m AHD (refer Photo 9 and Drawing 1), and in a few other locations elsewhere on the uphill side of the access track. There was water in Stringybark Creek along the northern boundary, with wet areas of tree bark and other partially submerged features (to a height of about 0.3 m above water level: refer Photo 10) suggesting that the creek is tidal.

There were four existing standpipes (MW01, MW03, MW04 and MW05) with metal monuments within the site, understood to have been installed by Senversa Pty Ltd (Senversa).

Based upon the survey drawing prepared by S.P. Site Setout Pty Ltd (Drawings SP1121-001, Sheets 1 to 9, dated 17 September 2018), the elevation of the site varies between RL28.4 m to RL1.9 m relative to the Australian Height Datum (m AHD).

Reference to the Sydney 1:100 000 Geological Series Sheet (Reference 1) indicates that the site is underlain by Hawkesbury Sandstone, with the eastern part of the site (adjacent to Stringybark Creek) underlain by Quaternary alluvium. Hawkesbury Sandstone is generally a medium to coarse grained, massive and cross-bedded quartz sandstone, horizontally bedded and vertically jointed, with minor shale and laminite layers. The alluvium is described as being ‘sandy mud’ and ‘muddy sand’, from a tidal flat depositional environment.

Reference to the 1:25 000 Acid Sulphate Soil Risk map for Parramatta-Prospect (Reference 2) indicates that the lower part of the site is located on an area of Disturbed Terrain, which has an unknown risk for acid sulphate soils, and that the alluvial soils within Stringybark creek have a high risk for acid sulphate soils.

3. Background Information

Existing, relevant geotechnical information for the site includes:

- Environmental Investigations Australia Pty Ltd: “Geotechnical Assessment, Proposed Industrial Subdivision, Lot 2 DP884454, Sirius Road, Lane Cove, NSW”, report reference E468.1 GA, dated 4 April 2006 (Reference 3); and
- Senversa Pty Ltd: “Phase 2 Acquisition Environmental Due Diligence Assessment, 1 Sirius Road, Lane Cove West, NSW”, report reference s16913_006_RPT_Rev1, dated 10 December 2018 (Reference 4).

The test pit and monitoring well locations from the previous investigations are shown on the site plan presented in Drawing 1 (in Appendix C). It is noted that co-ordinates and surface levels were not recorded on the Senversa test pit logs, and that the thickness of the soil layers and depth to sandstone as recorded in the logs has been considered in this report.

According to the Senversa report, groundwater monitoring wells MW01 and MW04 were screened within sandstone, and combined groundwater and gas monitoring wells MW03 and MW05 were screened in soil and sandstone between depths of 0 - 2 m and 3.4 - 6.4 m (MW03) and 0 - 5 m (MW05). Analysis of the groundwater for contaminants was completed by Senversa, whose report should be referenced for the results and discussion of the groundwater analytical data. The report indicates that groundwater was observed during drilling in each of the boreholes converted into monitoring wells, and within the alluvium of test pits TP117 and TP118 (excavated adjacent to Stringybark Creek).

Analysis of six samples by Senversa from the eastern part of the site (i.e. MW03, TP113 to TP117) indicates that the alluvial soils beneath the filling are potential acid sulfate soils (PASS). The filling material above the alluvium was not included in their assessment.

The Senversa report identified that a portion of the eastern area of the site adjacent to Stringybark Creek is subject to a NSW EPA Notice ‘Maintaining Remediation’ (Order No. 28027, dated 27 September 2005), with the area of contaminated land apparently ‘capped’. Based on the extent of capping shown in their Figure 2, the proposed development footprint extends over the area of capping in the north-eastern corner.

4. Field Work

4.1 Methods

The field work for the geotechnical investigation was undertaken between 12 and 15 November 2018, and included ten machine-drilled boreholes. A site walkover and measurement of groundwater levels in standpipe piezometers was carried out by an engineering geologist on 6 December 2018. The current test locations are shown on Drawing 1.

The boreholes were initially drilled using auger and rotary washbore drilling techniques (with dia-core drilling through buried concrete slabs, where required), then advanced into the underlying sandstone using NMLC rotary core drilling equipment to obtain continuous samples of the rock (50 mm diameter) for identification and strength testing purposes. The cored borehole depths ranged between 4.25 m and 17.72 m.

As parts of the site are relatively steeply sloping, the boreholes were drilled using both bobcat-mounted and track-mounted drilling rigs.

Standpipe piezometers to monitor groundwater levels were installed in Boreholes BH5 and BH7, to depths of between 6.15 m and 9.2 m, and developed following installation. Well construction details are recorded in the borehole logs. The water levels in the standpipes and Stringybark Creek were measured on 6 December 2018, with the creek measured relative to the top of the creek bank protection structure (top row of gabion baskets, at about RL2.3 m). The results of the water observations are presented in Table 2.

Ground surface levels at the borehole locations were interpolated from a provided survey plan, and the borehole positions determined using a differential GPS. The co-ordinates and levels are considered to have an accuracy of 1 m in plan, and 0.1 m in elevation.

4.2 Results

The subsurface conditions encountered in the boreholes are presented in the borehole logs in Appendix D, together with notes defining the descriptive terms and classification methods. Core photographs are also presented.

The subsurface conditions encountered in the boreholes during the current investigation can be summarised as:

FILLING	silty or gravelly sand filling (with or without concrete slabs) to depths of between 0.2 m and 0.7 m (central and western areas of the site: Boreholes BH1 to BH6), or silty clay, sandy clay or gravelly sand filling to depths of between 1.6 m and 3.2 m (eastern area of the site);
SILTY SAND / COBBLES and BOULDERS (colluvium)	silty sand and low to high strength sandstone cobbles and boulders, to depths of between 0.8 m and 1.4 m (including some voids: southern / higher part of the site only);
CLAYEY SAND / SAND (residual)	fine to coarse grained sand or clayey sand, in the central and western areas of the site (Boreholes BH2, and BH4 to BH6), to depths of between 0.8 m and 1.3 m;
PEATY SAND, CLAY and SANDY CLAY (alluvium)	very loose, fine to medium grained sand and stiff to very stiff medium plasticity clays, to depths of between 2.1 m and 12.9 m and predominantly wet (eastern area of the site: boreholes BH7 to BH10); overlying
SANDSTONE	medium to coarse grained, initially extremely low or very low strength, becoming generally medium or high strength and with the frequency of defects decreasing within about 1 m - 2 m below the top of rock.

A photograph of the diacore-drilled concrete slab from Borehole BH2 is included with the borehole log.

Medium to high strength sandstone was exposed along access tracks on both the northern and southern sides of the site, as well as forming clifflines along the south and south-eastern parts of the site. The top surface of sandstone within the site appears to be ‘stepped’ downslope.

The zones of core loss within the sandstone are interpreted to be zones of extremely low strength rock (except for Borehole BH1: cobbles and boulders), which were ground up or washed away during coring.

The medium and high strength sandstone encountered in the boreholes was generally slightly fractured to unbroken, and thinly to thickly bedded. Some joints, dipping in the range 30° to 50° and 70° to 90° from the horizontal, and occasional sub-horizontal sandy clay, clay or decomposed seams were observed in the core samples.

A summary of the elevations (RL, mAHD) of the top of soil (colluvial, residual or alluvial) and sandstone below filling materials in the current and previous tests is summarised in Table 1.

Table 1: Summary of Depths / Elevations of Soil and Rock

Test ID	Top of Stratum								
	Top of Test Location	Colluvial soil		Residual Soil		Alluvial Soil		Sandstone	
	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)
BH1	27.3	0.6	26.7	-	-	-	-	1.4	25.9
BH2	20.5	-	-	0.5	20.0	-	-	0.9	19.6
BH3	13.1	0.0	13.1	-	-	-	-	0.8	12.3
BH4	17.3	-	-	0.7	16.6	-	-	1.0	16.3
BH5	9.4	-	-	0.7	8.7	-	-	1.3	8.1
BH6	9.7	-	-	0.2	9.5	-	-	0.8	8.9
BH7	5.2	-	-	-	-	3.2	2.0	4.2	1.0
BH8	4.3	-	-	-	-	2.5	1.8	12.9	-8.6
BH9	4.1	-	-	-	-	2.7	1.4	4.2	-0.1
BH10	5.3	-	-	-	-	1.6	3.7	2.1	3.2
MW01	26.0	-	-	-	-	-	-	1.2	24.8
MW03	3.9	-	-	3.9	0.0	-	-	5.6	1.7
MW04	14.8	0.0	14.8	-	-	-	-	0.3	14.5
MW05	3.2	-	-	-	-	2.2	1.0	2.6	0.6
TP01	27.5$^{\#}$	-	-	0.5	27.0$^{\#}$	-	-	1.2	26.3$^{\#}$
TP02	29.0$^{\#}$	-	-	0.3	28.7$^{\#}$	-	-	1.0	28.0$^{\#}$
TP03	27.5$^{\#}$	-	-	0.3	27.2$^{\#}$	-	-	0.7	26.8$^{\#}$
TP04	26.0$^{\#}$	-	-	0.3	25.7$^{\#}$	-	-	0.6	25.4$^{\#}$
TP05	17.0$^{\#}$	-	-	0.3	16.7$^{\#}$	-	-	1.0	16.0$^{\#}$
TP06	17.5$^{\#}$	-	-	0.3	17.2$^{\#}$	-	-	1.7	15.8$^{\#}$
TP07	16.5$^{\#}$	-	-	0.4	16.1$^{\#}$	-	-	0.6	15.9$^{\#}$
TP08	3.0$^{\#}$	-	-	-	-	1.6	1.4$^{\#}$	>3.0	< -0.2$^{\#}$
TP09	3.2$^{\#}$	-	-	-	-	1.9	1.3$^{\#}$	>2.5	< 0.7 $^{\#}$
TP10	5.0$^{\#}$	-	-	-	-	>2.7	2.3$^{\#}$	>2.7	< 2.3 $^{\#}$
TP101	9.0$^{\wedge}$	-	-	-	-	-	-	0.5	8.5$^{\wedge}$
TP102	9.5$^{\wedge}$	-	-	-	-	-	-	1.5	8.0$^{\wedge}$
TP103	10.0$^{\wedge}$	-	-	0.2	9.8$^{\wedge}$	-	-	1.0	9.0$^{\wedge}$

Test ID	Top of Stratum								
	Top of Test Location	Colluvial soil		Residual Soil		Alluvial Soil		Sandstone	
	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)	Depth (m)	Elevation (RL)
TP104	14.0^	-	-	0.1	13.9^	-	-	0.2	13.8^
TP105	16.0^	-	-	0.5	15.5^	-	-	1.0	15.0^
TP106	18.0^	-	-	0.9	17.1^	-	-	1.4	16.4^
TP107	15.0^	-	-	-	-	-	-	1.0	14.0^
TP108	12.0^	-	-	-	-	-	-	0.1	11.9^
TP109	13.0^	-	-	-	-	-	-	0.2	12.8^
TP110	7.0^	-	-	-	-	-	-	0.1	6.9^
TP111	6.0^	-	-	-	-	-	-	2.0	4.0^
TP112	5.7^	-	-	-	-	-	-	2.0	3.7^
TP113	4.0^	-	-	-	-	-	-	1.6	2.4^
TP114	4.5^	-	-	-	-	3.6	0.9^	>4.0	<0.5^
TP115	4.5^	-	-	-	-	3.5	1.0^	>4.0	<0.5^
TP116	4.5^	-	-	-	-	3.2	1.3^	>3.4	<1.1^
TP117	2.5^	-	-	-	-	1.5	1.0^	>1.9	<0.6^
TP118	2.5^	-	-	-	-	1.9	0.6^	>2.2	<0.3^
TP119	4.5^	-	-	-	-	>3.8?	<0.7?^	>3.8?	< 0.7? ^
TP120	5.0^	-	-	-	-	-	-	2.9	2.1^

Notes: The origin of materials logged by Senversa within test pits and monitoring wells has been inferred based upon the material description provided in the logs and other geotechnical data. '-' indicates the material was not encountered. # indicates surface level interpolated based on survey contours from Environmental Investigations Australia report (Reference 3), ^ indicates surface level interpolated based on current survey data.

Free groundwater was observed during auger drilling in boreholes BH7 to BH10, with the use of drilling fluids preventing groundwater observations during washboring and rotary coring in the other boreholes. The standpipe piezometers installed in Boreholes BH5 and BH7 comprised screened PVC pipe with gravel backfill, a bentonite pellet seal below or across the soil-rock interface, with the blank PVC pipe standing proud of the ground ('stick-up') by between 0.56 m to 0.99 m above ground surface level (refer to the borehole logs for specific details).

Upon completion, the standpipes were flushed and then bailed to remove drilling fluids. Measurement of the groundwater levels within the standpipes was undertaken about 3 weeks after installation, with the measurements (below ground surface level) summarised in Table 2. The inferred level within Stringybark Creek and the groundwater levels recorded by others (i.e. test pits TP08 and TP09:

Reference 3, monitoring wells MW01, MW03 to MW05 and test pits TP117 and TP118: Reference 4) are also included in Table 2.

Table 2: Groundwater Observations

Borehole	Surface RL (AHD)	Water Observation During Site Work (m)	Standing Water Level Measurements			
			13 November 2018		6 December 2018	
			Depth (m BTOC)[1]	RL (AHD)[2]	Depth (m)	RL (AHD)
BH5	9.4	*not observed*	-	-	1.7	7.7
BH7	5.2	3.2	-	-	3.3	1.9
MW01	26.0	8.5	6.3	22.6	-	-
MW03	3.9	2.5	>4.9	<1.0	-	-
MW04	14.8	14.5	6.0	1.5	-	-
MW05	3.2	2.3	5.8	0.8	-	-
TP08	3.0#	1.6	-	-	-	-
TP09	3.2#	2.1	-	-	-	-
TP117	2.5^	1.5	-	-	-	-
TP118	2.5^	1.9	-	-	-	-
Stringybark Creek	2.3[3]	-	-	-	1.1[3]	1.2

Notes: '-' indicates not measured, ">" indicates the well was dry at the bottom depth of the well. (1) Data from Senversa, "Table T6", depth below top of casing, rounded to 2 significant figures. (2) Data from Senversa, "Figure 4", rounded to 2 significant figures. (3) Measurements taken relative to the top of a gabion basket creek back protection structure, at 09:30am on 6 December 2018, # indicates surface level interpolated based on survey contours from Environmental Investigations Australia report (Reference 3), ^ indicates surface level interpolated based on current survey data.

5. Laboratory Testing

5.1 Rock Core

Selected samples of the rock cores were tested in the laboratory to determine the Point Load Strength Index (Is_{50}) values to assist with rock strength classification. The test results are shown on the borehole logs at the appropriate depths. The Is_{50} values for the rock (74 axial tests completed) ranged from 0.12 MPa to 2.1 MPa, indicating that the tested rock samples were of low to high strength. The corresponding uniaxial compressive strength (UCS) values are in the range 2 MPa to 42 MPa, based on an approximate Is_{50} multiplier of 20.

5.2 Chemical Analysis

Four selected soil samples from the boreholes were tested in a NATA-accredited analytical laboratory to determine soil aggressivity (pH, electrical conductivity, sulfate and chloride ion concentrations).

The soil aggressivity results are summarised in Table 3, with the laboratory test reports included in Appendix E.

Table 3: Laboratory Test Results for Aggressivity to Buried Concrete and Steel

Sample ID	Sample Description	Elevation of Sample[1] (RL m)	pH	EC[2] (µS/cm)	Chloride (mg/kg)	Sulphate (mg/kg)
BH3, 1.0-1.37m	Sandstone	12.1	5.0	19	<10	24
BH7, 1.0-1.45m	Clay (Filling)	4.2	6.6	1300	<10	8900
BH8, 0.4-0.5m	Silty clay (Filling)	3.9	5.4	78	<10	140
BH8, 5.5-5.95m	Peaty Sand (Alluvium)	-1.2	3.8[3]	690	<10	1900

Notes: (1) Elevation quoted is for the 'top' of the samples. (2) EC = Electrical Conductivity. (3) Analysed soils were tested as a 1:5 mixture of soil:water. (3) Value considered to be oxidised and of lower pH than *in situ* / field pH values.

5.3 Mechanical Analysis

Four selected soil samples with significant clay content were tested at a NATA-accredited soils laboratory for field moisture and Atterberg limits.

The test results are summarised in Table 4, with the detailed test reports included in Appendix E.

Table 4: Laboratory Test Results for Atterberg Limits and Field Moisture Content

Sample ID	Sample Description	Elevation of Sample[1] (RL, mAHD)	Field Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
BH7, 3.3-3.5m	Peaty Sand (Alluvium)	1.0	31.1	39	25	14
BH8, 7.1-7.55m	Clay (Alluvium)	-2.8	20.6	62	19	43
BH10, 0.9-1.0m	Sandy Clay (Filling)	4.4	17.5	34	18	16
BH10, 1.7-1.8m	Sandy Clay (Alluvium)	3.6	22.2	34	15	19

Notes: (1) Elevation quoted is for the 'top' of the samples.

The results of the soil testing indicate that the alluvial clay (i.e. sample from Borehole BH8) is high plasticity, whereas the clay within the other samples is of medium plasticity.

6. Geotechnical Model

The geotechnical model for the southern, elevated part of the site is shallow granular filling and colluvial soils (to depths of between 0.1 m and 1.7 m, including cobbles and boulders), over a stepped sandstone profile, with some areas of sub-vertical and over-hanging cliff (between 5 m to 10 m high). Colluvial soils occur on lower elevations of the slope, below the rock outcrops, whereas residual soils are present overlying the sandstone away from these slopes (both soils typically occur to depths of between 0.8 m and 1.4 m). The geotechnical model for the eastern part of the site, near to Stringybark Creek, is layers of filling (to 3.8 m depth, including a clayey 'capping' layer) over saturated alluvial soils (to a depth of 12.9 m: Borehole BH8), overlying sandstone. Between Borehole BH8 and Test Pit TP112, the depth to sandstone in the north-eastern corner of the proposed development footprint appears to increase by over 10 m (to an elevation of RL-8.6 m) over a horizontal distance of about 10 m (refer Table 1).

The elevation of the top of rock varies between RL28.0 m and RL-8.6 m, with the sandstone initially highly or moderately weathered, becoming slightly weathered or fresh within about 3-5 m below the top of rock. The rock strength in the central and western areas of the site is initially very low to low strength, rapidly becoming medium or high strength, whereas in the area of lower ground on the eastern part of the site, with a more rapid transition to medium or high strength rock below the alluvial soil.

The rock materials encountered in the boreholes (summarised in Table 5) have been classified in accordance with the procedures given in Pells et. al. (1998: Reference 6), and Bertuzzi and Pells (2002: Reference 7). It should be noted that the profiles are accurate at the borehole locations only, and that variations must be expected away from the boreholes.

Table 5: Summary of Material Strata Levels and Rock Classifications

Borehole ID	Top of Stratum[1]							
	Class V [2]		Class IV [2]		Class III [2]		Class II / I [2]	
	Depth (m)	Level (RL)	Depth (m)	Level (RL)	Depth (m)	Level (RL)	Depth (m)	Level (RL)
BH1	-	-	1.4	25.9	-	-	2.2	25.1
BH2	0.9	19.6	-	-	3.3	17.2	4.9	15.6
BH3	0.8	12.3	1.3	11.8	-	-	2.2	10.9
BH4	1.0	16.3	1.8	15.5	-	-	2.5	14.8
BH5	1.3	8.1	2.9	6.5	-	-	4.5	4.9
BH6	0.8	8.9	-	-	1.1	8.6	-	-
BH7	-	-	4.2	1.0	5.4	-0.2	7.0	-1.8
BH8	-	-	-	-	12.9	-8.6	14.9	-10.6
BH9	-	-	4.2	-0.1	-	-	5.5	-1.4
BH10	-	-	-	-	2.1	3.2	4.0	1.3

For Notes to Table 5, refer to following page.

Notes for Table 5:
1 Depths and levels shown are to the top of rock classes in boreholes, with depths in metres and elevations in m AHD
2 Rock classifications are based on Pells et. al (1998) and Bertuzzi and Pells (2002). Class II and Class I have been grouped together.
3 '-' indicates the material was not encountered within the drilled length

In the process of preparing the rock classes and geotechnical model, some of the encountered rock classes have been downgraded due to significant weak seams or core losses, and that bands of higher strength rock do occur within rock of lower strength.

7. Proposed Development

The proposed development on the sloping and stepped site includes:

- site preparations (including the removal of existing stockpiles);
- excavation of the south-western part of the site to a depth of up to about 13 m below existing surface levels (to an elevation of RL6.5 m);
- filling of the north-eastern part of the site to a height of about 6 m above existing surface levels (up to an elevation of RL11 m);
- construction of three data hall structures (including two 2-level data halls and one 1-level data hall), over a common level for plant rooms and storage of water and fuel;
- construction of a two-storey office building, over the western 2-level data hall;
- construction of a substation on the sloping ground in the south-western part of the site; and
- construction of pavements and retaining walls.

It is noted from the Senversa report that at least some of the contaminated material has been recommended for removal off-site as part of the works, however, the removal of the material within the footprint of the building is not required from a geotechnical perspective.

The proposed excavation covers most of the western and central parts of the site, to within about 20 m of the western property boundary, with a filling embankment to be constructed in the eastern and north-eastern part of the development. Column loads for the building were not provided at the time of reporting.

The geotechnical issues considered relevant to the proposed development include excavation and associated vibration, stress relief, excavation support, earthworks, groundwater, settlement, foundations and earthquake provisions.

8. Comments

8.1 Site Preparation

8.1.1 General

Site preparations are expected to include:

- improvements to the main access track from Sirius Road, such as widening and re-surfacing of the track to ensure “all-weather” access;
- removal of stockpiles of various materials within the western and northern parts of the site (including the wreckage of an excavator);
- stripping of the vegetation and topsoil layers;
- remediation of filling materials in the eastern area of the site, in accordance with the recommendations outlined in the Senversa report;
- on-site processing of the medium and high strength boulders (such as on-site crushing and screening, to create materials suitable for use in drainage, access roads or for working platforms), or their removal off-site;
- delineation of exclusion zones around areas with the potential for rock falls, such as areas of cliffs with overhangs, until specific geotechnical assessment can be completed of these areas;
- compaction of engineered filling for the embankment;
- consideration of global slope stability (safe batter) angles for the filling embankment; and
- consideration of long-term settlement of the area of soft soils beneath the filling embankment (i.e. in the north-eastern corner)

8.1.2 Dilapidation Surveys

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

8.2 Excavation

8.2.1 General

Following completion of the site preparation, areas of excavation within the proposed development footprint are expected to encounter up to 1.7 m depth of gravelly and sandy filling and clayey sand residual soils, then rock of varying strength including medium and high strength sandstone. Excavation near cliff lines will require careful assessment with regard to safety of workers, both above and below the cliff.

The filling, colluvial and residual soils should be readily excavated using conventional earthmoving equipment, however, the use of heavy plant will be required to excavate medium strength and stronger rock. Based upon the exposed rock and the core from the boreholes, some discontinuities and lower strength bands are present within the medium and high strength rock units, which may aid excavation.

Rippability of the sandstone will be dependent upon the spacing of bedding and vertical joints, as well as on strength. Effective removal of the medium or higher strength sandstone within the lower levels of the excavation should be achieved by heavy bulldozers ripping in conjunction with rock hammers, however, excavation contractors should make their own assessment of likely productivity depending on their equipment capabilities and operator skills. Detailed excavations can be done using rock hammers, rock saws or milling heads. Rock saws should also be used where minimisation of over-break is important.

It is understood that minimal excavation is proposed in the eastern area of the site, where there is filling overlying saturated alluvium. The Senversa report indicates that the filling in this area of the site is affected by asbestos fibres and other contaminants, and that the underlying alluvium has the potential to become acidic upon exposure (i.e. the alluvium is PASS).

In accordance with the Senversa report recommendations, if excavations are proposed within the asbestos-affected or PASS materials (including pile excavations for building foundations) then an acid sulfate soil management plan will be required, and specific safety protocols will need to be developed and implemented. Additional excavation is likely to be required at the cut-fill interface on the eastern area of the site, with the width and depth of the excavation, and the materials to be used within this ‘transition zone’, to be specified at a later stage of the project.

8.2.2 Materials Re-Use

The preliminary architectural drawings indicate that ground levels on the north-eastern portion of the site are to be raised by about 6 m above existing ground surface levels, to support pavements, generators and the north-eastern corner of the building. The materials likely to be excavated from within the central and western part of the building footprint (e.g. sand, clayey soils, crushed sandstone boulders and sandstone) should be suitable for re-use from a geotechnical perspective to construct the filling embankments, provided these materials (prior to compaction) are suitably blended, moisture conditioned, placed in layers, and with a maximum particle size of half the layer thickness. When further details are known, further geotechnical advice should be sought on issues including placement and test rolling methodologies, required compaction densities and recommended layer thicknesses.

Any off-site disposal of material will require assessment for re-use or classification of the soil in accordance with *Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes* (NSW EPA, 2014: Reference 8), prior to disposal to an appropriately licensed landfill. 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.

8.2.3 Stress Relief

It is possible that “stress relief” movement of the high strength sandstone could result from the excavation. Release of stresses due to the excavation may cause horizontal movement along the rock bedding surfaces and partings.

Based on experience with similar excavations in the area, the movement (into the excavation) could be up to 1 mm to 2 mm per vertical metre depth of excavation into the bedrock, particularly for excavation faces with east-west trending orientations. The movements are likely to be greatest towards the centre of the long dimension of the excavation and reducing to the corners where the excavation is constrained.

Although stress relief movements are likely to occur over a relatively short duration, it is likely that there will be some small, long-term stress relief movements. It is impracticable to provide restraint for any relatively high in-situ horizontal stresses present within the Hawkesbury Sandstone. Therefore, concrete / structural elements should not be cast directly against the excavated rock face and it would be prudent to leave a gap between the structure and the rock face on the southern side, which will accommodate any minor movements. This should be inspected by a geotechnical consultant to confirm that there is a sufficient gap.

Regular monitoring of survey targets along the excavation perimeter during construction, such as following each successive ‘drop’ in excavation level, should be undertaken to monitor the effects of stress relief. If vertical or horizontal movements in excess of 6 mm are recorded, further excavation should be temporarily suspended to enable a careful review of the data and implementation of appropriate control measures.

8.3 Settlement

Filling of up to 6 m in depth is proposed for the north-eastern corner of the site and is expected to be placed and compacted in layers directly over the existing filling materials and alluvial soils. Immediate, consolidation and ongoing creep settlement of the underlying soil is expected to occur under the loading of the filling embankment, and of the floor slabs. The very loose, saturated alluvial sand could be vibration sensitive, with the potential for unpredictable settlements in adverse conditions.

Assuming that the existing filling is left in place, that the unit weight of the new filling is 20 kN/m^3, and that the surcharge of the new filling is 120 kPa, the total magnitude of immediate and consolidation settlement for an area of 25 m by 40 m is estimated to be in the range 200 - 300 mm, with an additional estimated 20 - 25 mm of settlement due to a floor surcharge of 10 kPa.

The duration of immediate and consolidation settlement could be reduced by the installation of ground treatment such as wick drains, and the magnitude of post-construction settlement could be reduced by pre-loading the area to be constructed over the alluvium (both of the provided examples are time dependent). However, based on the magnitude of calculated settlement it is expected that suspended floors will be required over all areas underlain by filling. Additional investigation and analysis would be required to assess the various available options, and to assess interactions with PASS and contaminant migration, if any.

8.4 Vibration Control

Noise and vibration will be caused by excavation work on the site. The use of rock hammers or impact breakers, such as to excavate the sandstone, will cause vibrations which could possibly result in damage to nearby structures and underground services (e.g. closer than 20 m) and disturbance to occupants if not managed appropriately.

Assuming that the nearby buildings are founded on medium or high strength sandstone, it is suggested that vibrations be provisionally limited to a peak particle velocity (PPV) of 8 mm/s at the ground level of the neighbouring buildings to protect architectural features.

This provisional level complies with AS/ISO 2631.2 - 2014 (Reference 9) and is below the normal building damage threshold level. It is suggested that the client assess whether the proposed vibration limit will have a serviceability impact on nearby sensitive structures (if present), or for human comfort. This provisional limit may need to be modified depending on the result of such assessments.

A site specific vibration monitoring trial may be required to determine vibration attenuation once excavation plant and methods have been finalised.

8.5 Batter Slopes

Based upon the preliminary architectural drawings, excavations within soil and rock are proposed within about 15 m of the southern property boundary (to a depth of 13 m: including within soils, and close to cliffs with overhangs), and within 10 m of the western property boundary (to about 4 m depth). There is likely to be sufficient space adjacent to the proposed excavation footprint to form temporary batters or benches, within the soil and extremely low to very low strength rock. It is noted that pavements are proposed to be constructed within the footprint of the temporary slope batters and near to the buildings, therefore filling over the temporary batters and benches will be required to construct the pavements.

Although batters are not shown in the elevation drawings provided, it is likely that a temporary batter / access ramp will need to be maintained through the central area of the site for continued construction access.

Where there is insufficient space for batters, vertical excavations within the surficial soils (including through colluvial cobbles and boulders) will require shoring, such as with soil nails, mesh and shotcrete.

Where batters are proposed in soils, it is expected that excavations will be mostly less than 1.5 m high, and the maximum batter slopes recommended for the design of temporary cuts are presented in Table 6. Permanent batters should be provided with erosion protection using vegetation cover or similar and may need to be flattened to 3H:1V for maintenance purposes (e.g. mowing).

Table 6: Recommended Maximum Batter Slopes for Excavated Slopes

Excavated material	Temporary Batter	Permanent Batter
Filling	1.5H:1V	2H:1V
Extremely low to very low strength sandstone	0.75H:1V	1H:1V
Low strength sandstone	0.5H:1V	1H:1V
Medium strength sandstone (or better)	Vertical [1]	Vertical [1]

Note: (1) Should be inspected by an engineering geologist for unstable wedges, which should be removed or rock bolted.

Material stockpiles and machinery / equipment should not be stored at the crest of unsupported excavations.

Where excavation is required close to existing structures supported on high-level footings, it may be necessary to incorporate a set-back to the top of the batters, or underpin the footings to a lower ‘stable’ founding stratum.

8.6 Excavation Support

8.6.1 General

The neighbouring multi-storey industrial developments appear to be constructed without basement levels, and are probably constructed with shallow footings founding within the near-surface sandstone.

For lengths of the excavation perimeter where forming temporary batters is not possible, the filling materials and extremely low to very low strength sandstone will need to be temporarily supported to ensure that excavation stability is maintained, from the ground surface down to at least the top of consistent medium strength rock (indicated to be to depths of up to 3.3 m).

For a retained height of up to 1.5 m, meshed shotcrete with temporary soil nails drilled and grouted into the natural soils or filling should be suitable. Where the retained height exceeds 1.5 m, such as along the northern side of the excavation, temporary and permanent lateral support will be required: a piled retaining wall founded within the underlying medium strength (or stronger) rock (i.e. at a depth of between 2.5 - 3 m) would be suitable. Shoring piles could potentially terminate in medium to high strength sandstone above the bulk excavation level, provided that the piles are restrained (including at the pile toe) with between 1-2 rows of anchors (to be confirmed during the detailed design stage of the project). Shoring piles should usually be founded at least 1 m below the base of the bulk excavation level (or any perimeter drainage trenches or footings) to provide lateral restraint at the base of the excavation, and to avoid the risk of adversely inclined joints undermining the pile bases.

Excavations in the medium or high strength sandstone can be cut vertically and left unsupported as the excavation progresses, subject to a detailed assessment of jointing and rock conditions by a suitably qualified geotechnical engineer/engineering geologist (recommended at about every 1.5 m ‘drop’). The geotechnical professional will advise on any support works considered necessary to maintain stability, such as spot bolting or installation of shotcrete. Based upon the sandstone encountered in boreholes during the investigation, it is expected that extensive areas of shotcrete will not be required.

Based upon the limited data on joint orientations for the Hawkesbury Sandstone at the site, joints are inferred to be oriented at acute angles to the proposed excavation faces. It is expected that some wedges will be formed where these near-vertical joints intersect the excavation faces.

8.6.2 Design of Excavation Support Structures

Excavation faces retained either temporarily or permanently will be subjected to earth pressures from the ground surface down to the top of medium strength rock. Suggested material parameters for the preliminary design of excavation support structures are summarised in Table 7.

Lateral pressures due to surcharge loads from adjacent buildings, sloping ground surface or other loads and construction machinery should be included where relevant. Unless positive drainage measures can be incorporated to prevent water pressure build up behind the walls, full hydrostatic head should be allowed for in design while, at the same time, allowing for the soil density to reduce to the buoyant condition.

Table 7: Suggested Material Parameters for Preliminary Design of Excavation Support Structures

Material	Bulk Density (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Earth Pressure at Rest (K_o)	Ultimate Passive Earth Pressure (kPa)
Filling	18	0.3	0.6	-
Soil: Residual and Colluvial	18	0.25	0.5	-
Sandstone: Extremely low to very low strength	22	0.1	0.2	400
Sandstone: Low strength	22	0	0.1	2000
Sandstone: Medium strength	22	0	0	6000

Based upon the supplied preliminary architectural drawings, fill embankments on the north-eastern portion of the site are to be constructed adjacent to and supported by the completed, braced building. A triangular pressure distribution on the walls of the structure from the filling embankment should be included in the design: the structural engineer should be consulted for further advice. If retaining walls are required elsewhere on the site, they should be designed to be capable of withstanding some outward rotation (e.g. cantilever walls). These may be designed on the basis of the parameters given in Table 7 and a triangular pressure distribution.

The values of active earth pressure coefficient, K_a, to be used for estimating soil pressures are for a level ground surface and a wall allowing for some lateral movement. To minimise movement of adjacent footings, the soil and weathered rock below the foundations should be designed with an “at rest” lateral earth pressure coefficient (K_o).

8.6.3 Ground Anchors

Regular rock-face inspections will be required during excavation to determine whether any potentially unstable rock wedges are present requiring permanent support. Anchors may be required to support blocks or wedges exposed during excavation. The design of temporary ground anchors for the support of potentially unstable rock wedges may be carried out using the typical average bond stresses at the grout-rock interface given in Table 8.

Table 8: Typical Allowable Bond Stresses for Anchor Design

Material Description	Allowable Bond Stress (kPa)	Ultimate Bond Stress (kPa)
Sandstone: Very low strength	50	100
Sandstone: Low strength	150	300
Sandstone: Medium strength	500	1000
Sandstone: High strength	1500	3000

Ground anchors should be designed to have a free length of at least 3 m and have a minimum 3 m bond length. After installation they should be proof loaded to 125% of the design working load and locked-off at no higher than 80% of the working load. Periodic checks should be carried out during the construction phase to ensure that the lock-off load is maintained and not lost due to creep effects or other causes.

The parameters given in Table 8 assume that the anchor holes are clean and adequately flushed, with grouting and other installation procedures carried out carefully and in accordance with good anchoring practice. Careful installation and close supervision by a geotechnical specialist may allow increased bond stresses to be adopted during construction, subject to testing.

In normal circumstances the building will restrain the excavation over the long term and therefore ground anchors (i.e. for potentially unstable large blocks or wedges) are expected to be temporary only. The use of permanent anchors would require careful attention to corrosion protection. Further advice on design and specification should be sought if permanent anchors are to be employed at this site.

It will be necessary to obtain permission from neighbouring landowners prior to installing anchors that will extend beyond the site boundaries. In addition, care should be taken to avoid damaging buried services, pipes and subsurface structures during anchor installation.

8.7 Groundwater

During the current investigation, groundwater was observed during auger drilling in boreholes BH7 to BH10, and was subsequently measured in the installed standpipes at depths below ground level of 1.65 m (RL7.8 m: Borehole BH5) and 3.29 m (RL1.9: Borehole BH7). Measurements of groundwater completed by others (from standpipes screened within the sandstone) indicate that the groundwater level decreases towards the north / north-west (from RL22.6 m in MW01 to RL1.5 m in MW04), whilst measurements of standpipes screened within the filling and alluvial soil (i.e. MW03 and MW05) have groundwater levels similar to that of the nearby creek (RL1.2 m).

Observation of seepage within the access track at an elevation of about RL11 m, indicates a perched water table is present within elevated areas of the site, at the soil-rock interface. Groundwater levels are potentially transient, and affected by the prevailing weather conditions and downslope drainage conditions.

It is anticipated that groundwater ingress into the excavation will occur as seepage through and along strata boundaries on the site, and from rock defects (e.g. joints and seams). At this stage it is not possible to accurately estimate the likely extent and rate of seepage. Although the permeability of the rock mass and inflow rates are expected to be low, it is anticipated that relatively large volumes of seepage into the excavation will occur due to the length of the excavation and its location between the higher ground to the south-east and the river to the north-west. Careful attention to drainage provisions should be made during construction, including installation of permanent sub-floor drainage. Seepage water should be directed to a discharge point. Pumps may be needed to remove seepage from bored pile excavations prior to placement of concrete, if bored piles are used as part of the structural design.

It is suggested that monitoring of flow during the early phases of excavation be undertaken to assess long term pumping requirements. Grouting of open joints and partings may be necessary if excessive water ingress is an issue during excavation.

It will be necessary to provide under-floor drainage to safeguard against uplift pressures if the slab is designed for drained conditions. This could comprise a minimum 100 mm thick, durable open graded crushed rock with subsurface drains and sumps.

Previous experience indicates that the groundwater within the Hawkesbury Sandstone can have moderate concentrations of dissolved solids, including iron. Once groundwater comes into contact with the atmosphere, precipitation of iron oxides is likely to occur and provision should be made for the filtering and/or cleaning of this precipitate from subsoil drains, sumps, pumps and other fittings over the medium to longer term.

Based upon the groundwater observations and ground conditions encountered during the investigation, the groundwater drawdown effects on adjacent properties are likely to be negligible.

8.8 Foundations

Medium or high strength sandstone (Class II or Class I) is expected to be encountered at bulk excavation levels in the central and western areas of the proposed excavation, whereas very low to low strength fractured sandstone (Class IV) is expected to be encountered at lower elevations, near the eastern limit of the proposed excavation (i.e. where the depth of rock excavation is less).

Spread footings (i.e. pad or strip footings) should therefore be suitable for supporting the proposed building loads over the excavation footprint within rock. Foundations on the eastern side of the development footprint will need to be taken deeper, through the weaker rock layers to Class II sandstone. Foundations for the building over filled areas will need to be taken to a uniform founding stratum, such as Class II sandstone. Provision should be made for casing of the pile hole excavations, to prevent their collapse due to the ingress of groundwater.

Accordingly, it is recommended that the foundations be designed for a maximum allowable bearing pressure of 3500 kPa. Recommended maximum allowable (and ultimate) bearing pressures, shaft adhesions and modulus values for the range of rock encountered in boreholes at the site are presented in Table 9. These parameters apply to the design of spread foundations, such as pads or strip footings, or for socketed bored piles, for the support of axial compression loadings. They can be adopted on the assumption that the excavations are clean and free of loose debris, with pile sockets (if constructed) free of smear and adequately roughened immediately prior to concrete placement. An experienced geotechnical professional should inspect all spread footings (e.g. pads) and pile excavations prior to the placement of concrete and steel.

Footings taken down into consistent Class II sandstone could potentially be designed for an allowable bearing pressure of 6000 kPa and possibly up to 12000 kPa, subject to additional borehole drilling and spoon testing during construction. If an allowable bearing pressure of 3500 kPa is used for design then testing during construction could be limited to inspection of the excavations.

Table 9: Recommended Design Parameters and Moduli for Foundation Design

Foundation Stratum[1]	Allowable End Bearing (MPa)	Ultimate End Bearing (MPa)	Allowable Shaft Adhesion (kPa)[2]	Ultimate Shaft Adhesion (kPa)[2]	Field Elastic Modulus (MPa)
Sandstone – Class IV	1.0	4	100	250	100
Sandstone – Class III	3.5	20	350	800	350
Sandstone – Class II	6.0	60	600	1500	900

Notes 1 Rock Classification based on Pells et. al (1998) and Bertuzzi and Pells (2002).
2 Shaft adhesion applicable to the design of bored piles, uncased over the rock socket length, where adequate sidewall cleanliness and roughness are achieved

Where footings are located within the zone of influence of adjacent excavations, drawn upward at 45 degrees from the toe of the excavation (such as lift shafts or tanks), the allowable bearing pressure should be reduced by 25% and the excavation floor carefully inspected for adversely oriented joints. Alternatively, the footings may be taken deeper, below the zone of influence.

The settlement of a spread footing is dependent on the loads applied to the footing and the foundation conditions below the footing. The total settlement of a spread footing designed using the allowable parameters provided in Table 9 should be less than 1% of the footing width upon application of the design load. Differential settlements between adjacent footings may be in the order of 50% of the value of total settlement.

In limit state design, the footing dimensions are usually governed by settlement criteria and performance rather than the ultimate bearing capacity. The Serviceability limit could be assessed, for normal 'static' load cases, using the elastic modulus values given in Table 9. These modulus values are appropriate for the anticipated working stress values or strain expected under serviceability loading.

For Ultimate Limit State Design, a geotechnical strength reduction factor (ϕ_g) should be applied to the ultimate geotechnical strength of the pile ($R_{d,ug}$), in accordance with AS2159 – 2009 (Reference 5). The ϕ_g value adopted is dependent on the level of confidence in the selected design parameters, design methods and construction/installation methods. The level of site investigation and pile load testing are key inputs in determining the ϕ_g value. A value of 0.4 should be adopted for preliminary design, updated as the detailed design proceeds.

All spread footings should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material and proof drilled or spoon tested as appropriate.

8.9 Soil Aggressivity to Concrete and Steel Structures

In accordance with Australian Standard AS 2159-2009 (Reference 5), the results of the chemical laboratory testing indicate:

- the sandstone and silty clay filling (above the water table) are mildly aggressive to buried concrete and non-aggressive to buried steel;
- the clay filling (above the water table) is mildly aggressive to buried concrete and moderately aggressive to buried steel; and
- the peaty sand alluvium below the water table (when oxidised) is very severely aggressive to buried concrete and moderately aggressive to buried steel.

Close to Stringybark Creek the groundwater within the alluvium will have the same chemical properties as seawater, with some fluctuations in level due to tides. AS2159, Section 6.3 notes: “Piles installed in acid sulfate soil locations shall require specific durability design to resist acid attack. The effects of the method of pile construction on the formation of sulfuric acid shall be considered.”

8.10 Seismic Design

In accordance with the Earthquake Loading Standard, AS 1170.4 – 2007 (Reference 10), the site has a hazard factor (z) of 0.08. A site sub-soil class of shallow soil (C_e) is considered appropriate, unless areas of the buildings over rock can be isolated completely from the areas where soil greater than 3 m in depth can load the structure during earthquakes.

9. Additional Investigation

It is recommended that supplementary geotechnical investigation be completed at a later stage of the project, to confirm the geotechnical model in areas where there are geotechnical data gaps. The supplementary investigations include:

- the site of the proposed electrical substation, in the south-west corner of the site (including thermal resistivity);
- investigation and assessment of groundwater levels and rock mass permeability, to refine the assessment of likely groundwater flows into the excavation;
- further testing and assessment of the filling and alluvial soils in the eastern area of the site, to refine estimates of settlement and to confirm the depth and extent of potential acid sulfate soils.

10. References

1. Herbert C., 1983, Sydney 1:100 000 Geological Sheet 9130, 1st edition. Geological Survey of New South Wales, Sydney.
2. The Department of Land and Water Conservation, 1995. 1:25 000 Acid Sulphate Soil Risk map for Parramatta-Prospect.

3. Environmental Investigations Australia Pty Ltd: “Geotechnical Assessment, Proposed Industrial Subdivision, Lot 2 DP884454, Sirius Road, Lane Cove, NSW”, report reference E468.1 GA, dated 4 April 2006.
4. Senversa Pty Ltd: “Phase 2 Acquisition Environmental Due Diligence Assessment, 1 Sirius Road, Lane Cove West, NSW”, report reference s16913_006_RPT_Rev1, dated 10 December 2018.
5. Australian Standard AS2159-2009, “Piling – Design and Installation”, Third edition, 2009, Standards Australia.
6. Pells, PJN., Mostyn, G., and Walker, BF, 1998, “Foundations on Sandstone and Shale in the Sydney region”, Australian Geomechanics Journal, Vol. 33, No. 3.
7. Bertuzzi, R. and Pells, PJN, 2002, “Geotechnical parameters of Sydney Sandstone and Shale”, Australian Geomechanics Journal, Vol. 37, No. 5.
8. NSW Environment Protection Authority (EPA), 2014. “Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes”.
9. Australian / International Standard AS/ISO 2631.2 – 2014, “Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Vibration in buildings (1 Hz to 80 Hz)”.
10. Australian Standard AS 1170.4 – 2007, “Structural design actions, Part 4: Earthquake actions in Australia”.

11. Limitations

DP has prepared this report for this project at 1 Sirius Road, Lane Cove West, in accordance with DP’s proposal SYD181146, dated 9 November 2018 and acceptance received from Mr Justin Smith of AW Edwards Pty Ltd dated 9 November 2018, on behalf of Greenbox Architecture Pty Ltd. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Greenbox Architecture Pty Ltd or their agents for this project only and for the purposes as described in the report. It should not be used for other projects or purposes 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.

This report must be read in conjunction with all of the attachments 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.

It is noted that asbestos was detected by others within filling materials at the site, and building demolition materials were observed at the surface, such as glass. These are considered as indicative of the possible presence of hazardous building materials (HBM), including asbestos.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above). It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

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

Douglas Partners Pty Ltd

Appendix A

About This Report

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.

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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.

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

Site Photographs

Photo 1 – View north-west over the broad, slightly sloped central area of the site, with some soil stockpiles.

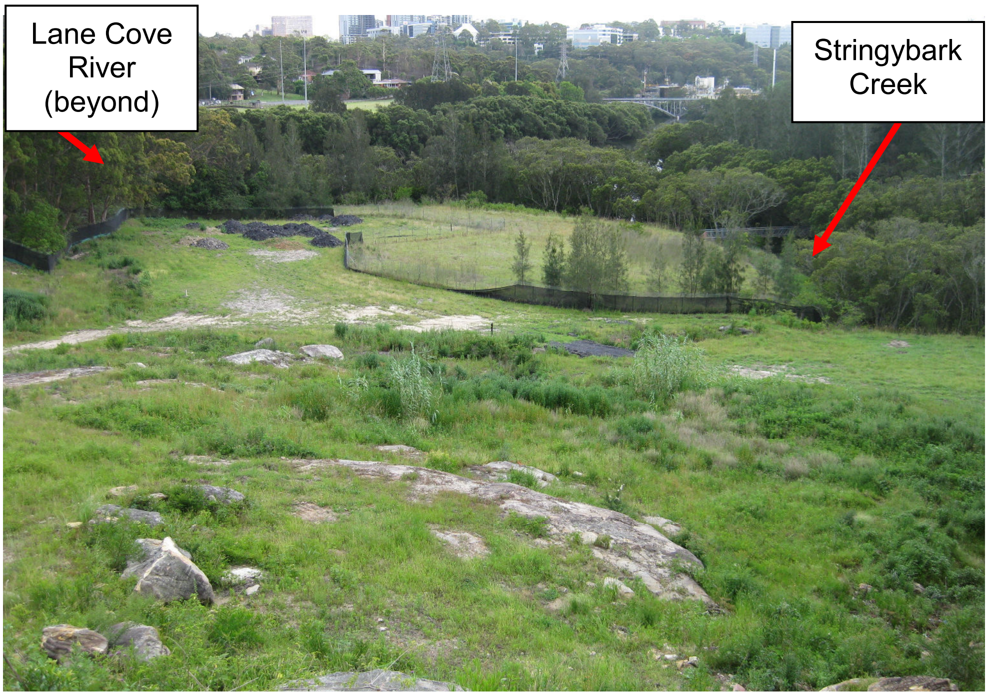


Photo 2 – View north towards Stringybark Creek and the Lane Cove River. The site slopes down to the north-east, towards a filled and levelled area.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Proposed Data Centre** **1 Sirius Road, Lane Cove West**	PROJECT:	86621.00
		PLATE No:	1
		REV:	0
	CLIENT: Greenbox Architecture Pty Ltd	DATE:	07/12/18

Photo 3 – View west towards the western property boundary from an access track. The site slopes down to the south-west.

Photo 4 – View south towards neighbouring multi-storey industrial developments.

Douglas Partners *Geotechnics / Environment / Groundwater*	**Site Photographs**	PROJECT: 86621.00
	Proposed Data Centre	PLATE No: 2
	1 Sirius Road, Lane Cove West	REV: 0
	CLIENT: Greenbox Architecture Pty Ltd	DATE: 07/12/18

Photo 5 – View south towards a cliffline and rock overhangs adjacent to an access track leading from Sirius Road.

Photo 6 – View south-east towards a colluvial slope and cliffline, with cobbles and boulders at the ground surface.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	86621.00
	Proposed Data Centre	PLATE No:	3
	1 Sirius Road, Lane Cove West	REV:	0
	CLIENT: Greenbox Architecture Pty Ltd	DATE:	07/12/18

Photo 7 – View south-east towards the southern property boundary and neighbouring developments, across stockpiles of soil and excavation rubble within the central part of the site.

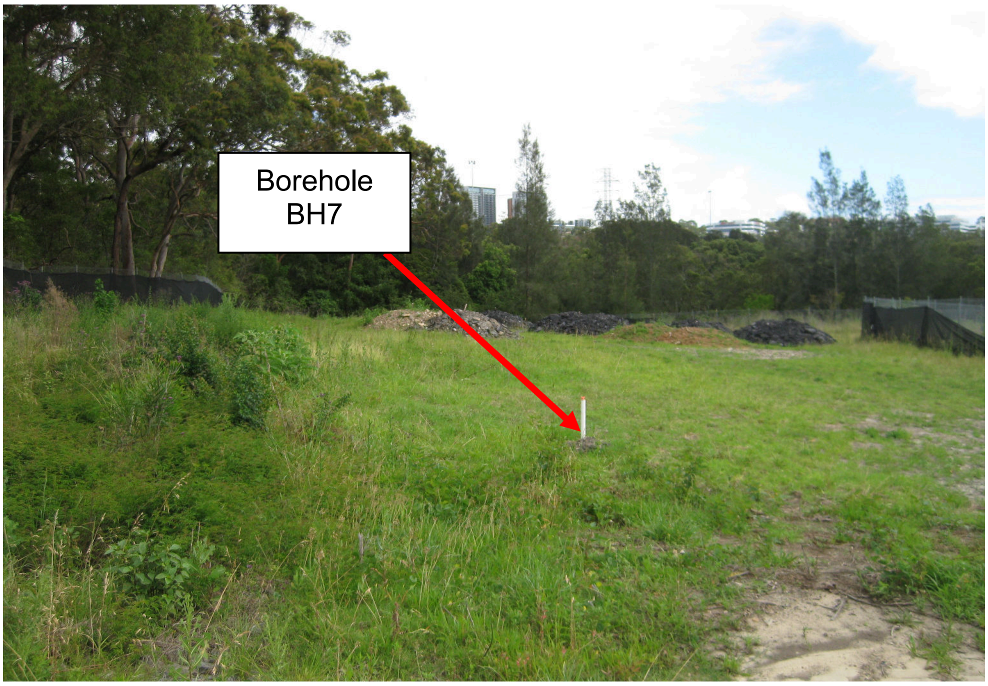


Photo 8 – View north-west across a filled and levelled area on the lower level of the site, towards the Lane Cove River (beyond) and stockpiles of soil and excavation rubble. The location of Borehole BH7 is indicated as shown.

Douglas Partners *Geotechnics / Environment / Groundwater*	**Site Photographs**	PROJECT:	86621.00
	Proposed Data Centre	PLATE No:	4
	1 Sirius Road, Lane Cove West	REV:	0
	CLIENT: Greenbox Architecture Pty Ltd	DATE:	07/12/18

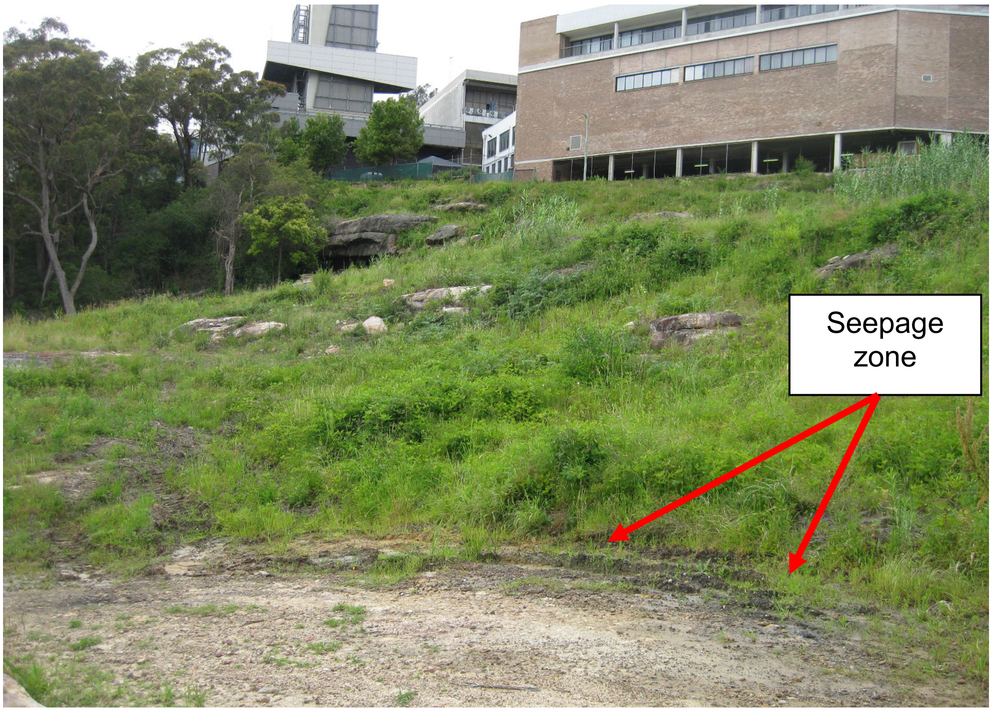


Photo 9 – View south-east from the winding access track, towards a zone of seepage onto the access track as indicated.

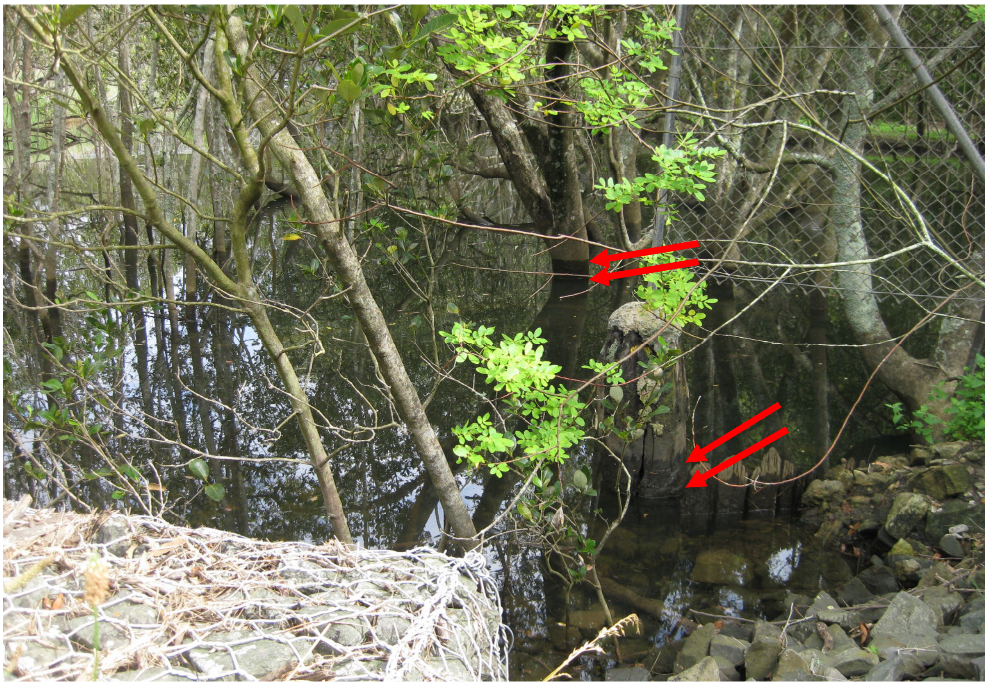
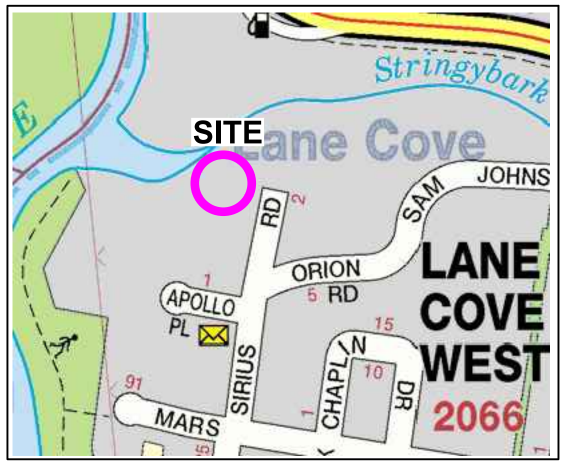


Photo 10 – View north-west from the southern bank of Stringybark Creek, with wet sections of partly submerged features within the creek (as shown with arrows) indicating the water level in the creek has recently gone down (i.e. falling tidal level).

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	86621.00
	Proposed Data Centre	PLATE No:	5
	1 Sirius Road, Lane Cove West	REV:	0
	CLIENT: Greenbox Architecture Pty Ltd	DATE:	07/12/18

Appendix C

Drawing



Locality Plan

LEGEND

- ✚ Current borehole location
- ✚ Historical test pits (Environmental Investigations Australia report E468.1 GA, dated April 2006)
- ▲ Environmental monitoring well location (Senversa, November 2018)
- ✚ Historical test pits (Senversa report 16913_006_RPT_Rev1, dated December 2018)
- 〰 Seepage
- ① Photo number with direction of view

NOTES:
1: Base image from Nearmap.com (dated 23 October 2018)
2: Test locations are approximate only and are shown with reference to existing features.
3: Outline of proposed new buildings and facilities taken from Greenbox Architecture Pty Ltd drawings ATSYD2_SSD_DRG_ARC_0100 to ATSYD2_SSD_DRG_ARC_0103, and ATSYD2_SSD_DRG_ARC_0050 (Issue 1), dated 12 December 2018.

0 5 10 20 30 40 50 75 100 125m

1:1250 @ A3

CLIENT: AW Edwards Pty Ltd		TITLE: **Site and Test Location Plan**	PROJECT No: 86621.00
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Data Centre**	DRAWING No: 1
SCALE: 1:1250 @ A3	DATE: 5.12.2018	**1 Sirius Road, LANE COVE WEST**	REVISION: 0

Appendix D

Field Work Results

Sampling Methods

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

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

Rock Strength

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

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Degree of Fracturing

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

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

Rock Descriptions

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

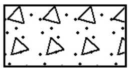
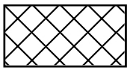
Other

fg	fragmented
bnd	band
qtz	quartz

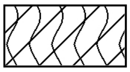
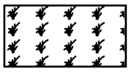
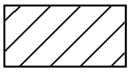
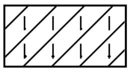
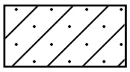
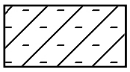
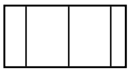
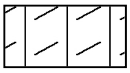
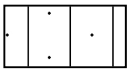
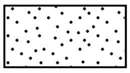
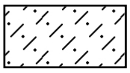
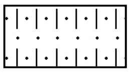
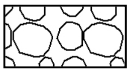
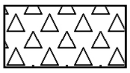
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

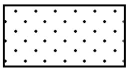
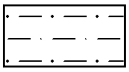
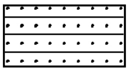
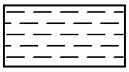
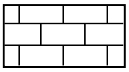
General

■	Asphalt
	Road base
	Concrete
	Filling

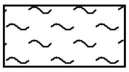
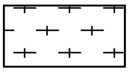
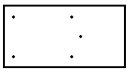
Soils

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

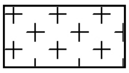
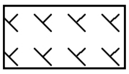
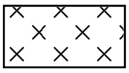
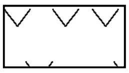
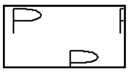
Sedimentary Rocks

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

Metamorphic Rocks

	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

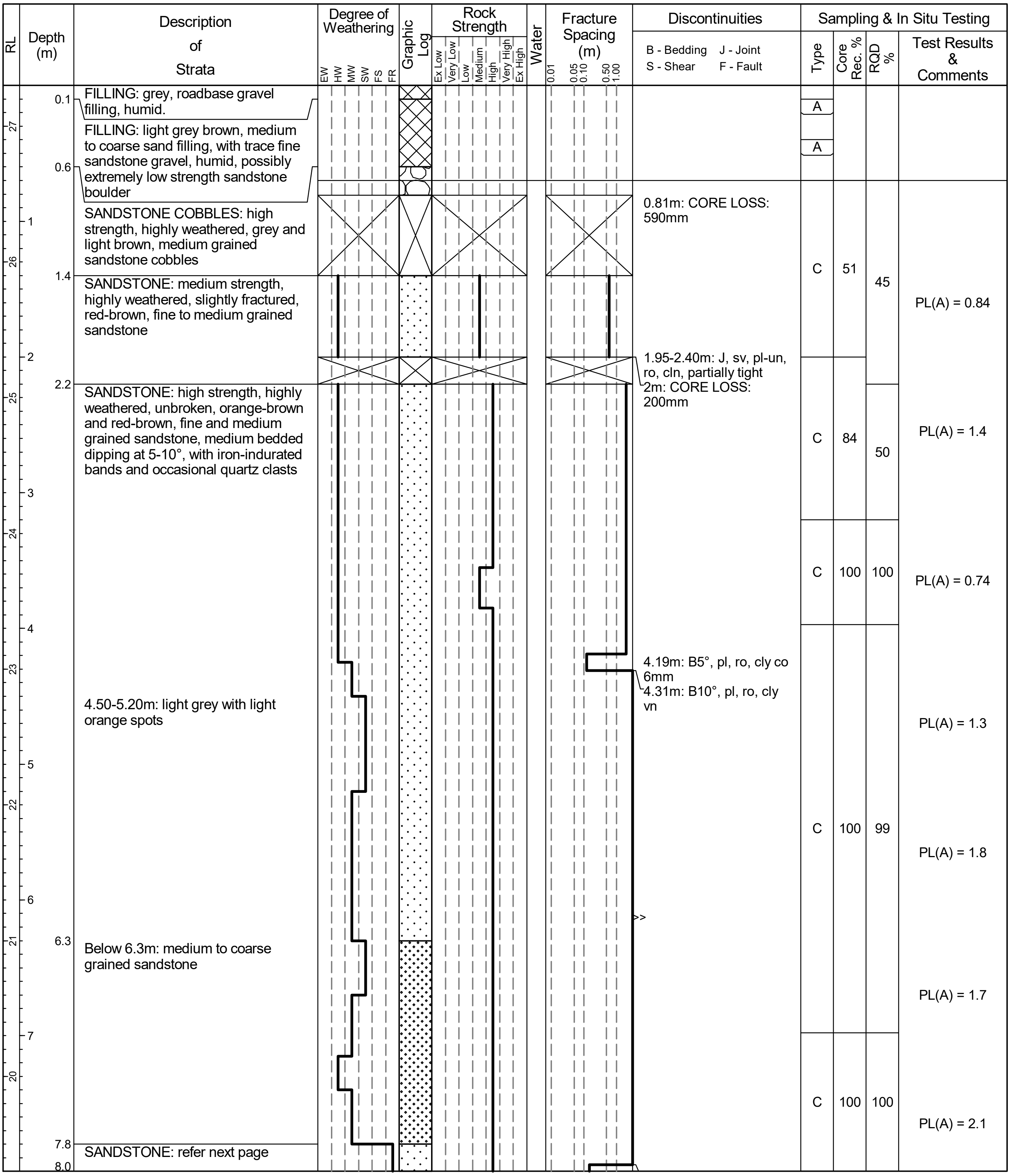
	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 27.3 AHD
EASTING: 328372
NORTHING: 6257615
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86621.00
DATE: 13/11/2018
SHEET 1 OF 2



Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
0.1	FILLING: grey, roadbase gravel filling, humid.		A			
0.6	FILLING: light grey brown, medium to coarse sand filling, with trace fine sandstone gravel, humid, possibly extremely low strength sandstone boulder		A			
	SANDSTONE COBBLES: high strength, highly weathered, grey and light brown, medium grained sandstone cobbles	0.81m: CORE LOSS: 590mm				
1.4	SANDSTONE: medium strength, highly weathered, slightly fractured, red-brown, fine to medium grained sandstone		C	51	45	PL(A) = 0.84
2.2	SANDSTONE: high strength, highly weathered, unbroken, orange-brown and red-brown, fine and medium grained sandstone, medium bedded dipping at 5-10°, with iron-indurated bands and occasional quartz clasts	1.95-2.40m: J, sv, pl-un, ro, cln, partially tight 2m: CORE LOSS: 200mm	C	84	50	PL(A) = 1.4
			C	100	100	PL(A) = 0.74
	4.50-5.20m: light grey with light orange spots	4.19m: B5°, pl, ro, cly co 6mm 4.31m: B10°, pl, ro, cly vn	C	100	99	PL(A) = 1.3 PL(A) = 1.8 PL(A) = 1.7
6.3	Below 6.3m: medium to coarse grained sandstone		C	100	100	PL(A) = 2.1
7.8	SANDSTONE: refer next page					
8.0						

RIG: Bobcat **DRILLER:** GM **LOGGED:** JDB **CASING:** HW to 0.7m, HQ to 2.2m
TYPE OF BORING: Solid flight auger (TC-bit) to 0.70m, NMLC-coring to 11.11m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
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BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 27.3 AHD
EASTING: 328372
NORTHING: 6257615
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 86621.00
DATE: 13/11/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering EW HW MW SW FS FR	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
19 18	9	SANDSTONE: high strength, fresh, slightly fractured then unbroken, grey, fine to medium grained sandstone, thinly bedded, dipping approximately 20°	FR	High			7.95m: B20°, pl, ro, cly co 6mm 8.1m: B10°, pl, ro, cly co 2mm 8.45m: B20°, pl, ro, sand 1mm 8.83m: B0°, un, ro, cbs vn	C	100	100	PL(A) = 1.8 PL(A) = 1.7
17	10 10.0	SANDSTONE: high strength, fresh, unbroken, grey, fine to medium grained, massive sandstone 10.71-10.82m: light grey, fine grained sandstone	FR	High				C	100	100	PL(A) = 1.5 PL(A) = 1.6
16 15 14 13 12	11 11.11 12 13 14 15	Bore discontinued at 11.11m Target depth reached									

RIG: Bobcat **DRILLER:** GM **LOGGED:** JDB **CASING:** HW to 0.7m, HQ to 2.2m
TYPE OF BORING: Solid flight auger (TC-bit) to 0.70m, NMLC-coring to 11.11m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

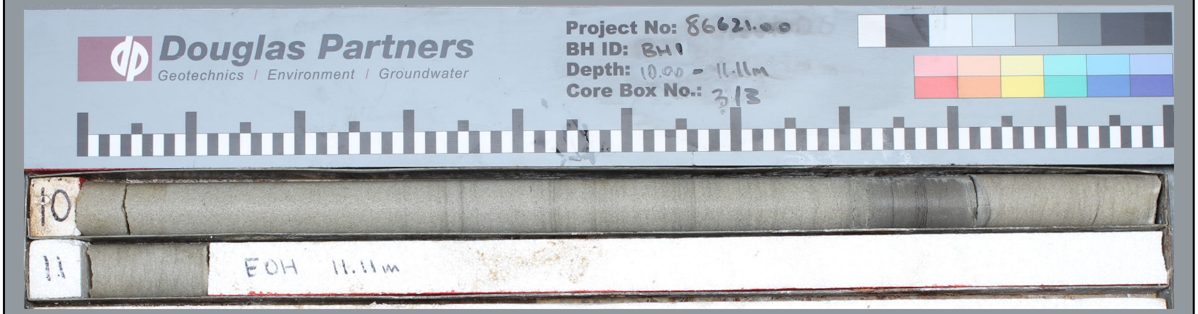
BORE: BH1 PROJECT: LANE COVE WEST DECEMBER 2018

0.74m – 5m

BORE: BH1 PROJECT: LANE COVE WEST DECEMBER 2018

5m – 10m

BORE: BH1 PROJECT: LANE COVE WEST DECEMBER 2018



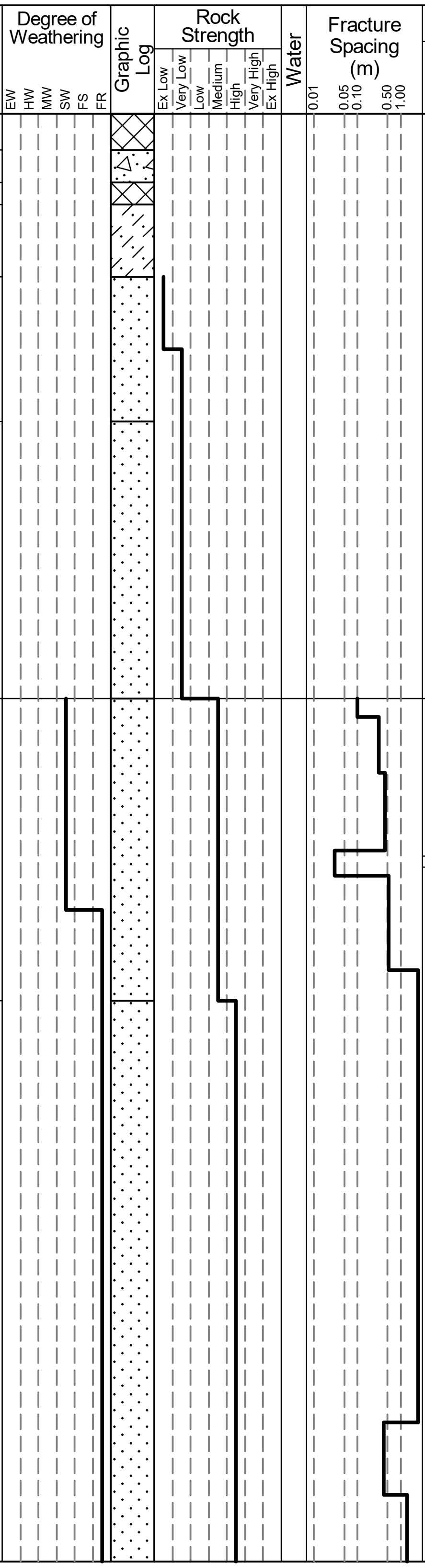
10m – 11.11m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 20.5 AHD
EASTING: 328285
NORTHING: 6257587
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86621.00
DATE: 14/11/2018
SHEET 1 OF 2



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
	0.2	FILLING: light grey-brown, slightly gravelly fine sand filling, humid		A			
	0.38	CONCRETE: slab					
20	0.5	FILLING: light grey-brown, fine sand filling		A			
	0.9	CLAYEY SAND: medium dense, brown mottled yellow-grey, clayey sand, humid, MC<PL (residual)		A			
19	1	SANDSTONE: extremely low strength, light brown, fine to medium grained sandstone 1.30m: becomes very low strength, dark brown		S			1,3,15 N = 18
18	1.7	SANDSTONE: very low strength, grey, fine to medium grained sandstone		A S			15/70 refusal
17	3.23	SANDSTONE: medium strength, slightly weathered, slightly fractured to unbroken, grey, fine to medium grained sandstone, thinly to medium bedded with occasional cross-beds Between 4.16-4.21m: extremely low strength, extremely weathered seam Below 4.4m: becoming light grey-brown	3.33m: J70°, pl, ro, cln 3.64m: B5°, pl, ro, cly vn 4.07m: B0°, un, ro, cly co 4mm 4.1m: B0°, pl, ro, cly vn 4.16m: Ds, 50mm 4.73m: B10°, pl, ro, cbs vn	C	100	96	PL(A) = 0.54 PL(A) = 0.5 PL(A) = 0.77
16	4.9	SANDSTONE: high strength, fresh, unbroken, light grey-brown, fine grained sandstone, thinly to medium bedded, with occasional cross-beds 7.81-7.85m: with some siltstone and quartz clasts	7.23m: B10°, pl, ro, cbs vn 7.63m: B5°, pl, ro, cbs vn	C	100	100	PL(A) = 1.1 PL(A) = 1.2 PL(A) = 0.94

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 2.5m, HQ to 3.2m

TYPE OF BORING: Solid flight auger (TC-bit) to 0.2m, Diacore to 0.38m, Rotary (Blade) to 3.23m, NMLC-coring to 14.09m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Rock below 4.4m appeared to change colour between drilling and core photography, to become yellow-brown

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: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 20.5 AHD
EASTING: 328285
NORTHING: 6257587
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 86621.00
DATE: 14/11/2018
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
12		SANDSTONE: high strength, fresh, unbroken, light grey-brown, fine grained sandstone, thinly to medium bedded, with occasional cross-beds *(continued)*		C	100	100	
							PL(A) = 1.1
	9.03	LAMINITE: high strength, fresh, grey, interbedded siltstone and sandstone (50:50)	9.03m: B0°, pl, sm, cbs co 2mm				PL(A) = 1.6
11	9.18	SANDSTONE: high strength, fresh, unbroken, light grey-brown, fine to medium grained sandstone, massive 9.35-9.48m: with some irregular siltstone bands and clasts Below 9.7m: thinly bedded at 10-30°, with occasional cross-beds	9.35m: B0-10°, un, ro, cbs vn	C	100	100	PL(A) = 1
10							PL(A) = 1.3
9							PL(A) = 1.1
8		12.3m: siltstone band 40mm thick	12.3m: B10°, pl, sm, cbs vn	C	100	100	PL(A) = 1.2
7			13.63m: B20°, pl, ro, cly co 2mm				PL(A) = 1.7
6	14.09	Bore discontinued at 14.09m Target depth reached					
5							

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 2.5m, HQ to 3.2m

TYPE OF BORING: Solid flight auger (TC-bit) to 0.2m, Diacore to 0.38m, Rotary (Blade) to 3.23m, NMLC-coring to 14.09m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Rock below 4.4m appeared to change colour between drilling and core photography, to become yellow-brown

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
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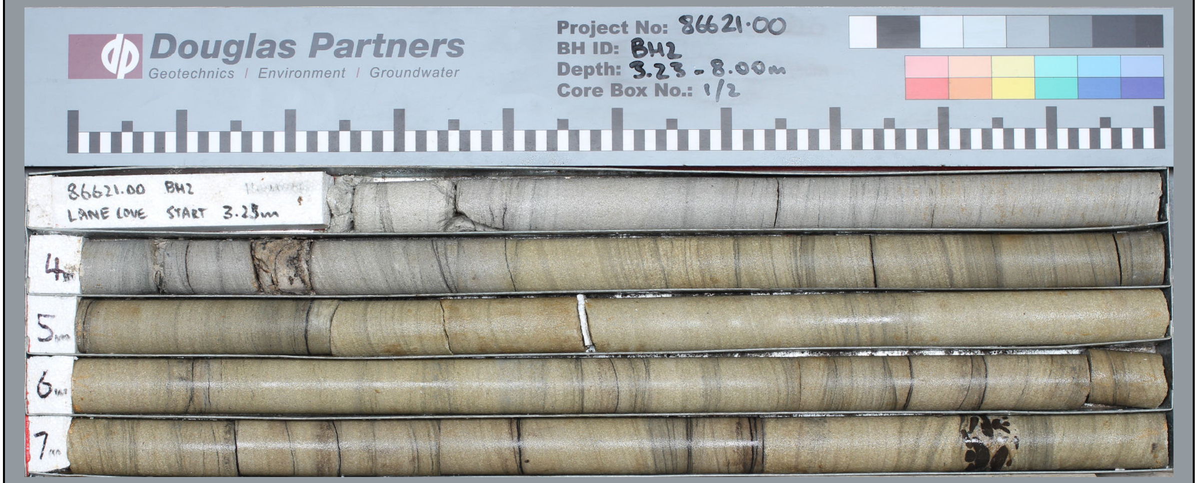
Photo D1 – View of concrete core obtained from 0.2 m depth, within Borehole BH2.

Douglas Partners *Geotechnics / Environment / Groundwater*	**Photograph** **Proposed Data Centre** **1 Sirius Road, Lane Cove West**	PROJECT:	86621.00
		PLATE No:	D1
		REV:	0
	CLIENT: AW Edwards Pty Ltd	DATE:	10/12/2018

BORE: BH2 PROJECT: LANE COVE WEST DECEMBER 2018



3.23m – 8m

BORE: BH2 PROJECT: LANE COVE WEST DECEMBER 2018

8m – 13m

BORE: BH2 PROJECT: LANE COVE WEST DECEMBER 2018

Project No: 86621.00
BH ID: BH2
Depth: 13.00 - 14.09m
Core Box No.: 3/3

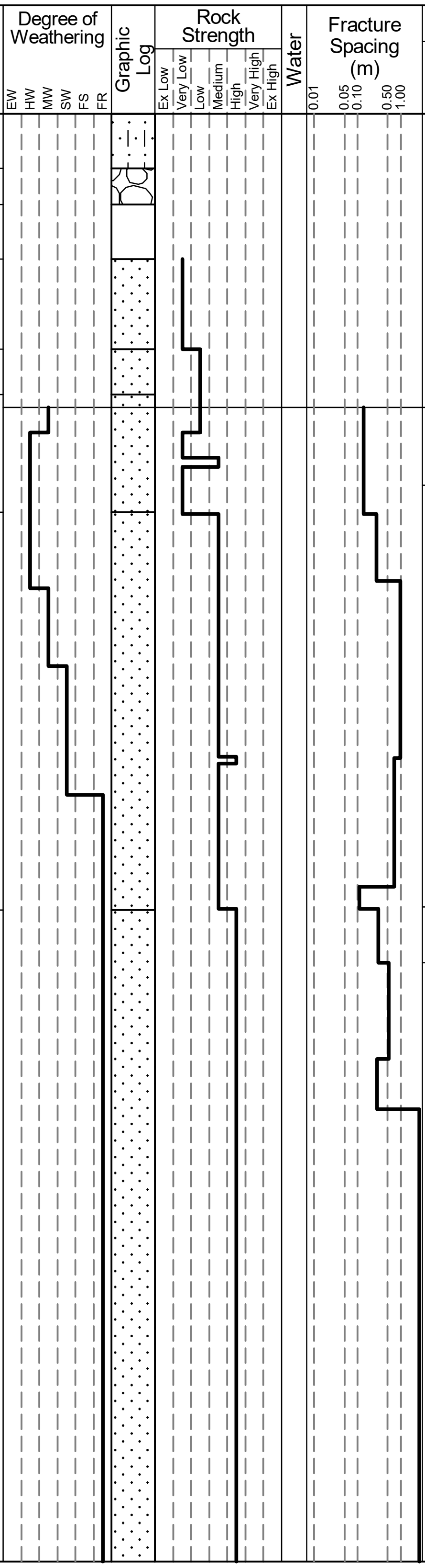
13m – 14.09m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 13.1 AHD
EASTING: 328206
NORTHING: 6257530
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86621.00
DATE: 12/11/2018
SHEET 1 OF 2



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
13	0.3	SILTY SAND: dark grey-brown, silty, fine to medium sand with some rootlets, moist (colluvial)		A			
	0.5	SANDSTONE BOULDER: apparently low strength, light grey brown, fine to medium grained sandstone boulder		A			
	0.8	VOID		A			
12	1.3	SANDSTONE: very low strength, grey and red-brown sandstone, with some clay bands		S			4,8,18/70 refusal Bouncing
	1.55	SANDSTONE: low strength, light grey, fine to medium grained sandstone					PL(A) = 0.12
11	2.2	SANDSTONE: low strength, highly weathered, slightly fractured, red-brown and grey, fine to medium grained sandstone with some very low strength bands	1.74m: Ds, 160mm 1.95m: Ds, 50mm 2.05m: Ds, 160mm	C	100	60	
10		SANDSTONE: medium strength, highly weathered to fresh, unbroken, grey and orange brown, fine to medium grained sandstone	2.58m: B20°, pl, ro, cly vn				PL(A) = 0.88
							PL(A) = 0.95
9			3.55-3.56m: B(x2), 0-10°, un, ro, fe	C	100	98	
		4.25-4.40m: with some siltstone clasts and carbonaceous laminations	4.27m: B10-20°, un, ro, cbs vn				
8	4.4	SANDSTONE: high strength, fresh, slightly fractured then unbroken, grey, fine to medium grained sandstone, medium bedded	4.38m: Ds, 10mm, siltstone 4.69m: B0°, pl, ro, cbs vn				PL(A) = 1.3
			5.22m: B20°, pl, ro, cly co 2mm 5.5m: B(x2), 20°, pl, ro, cly co 2-4mm, fe stn				PL(A) = 1.2
7							
6				C	100	100	PL(A) = 1.4
							PL(A) = 1

RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 1.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 1.0m, Rotary (Blade) to 1.55m, NMLC-coring to 10.26m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

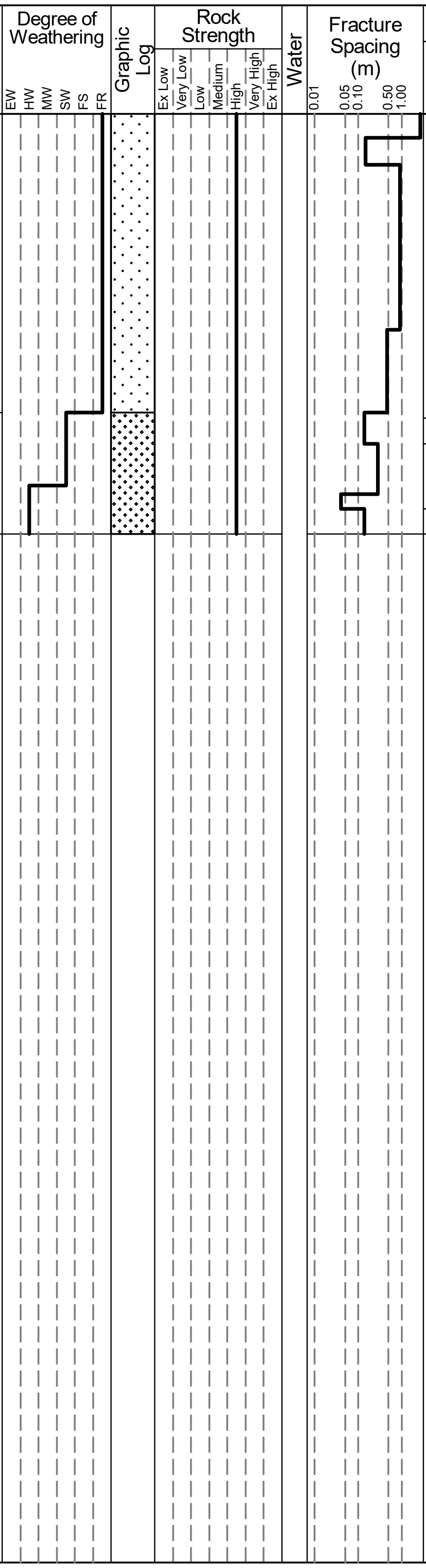
CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 13.1 AHD
EASTING: 328206
NORTHING: 6257530
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 86621.00
DATE: 12/11/2018
SHEET 2 OF 2

RL: 5 4 3 2 1 0 -1 -2
Depth (m): 9 10 11 12 13 14 15

RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		SANDSTONE: high strength, fresh, slightly fractured then unbroken, grey, fine to medium grained sandstone, medium bedded *(continued)* 8.15-8.85m: with some siltstone clasts and carbonaceous laminations	8.13m: B20°, pl, ro, cln 8.28m: B10°, ir, ro, cly co 4mm	C	100	100	
			9.19m: Ds, 10mm	C	100	93	PL(A) = 1.3 PL(A) = 1.8
	9.65	SANDSTONE: high strength, slightly weathered then highly weathered, fractured, light grey and dark grey-purple, medium to coarse grained sandstone, with some ironstone bands	9.65m: B0°, pl, ro, fe stn 9.68m: B0°, pl, ro, fe stn 9.82m: B15°, pl, ro, fe stn 10.10-10.14m: B(x3), 0-10°, un, ro, fe stn 10.18-10.32m: J, sv, un, ro, fe 1-2mm				PL(A) = 1.6
	10.32	Bore discontinued at 10.32m Target depth reached					



RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 1.4m
TYPE OF BORING: Solid flight auger (TC-bit) to 1.0m, Rotary (Blade) to 1.55m, NMLC-coring to 10.26m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: BH3 PROJECT: LANE COVE WEST DECEMBER 2018

1.62m – 6m

BORE: BH3 PROJECT: LANE COVE WEST DECEMBER 2018

6m – 10.32m

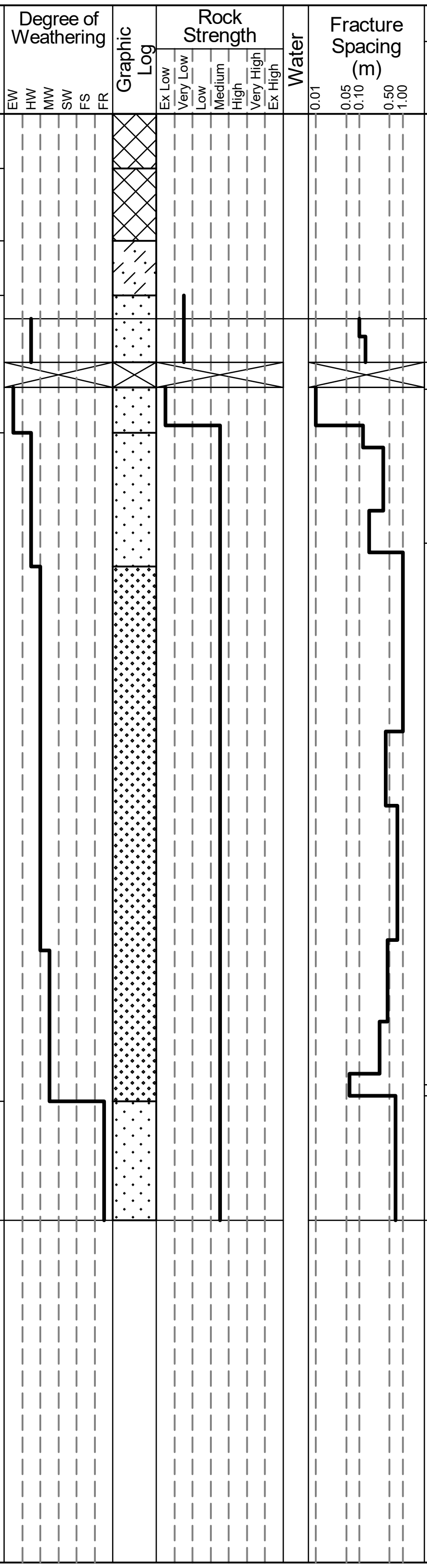
BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 17.3 AHD
EASTING: 328238
NORTHING: 6257590
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 86621.00
DATE: 13 - 14/11/2018
SHEET 1 OF 1

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
0.3	FILLING: dark brown, silty sand filling, slightly gravelly, medium to coarse sand with some rootlets, humid		A			
0.7	FILLING: light grey-brown, fine to medium sand filling, trace clay, humid		A			
1.0	CLAYEY SAND: apparently medium dense, light grey mottled light brown, clayey sand, fine to medium sand, humid, MC<PL (residual)		A S			25/70 refusal
1.51	SANDSTONE: very low then extremely low strength, extremely and highly weathered, grey-brown and red, fine to medium grained sandstone	1.23m: J80°, pl, ro, cly co 2mm, fe stn, rootlets 1.37m: CORE LOSS: 140mm 1.52m: Ds, 200mm	C	95	78	
1.76	SANDSTONE: medium strength, highly weathered, slightly fractured, red-brown and grey, fine to medium grained sandstone	1.84-1.96m: J70°, pl, ro, partially ti, cln 2.19-2.20m: B(x2), 0°, pl, ro, cly co 2mm 2.37m: Cs, 50mm				PL(A) = 0.51
2.5	Below 2.5m: becoming highly to moderately weathered, and medium to coarse grained	3.41m: J30°, pl, ro, sandy cly co 2mm, roots 3.82m: J20°, pl, ro, clayey sand co 2mm, roots				PL(A) = 0.73 PL(A) = 0.75
	4.50-4.56m: band of light grey, fine grained sandstone	4.56m: Cs, sandy clay 10mm	C	100	94	PL(A) = 0.86
	5.25m: siltstone clast	5.01m: B10°, pl, ro, fe stn 5.3m: J50°, pl, ro, fe stn 5.36m: fg, 60mm 5.42m: J50°, pl, ro, fe				
5.45	SANDSTONE: medium strength, fresh, unbroken, grey, fine to medium grained sandstone					PL(A) = 0.75
6.11	Bore discontinued at 6.11m Target depth reached					



RIG: Bobcat **DRILLER:** GM/JE **LOGGED:** JDB **CASING:** HW to 1.1m

TYPE OF BORING: Solid flight auger (TC-bit) to 1.0m, Rotary (Blade) to 1.13m, NMLC-coring to 6.11m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: BH4 PROJECT: LANE COVE WEST DECEMBER 2018

1.13m – 5m

BORE: BH4 PROJECT: LANE COVE WEST DECEMBER 2018

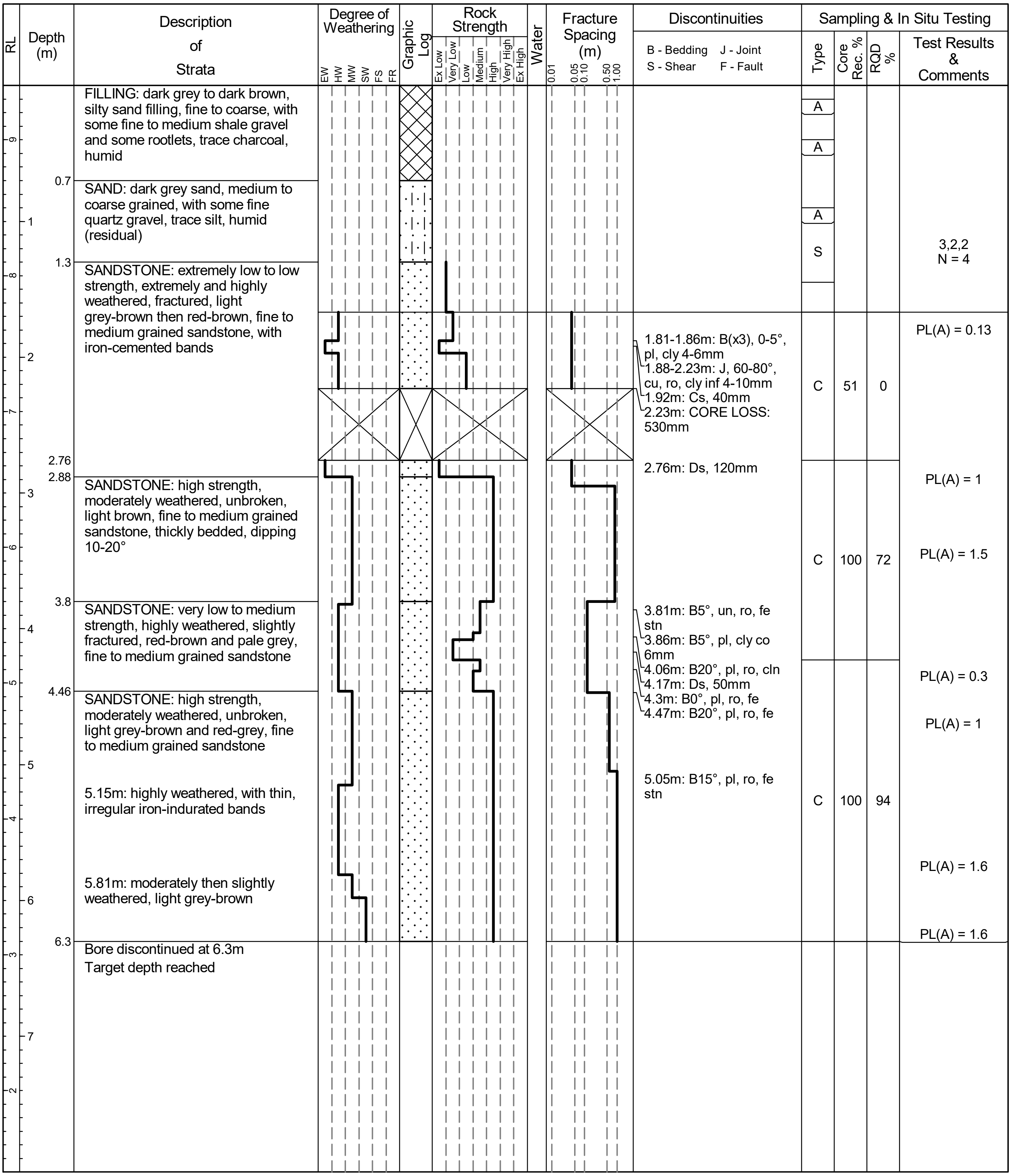
5m – 6.11m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 9.4 AHD
EASTING: 328158
NORTHING: 6257571
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 86621.00
DATE: 12/11/2018
SHEET 1 OF 1



Depth (m)	Description of Strata
	FILLING: dark grey to dark brown, silty sand filling, fine to coarse, with some fine to medium shale gravel and some rootlets, trace charcoal, humid
0.7	SAND: dark grey sand, medium to coarse grained, with some fine quartz gravel, trace silt, humid (residual)
1.3	SANDSTONE: extremely low to low strength, extremely and highly weathered, fractured, light grey-brown then red-brown, fine to medium grained sandstone, with iron-cemented bands
2.76	
2.88	SANDSTONE: high strength, moderately weathered, unbroken, light brown, fine to medium grained sandstone, thickly bedded, dipping 10-20°
3.8	SANDSTONE: very low to medium strength, highly weathered, slightly fractured, red-brown and pale grey, fine to medium grained sandstone
4.46	SANDSTONE: high strength, moderately weathered, unbroken, light grey-brown and red-grey, fine to medium grained sandstone 5.15m: highly weathered, with thin, irregular iron-indurated bands 5.81m: moderately then slightly weathered, light grey-brown
6.3	Bore discontinued at 6.3m Target depth reached

Discontinuities

1.81-1.86m: B(x3), 0-5°, pl, cly 4-6mm
1.88-2.23m: J, 60-80°, cu, ro, cly inf 4-10mm
1.92m: Cs, 40mm
2.23m: CORE LOSS: 530mm
2.76m: Ds, 120mm
3.81m: B5°, un, ro, fe stn
3.86m: B5°, pl, cly co 6mm
4.06m: B20°, pl, ro, cln
4.17m: Ds, 50mm
4.3m: B0°, pl, ro, fe
4.47m: B20°, pl, ro, fe
5.05m: B15°, pl, ro, fe stn

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			3,2,2 N = 4
C	51	0	PL(A) = 0.13
C	100	72	PL(A) = 1 PL(A) = 1.5
C	100	94	PL(A) = 0.3 PL(A) = 1 PL(A) = 1.6 PL(A) = 1.6

RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 1.4m

TYPE OF BORING: Solid flight auger (TC-bit) to 1.0m, Rotary (Blade) to 1.65m, NMLC-coring to 6.30m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed upon completion; Screen: 6.15-3.15m, Blank: 3.15-0.0m + 0.99m stick-up, Backfill: 6.3-6.15, Gravel: 6.15-2.6m, Bentonite: 2.6-1.8m, Gravel 1.8-0.0m

SAMPLING & IN SITU TESTING LEGEND

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

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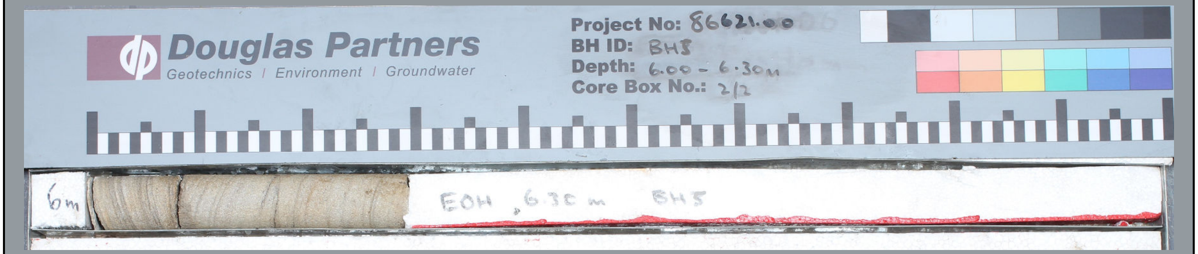
BORE: BH5 PROJECT: LANE COVE WEST DECEMBER 2018

1.67m – 6m

BORE: BH5 PROJECT: LANE COVE WEST DECEMBER 2018



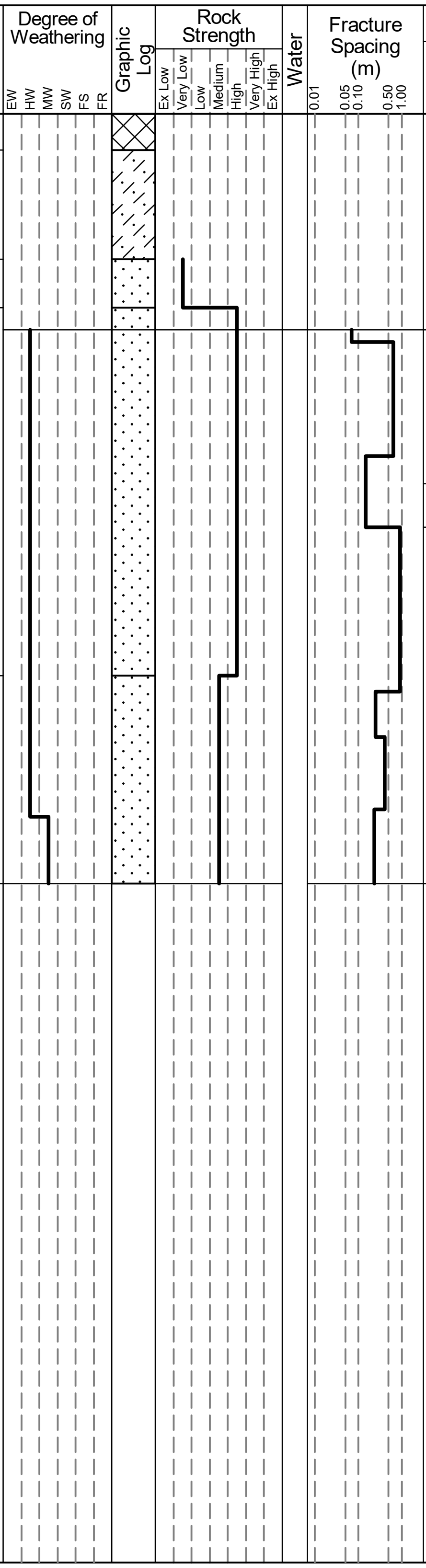
6m – 6.30m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 9.7 AHD
EASTING: 328244
NORTHING: 6257638
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 86621.00
DATE: 12/11/2018
SHEET 1 OF 1



Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
0.2	FILLING: grey-brown, slightly gravelly, sand filling, with some silt, humid		A			
0.8	CLAYEY SAND: apparently medium dense, yellow-brown, fine to medium clayey sand, trace ironstone gravel, moist (residual)		A			
1.07	SANDSTONE: very low strength, orange-brown, fine to medium grained sandstone		A S			14/70 refusal Bouncing
3.1	SANDSTONE: high strength, highly weathered, slightly fractured, light brown and red-brown, fine to medium grained sandstone	1.26m: B10°, pl, ro, fe stn 1.89m: B10°, pl, ro, fe stn 2.00-2.04m: B(x2), 5°, pl, ro, fe stn 2.28m: B10°, pl, ro, cln	C	100	97	PL(A) = 1.8 PL(A) = 1.1
4.25	SANDSTONE: medium strength, highly then moderately weathered, fractured, light brown and red-brown, fine to medium grained sandstone	3.19m: B10°, un, ro, cbs vn 3.44m: B10°, pl, ro, cln 3.81m: B10°, pl, ro, sandy clay / roots 4.07m: Ds, 20mm	C	100	99	PL(A) = 0.84 PL(A) = 0.61
	Bore discontinued at 4.25m Target depth reached					

RL scale: 9, 8, 7, 6, 5, 4, 3, 2
Depth scale: 1, 2, 3, 4, 5, 6, 7

RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 1.15m

TYPE OF BORING: Solid flight auger (TC-bit) to 1.0m, Rotary (Blade) to 1.19m, NMLC-coring to 4.25m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: BH6 PROJECT: LANE COVE WEST DECEMBER 2018

1.19m – 4.25m

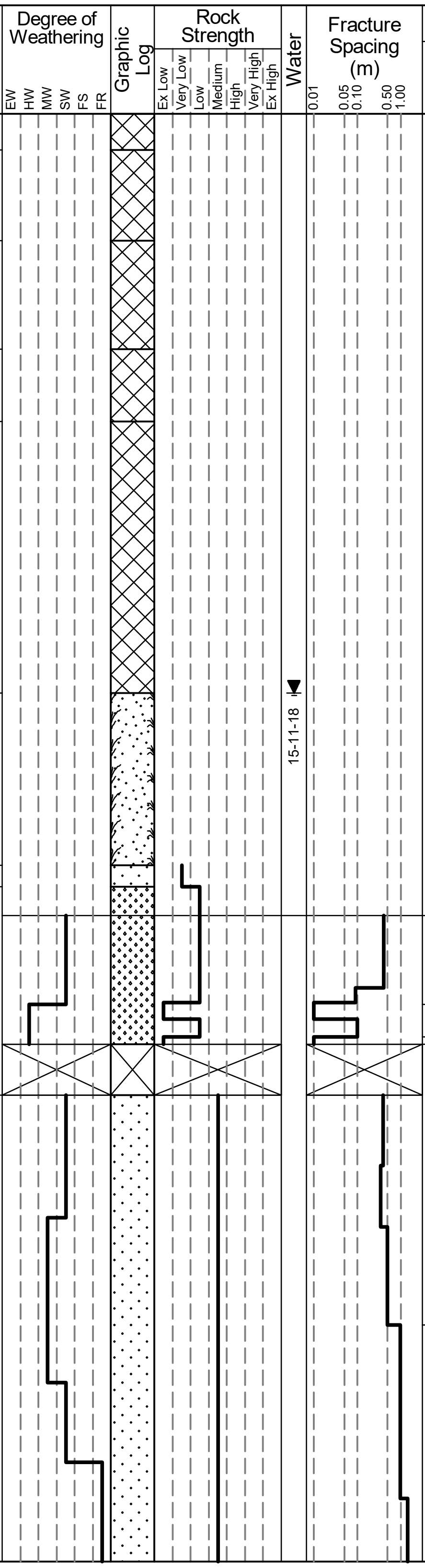
BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 5.2 AHD
EASTING: 328256
NORTHING: 6257680
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 86621.00
DATE: 14 - 15/11/2018
SHEET 1 OF 2

Depth (m)	Description of Strata
0.2	FILLING: brown, slightly silty clay filling with trace rootlets and fine igneous gravel, humid
0.7	FILLING: brown, fine to medium silty sand filling with trace rootlets, humid
1.3	FILLING: red mottled grey, slightly silty clay filling, trace slag, medium plasticity, damp
1.7	FILLING: dark brown, fine to medium sand filling with some fine igneous gravel, trace charcoal and slag, humid
3.2	FILLING: grey and dark grey, fine and medium sand filling, humid
4.15	PEATY SAND: very loose, dark grey, fine peaty sand, wet (alluvium)
4.27	SANDSTONE: very low strength, grey, fine to medium grained sandstone
5.14	SANDSTONE: low strength, slightly weathered, slightly fractured, light grey-brown, medium to coarse grained sandstone 4.92m: with some extremely low strength bands
5.42	CORE LOSS: 280mm
	SANDSTONE: medium strength, moderately and slightly weathered, slightly fractured, grey and orange and brown, fine to medium grained sandstone



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

- 4.83m: B10°, un, ro, cly vn
- 4.92m: Ds, 80mm
- 5.10m: Ds, 40mm
- 5.14m: CORE LOSS: 280mm
- 5.81-6.04m: J, sv, un, ro, cln
- 6.15m: B10°, pl, ro, cly 1mm
- 6.65m: B20°, un, ro, cly co 4mm
- 6.69m: J30°, ir, ro, fe
- 7.65m: B20°, pl ro, cbs cly vn

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
A			
A			
A			
S			4,5,7 N = 12
S			11,8,10 N = 18
A			
S			0,15/110 refusal
C	90	50	PL(A) = 0.24 PL(A) = 0.13
C	100	100	PL(A) = 0.77 PL(A) = 0.55 PL(A) = 0.82

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 4.15m

TYPE OF BORING: Solid flight auger (TC-bit) to 4.00m, Rotary (blade) to 4.43m, NMLC-coring to 9.29m

WATER OBSERVATIONS: Groundwater observed at 3.2m

REMARKS: Standpipe installed upon completion; Screen: 9.2-5.0m, Blank: 5.0-0.0m + 0.56m stick-up, Backfill: 9.3-9.2m, Gravel: 9.2-4.9m, Bentonite: 4.5-2.9m, Gravel 2.9-0.0m

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 5.2 AHD
EASTING: 328256
NORTHING: 6257680
DIP/AZIMUTH: 90°/--

BORE No: BH7
PROJECT No: 86621.00
DATE: 14 - 15/11/2018
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)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
-3		SANDSTONE: medium strength, moderately and slightly weathered, slightly fractured, grey and orange and brown, fine to medium grained sandstone *(continued)*							C	100	100	PL(A) = 0.94
	9							9.1m: B10°, pl, ro, cly vn				
-4	9.29											PL(A) = 0.46
		Bore discontinued at 9.29m Target depth reached										
	10											
-5												
	11											
-6												
	12											
-7												
	13											
-8												
	14											
-9												
	15											
-10												

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 4.15m

TYPE OF BORING: Solid flight auger (TC-bit) to 4.00m, Rotary (blade) to 4.43m, NMLC-coring to 9.29m

WATER OBSERVATIONS: Groundwater observed at 3.2m

REMARKS: Standpipe installed upon completion; Screen: 9.2-5.0m, Blank: 5.0-0.0m + 0.56m stick-up, Backfill: 9.3-9.2m, Gravel: 9.2-4.9m, Bentonite: 4.5-2.9m, Gravel 2.9-0.0m

SAMPLING & IN SITU TESTING LEGEND

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

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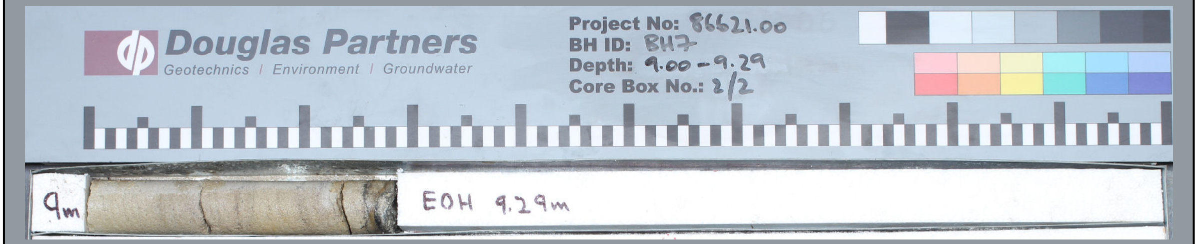
BORE: BH7 PROJECT: LANE COVE WEST DECEMBER 2018

4.43m – 9m

BORE: BH7 PROJECT: LANE COVE WEST DECEMBER 2018



9m – 9.29m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 4.3 AHD
EASTING: 328347
NORTHING: 6257672
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86621.00
DATE: 13/11/2018
SHEET 1 OF 3

Depth (m)	Description of Strata	Water	Sampling & In Situ Testing: Type	Test Results & Comments
	FILLING: grey mottled red-brown, silty clay filling with some rootlets and fine to medium ironstone gravel, humid		A A	
0.7	FILLING: light brown, fine to medium sand filling with some fine to medium sandstone gravel, trace silt, humid (possible ripped sandstone filling)		A S	5,6,14 N = 20
1.4	FILLING: dark brown, silty, medium to coarse sand filling with trace fine igneous gravel and charcoal, trace roots, humid		A	
2.5	PEATY SAND: very loose, dark brown, peaty, fine to medium sand, damp (alluvium)		S	1,0,0 N = 0
	3.00m: becomes wet	▼ 13-11-18	A	
			S	0,0,0 N = 0
			S	0,0,1 N = 1
6.9	CLAY: stiff to very stiff, mottled red-brown and grey clay, trace sand, medium plasticity, moist to wet (alluvium)		S	4,6,8 N = 14

RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 7.0m
TYPE OF BORING: Solid flight auger (TC-bit) to 5.50m, Rotary (Blade) to 13.00m, NMLC-coring to 17.73m
WATER OBSERVATIONS: Groundwater observed at 3.0m
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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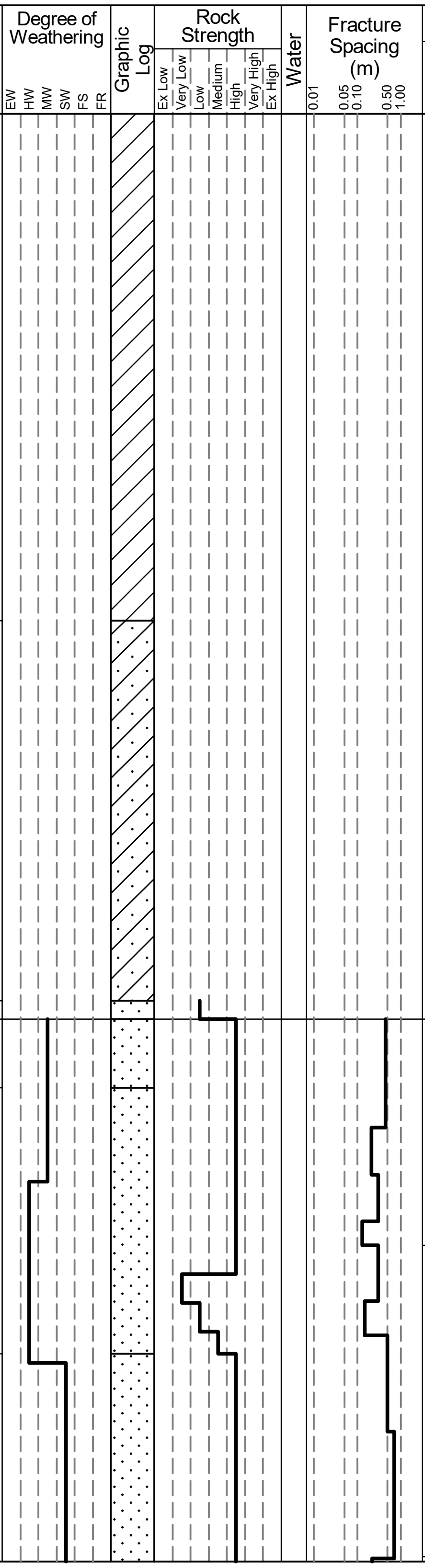
BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 4.3 AHD
EASTING: 328347
NORTHING: 6257672
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86621.00
DATE: 13/11/2018
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
-4		CLAY: stiff to very stiff, mottled red-brown and grey clay, trace sand, medium plasticity, moist to wet (alluvium) *(continued)*					
				S			2,2,4 N = 6
-5	9						
-6	10			S			2,4,10 N = 14
	10.8	SANDY CLAY: stiff to very stiff, light brown with some red-brown, fine sandy clay, medium plasticity, moist to wet (alluvium?)					
-7	11			S			2,9,7 N = 16
-8	12						
	12.9	SANDSTONE: very low strength, grey-brown, fine to medium grained sandstone		S			27/120 refusal
	13 13.0			C	100	100	
-9	13.38	SANDSTONE: high strength, moderately weathered, slightly fractured, grey-brown, fine to medium grained sandstone	13.44m: B0-5°, pl, ro, cln				PL(A) = 1.4
-10	14	SANDSTONE: medium strength, highly and moderately weathered, slightly fractured, brown and light brown, fine to medium grained sandstone, thinly bedded at 0-5° Between 14.41-14.73m: very low strength associated with steep joint	13.88m: J40°, pl, ro, fe stn 14.1m: J40°, un, ro, fe stn, partially ti 14.25-14.35m: J(x2) 70° & 90°, pl, ro, cly 2-6mm 14.56m; Ds, 40mm 14.75-14.82m: J80°, pl-un, ro, cln	C	100	92	PL(A) = 0.69
-11	14.85 15	SANDSTONE: high strength, fresh, unbroken, pale grey and light grey-brown, massive, fine to medium grained sandstone Below 15.97m: medium bedded	15.28m: B5°, un, ro, fe stn				PL(A) = 1.3



RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 7.0m

TYPE OF BORING: Solid flight auger (TC-bit) to 5.50m, Rotary (Blade) to 13.00m, NMLC-coring to 17.73m

WATER OBSERVATIONS: Groundwater observed at 3.0m

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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BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 4.3 AHD
EASTING: 328347
NORTHING: 6257672
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 86621.00
DATE: 13/11/2018
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
-12		SANDSTONE: high strength, fresh, unbroken, pale grey and light grey-brown, massive, fine to medium grained sandstone *(continued)*	15.97m: B5°, un, ro, cbs vn 16.06m: Ds, 10mm 16.21m: B10ª, pl, ro, fe	C	100	92	PL(A) = 1.9
	17	16.72m: becomes light grey, fresh	16.65m: B10°, pl, ro, fe stn 16.7m: B10°, un, ro, fe stn	C	100	95	
-13							PL(A) = 1.3
	17.72	Bore discontinued at 17.72m Target depth reached					
	18						
-14							
	19						
-15							
	20						
-16							
	21						
-17							
	22						
-18							
	23						
-19							

Degree of Weathering: EW HW MW SW FS FR
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01 0.05 0.10 0.50 1.00

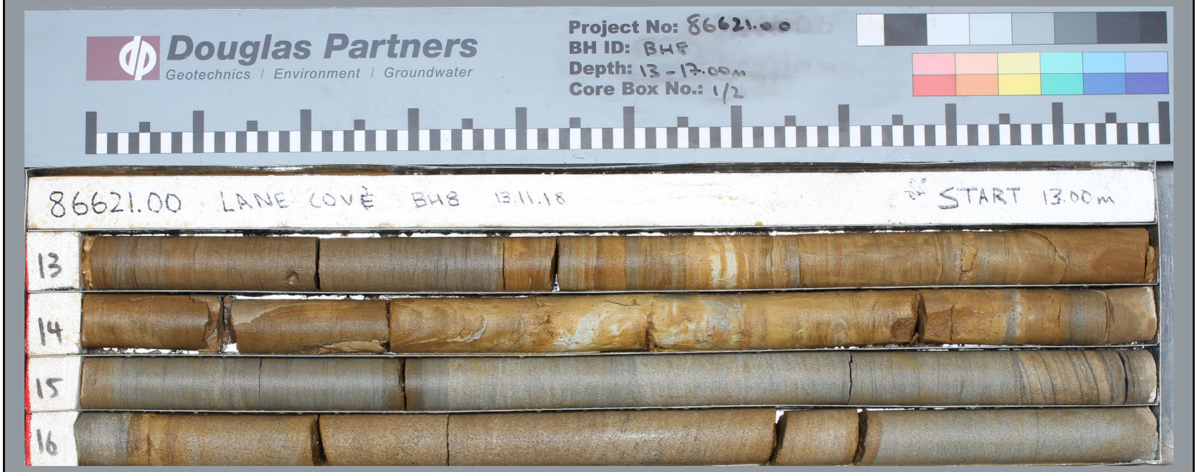
RIG: Comacchio 305 **DRILLER:** SS **LOGGED:** JDB **CASING:** HW to 7.0m
TYPE OF BORING: Solid flight auger (TC-bit) to 5.50m, Rotary (Blade) to 13.00m, NMLC-coring to 17.73m
WATER OBSERVATIONS: Groundwater observed at 3.0m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

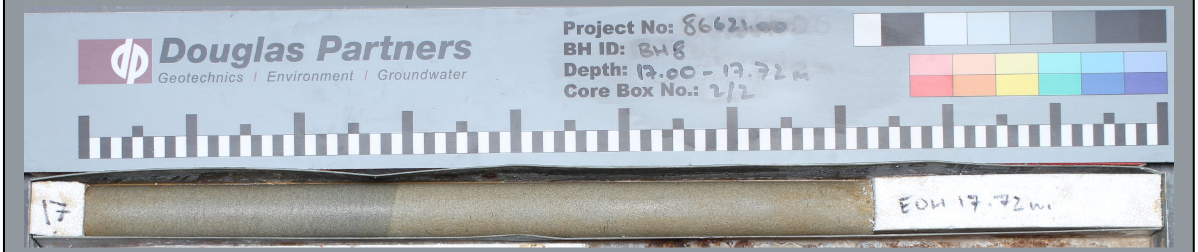
Douglas Partners
Geotechnics / Environment / Groundwater

BORE: BH8 PROJECT: LANE COVE WEST DECEMBER 2018



13m – 17m

BORE: BH8 PROJECT: LANE COVE WEST DECEMBER 2018



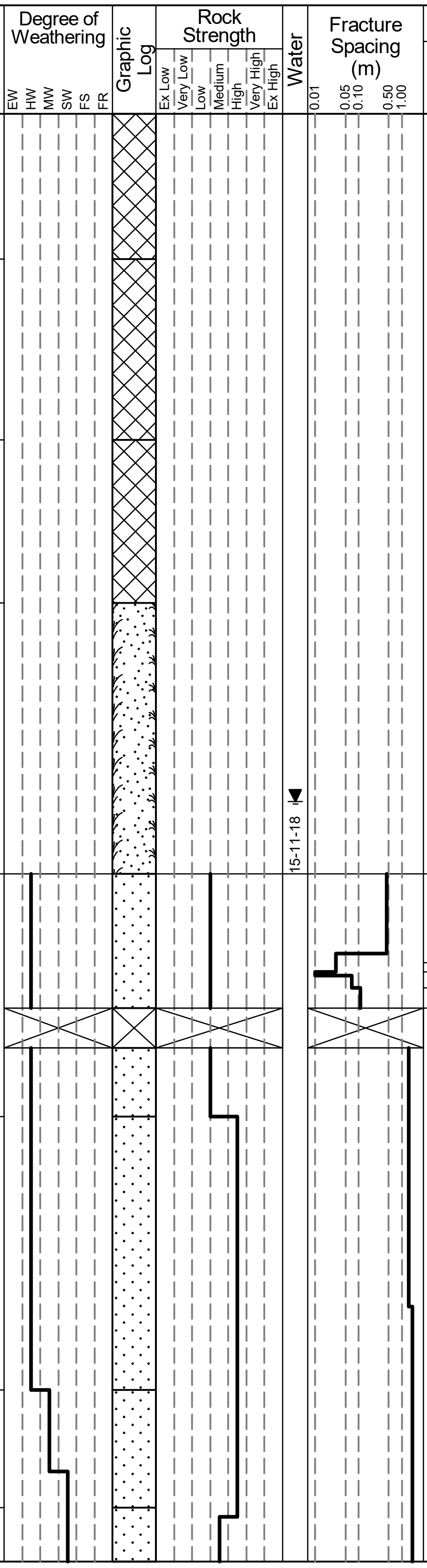
17m – 17.72m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 4.1 AHD
EASTING: 328277
NORTHING: 6257680
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 86621.00
DATE: 15/11/2018
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
	FILLING: dark brown and brown, medium to coarse sand filling, slightly gravelly or clayey, with silt, trace rootlets, humid		A A			
0.8	FILLING: light brown, medium to coarse gravelly sand filling, trace charcoal, humid (possible sandstone cobble or boulder)		A S			12,12,15 N = 27
1.8	FILLING: dark brown, slightly silty, coarse sand filling with some fine sandstone gravel, humid		A			
2.7	PEATY SAND: dark grey-brown, peaty sand, fine to medium, moist (alluvium) 3.80m: becomes wet		S S			23,8,3 N = 11 0,25/140 refusal
4.2	SANDSTONE: low to medium strength, highly weathered, fractured, dark brown and light brown, medium grained sandstone, thinly bedded at 0-10°, with iron-cemented bands	4.64m: B20°, pl, ro, cly 4mm 4.69m: Ds, 20mm 4.74m: Ds, 20mm 4.83m: B10°, un, ro, cly vn 4.94m: CORE LOSS: 220mm	C	83	60	PL(A) = 0.29 PL(A) = 0.19 PL(A) = 0.3
5.16						
5.54	SANDSTONE: high strength, highly weathered, unbroken, light to dark brown and grey, fine to medium grained sandstone, medium bedded at 10-30°	6.49m: B20°, pl, ro, cbs vn	C	100	100	PL(A) = 1.2 PL(A) = 1.7
7.05	SANDSTONE: high strength, moderately weathered to slightly weathered, unbroken, pale grey-red then light grey-brown, fine to medium grained sandstone, medium beddded					
7.7	SANDSTONE: refer next page					PL(A) = 0.77
8.0						

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB/SLB **CASING:** HW to 4.2m
TYPE OF BORING: Solid flight auger (TC-bit) to 4.00m, Rotary (Blade) to 4.20m, NMLC-coring to 8.37m
WATER OBSERVATIONS: Groundwater observed at 3.8m
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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BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 4.1 AHD
EASTING: 328277
NORTHING: 6257680
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 86621.00
DATE: 15/11/2018
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
-4	8.37	SANDSTONE: medium strength, slightly weathered then fresh, unbroken, yellow-brown, fine to medium grained sandstone, medium beddded							C	100	100	PL(A) = 0.87
		Bore discontinued at 8.37m Target depth reached										
-5	9											
-6	10											
-7	11											
-8	12											
-9	13											
-10	14											
-11	15											

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB/SLB **CASING:** HW to 4.2m
TYPE OF BORING: Solid flight auger (TC-bit) to 4.00m, Rotary (Blade) to 4.20m, NMLC-coring to 8.37m
WATER OBSERVATIONS: Groundwater observed at 3.8m
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: BH9 PROJECT: LANE COVE WEST DECEMBER 2018

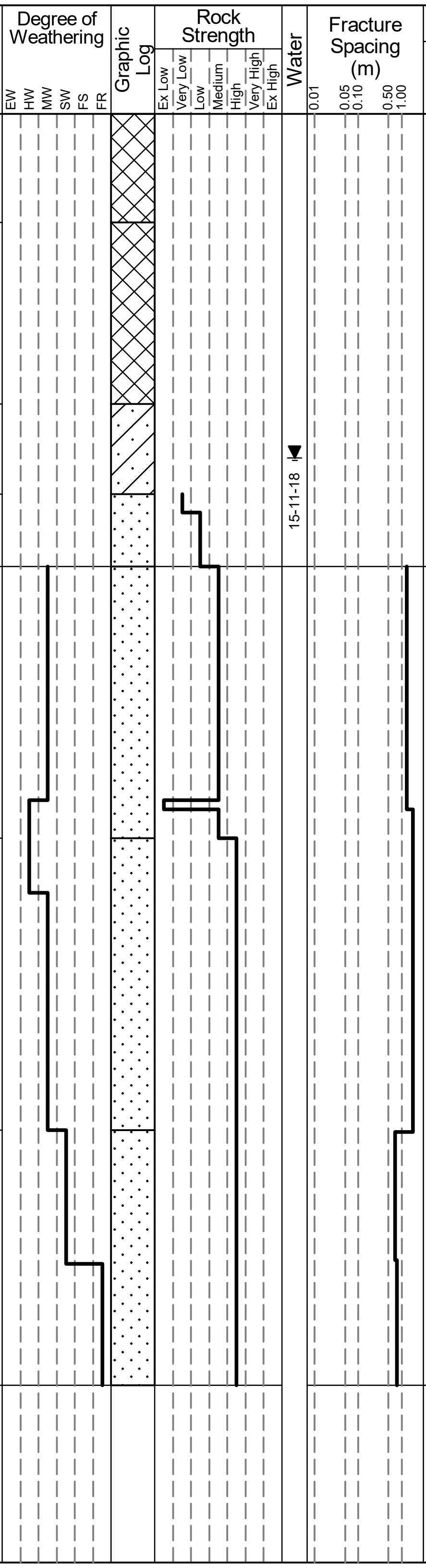
4.2m – 8.37m

BOREHOLE LOG

CLIENT: AW Edwards Pty Ltd
PROJECT: Proposed Data Centre
LOCATION: 1 Sirius Road, Lane Cove West

SURFACE LEVEL: 5.3 AHD
EASTING: 328331
NORTHING: 6257657
DIP/AZIMUTH: 90°/--

BORE No: BH10
PROJECT No: 86621.00
DATE: 15/11/2018
SHEET 1 OF 1



Depth (m)	Description of Strata	Water	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
	FILLING: brown, silty sand filling, fine grained, with some fine to coarse igneous and sandstone gravel and trace glass fragments, humid			A A			
0.6	FILLING: dark brown, sandy clay filling, slightly silty, with some sandstone gravel, trace charcoal, humid			A S			2,2,1 N = 3
1.6	SANDY CLAY: brown, sandy clay, fine grained sand, medium plasticity, moist to saturated (alluvium?)	▼ 15-11-18		A			
2.1	SANDSTONE: very low and low strength, light brown, fine to medium grained sandstone			A			
2.5	SANDSTONE: medium strength, moderately weathered, unbroken, light brown, fine to medium grained sandstone, thickly bedded 3.30m: with some irregular bedding and dark grey staining		3.79m: fg, 50mm, fe stn	C	100	98	PL(A) = 0.53 PL(A) = 0.9
4.0	SANDSTONE: high strength, highly and moderately weathered, unbroken, red-brown then light brown, fine to medium grained sandstone, medium beddded 4.25m: with some irregular bedding			C	100	99	PL(A) = 1.1
5.61	SANDSTONE: high strength, fresh, slightly fractured, pale grey, fine to medium grained sandstone, very thinnly to thinly bedded, dipping 10-20° Below 6.33m: thinly bedded		5.62m: Cs, 10mm 6.33-6.35m: B(x3), 0-10°, un, ro, fe stn				PL(A) = 1.6 PL(A) = 1.5
7.02	Bore discontinued at 7.02m Target depth reached						

RIG: Bobcat **DRILLER:** JE **LOGGED:** JDB **CASING:** HW to 2.25m
TYPE OF BORING: Solid flight auger (TC-bit) to 2.25m, Rotary (Blade) to 2.5m, NMLC-coring to 7.02m
WATER OBSERVATIONS: Groundwater observed at 1.9m
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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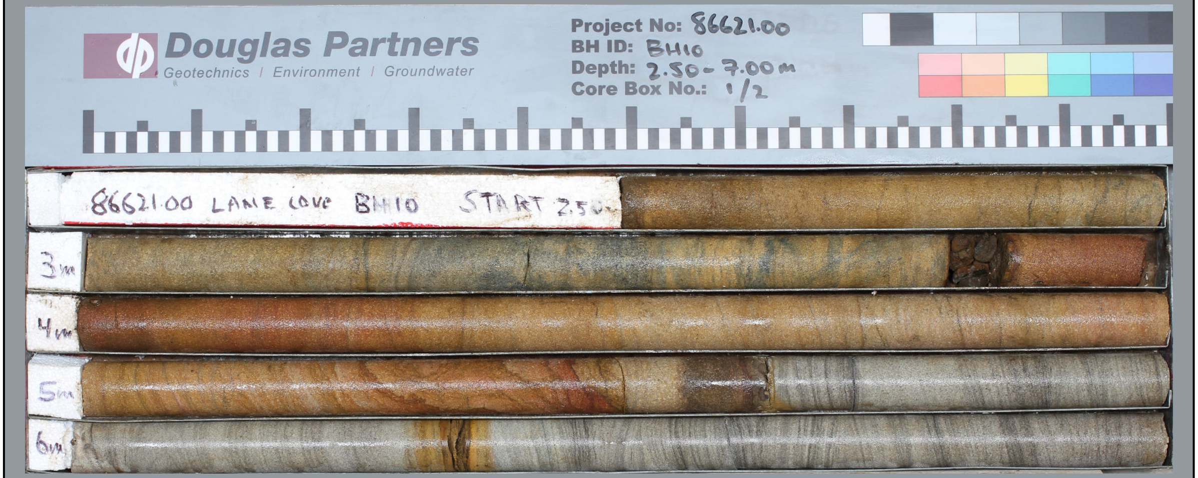
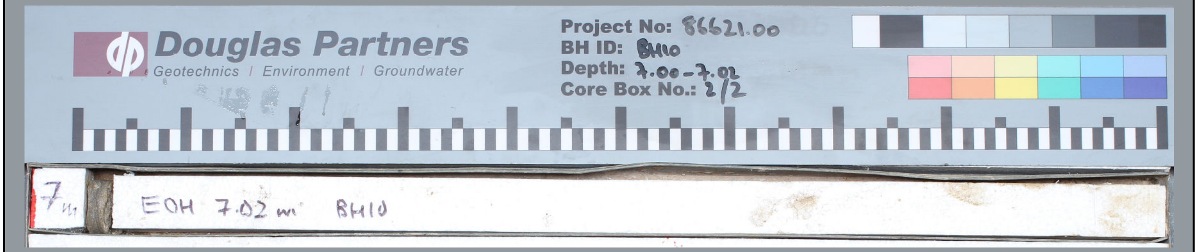
BORE: BH10 PROJECT: LANE COVE WEST DECEMBER 2018



2.5m – 7m

BORE: BH10 PROJECT: LANE COVE WEST DECEMBER 2018



7m – 7.02m

Appendix E

Laboratory Test Results

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

CERTIFICATE OF ANALYSIS 207253

Client Details

Client	Douglas Partners Pty Ltd
Attention	Huw Smith
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**86621.00, Lane Cove West**
Number of Samples	4 Soil
Date samples received	04/12/2018
Date completed instructions received	04/12/2018

Analysis Details

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

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

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

Report Details

Date results requested by	11/12/2018
Date of Issue	10/12/2018

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

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Misc Inorg - Soil					
Our Reference		207253-1	207253-2	207253-3	207253-4
Your Reference	UNITS	BH7	BH3	BH8	BH8
Depth		1-1.45	1-1.37	0.4-0.5	5.5-5.95
Date Sampled		15/11/2018	16/11/2018	17/11/2018	18/11/2018
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Date analysed	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018
pH 1:5 soil:water	pH Units	6.6	5.0	5.4	3.8
Electrical Conductivity 1:5 soil:water	µS/cm	1,300	19	78	690
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	8,900	24	140	1,900

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

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			07/12/2018	1	07/12/2018	07/12/2018		07/12/2018	[NT]
Date analysed	-			07/12/2018	1	07/12/2018	07/12/2018		07/12/2018	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	6.6	6.6	0	104	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	1300	1300	0	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	88	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	8900	9500	7	91	[NT]

Result Definitions

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

Quality Control Definitions

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY DESPATCH SHEET

Project No:	86621.00	**Suburb:**	Lane Cove West	**To:**	EnviroLab
Project Name:	Lane Cove West	**Order Number**			12 Ashley Street, Chatswood 2067
Project Manager:	Huw Smith	**Sampler:**	Joshua Bedit	**Attn:**	Aileen Hie
Emails:	huw.smith@douglaspartners.com.au			**Phone:**	(02) 9910 6200
Date Required:	Same day ☐ 24 hours ☐ 48 hours ☐ 72 hours ☐ Standard ☑			**Email:**	Ahie@envirolab.com.au

Prior Storage: ☐ Esky ☐ Fridge ☑ Shelved Do samples contain 'potential' HBM? Yes ☐ No ☑ (If YES, then handle, transport and store in accordance with FPM HAZ

Sample ID	Lab ID	Date Sampled	Sample Type S - soil W - water	Container Type G - glass P - plastic	Analytes								Notes/preservation
						Aggresivity (pH, EC, sulfates, chlorides							
BH7 1m - 1.45m	1	15/11/18	S	P		X							
BH3 1m-1.37m	2	16/11/18	S	P		x							
BH8 0.4m -0.5m	3	17/11/18	S	P		x							
BH8 5.5m-5.95m	4	18/11/18	S	P		x							
PQL (S) mg/kg													ANZECC PQLs req'd for all water analyt

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 207253
Date Received: 4·12·18
Time Received 16:16
Received By: TD
Temp: [✓ Cool]/Ambient
Cooling: Ice/[✓ Icepack]
Security: [✓ Intact]/Broken/None

PQL = practical quantitation limit. If none given, default to Laboratory Method Detection Limit

Metals to Analyse: 8HM unless specified here: NA

Lab Report/Reference No:

Total number of samples in container: 4 **Relinquished by:** H-SMITH **Transported to laboratory by:**

Send Results to: Douglas Partners Pty Ltd **Address:** 96 Hermitage Road West Ryde **Phone:** 02 9809 0666 **Fax:** —

Signed: **Received by:** GLS **Date & Time:** 4·12·18 16:16

Material Test Report

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

Report Number: **86621.00-1**
Issue Number: 1
Date Issued: 12/12/2018
Client: AW Edwards Pty Ltd
Unit 6/35 Merrigal Road, Port Macquarie NSW 2444
Contact: Justin Smith
Project Number: 86621.00
Project Name: Proposed Data Centre
Project Location: 1 Sirius Road, Lane Cove
Work Request: 3912

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing

Lujia Wu

Approved Signatory: Lujia Wu
soil technician
NATA Accredited Laboratory Number: 828

Moisture Content AS 1289 2.1.1

Sample Number	Sample Location	Moisture Content	Material
18-3912A	BH10 (1.7-1.8m)	22.2 %	Saturated Sandy Clay
18-3912B	BH10 (0.9x1.0m)	17.5 %	Sandy Clay Filling
18-3912C	BH7 (3.3x3.5m)	31.1 %	Peaty Sand
18-3912D	BH8 (7.1x7.55m)	20.6 %	Clay

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater

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

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Approved Signatory: Lujia Wu
soil technician

NATA Accredited Laboratory Number: 828

Report Number: **86621.00-1**
Issue Number: 1
Date Issued: 12/12/2018
Client: AW Edwards Pty Ltd
Unit 6/35 Merrigal Road, Port Macquarie NSW 2444
Contact: Justin Smith
Project Number: 86621.00
Project Name: Proposed Data Centre
Project Location: 1 Sirius Road, Lane Cove
Work Request: 3912
Sample Number: 18-3912C
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH7 (3.3x3.5m)**
Material: Peaty Sand

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	39		
Plastic Limit (%)	25		
Plasticity Index (%)	**14**		

Material Test Report

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

Report Number: **86621.00-1**
Issue Number: 1
Date Issued: 12/12/2018
Client: AW Edwards Pty Ltd
Unit 6/35 Merrigal Road, Port Macquarie NSW 2444
Contact: Justin Smith
Project Number: 86621.00
Project Name: Proposed Data Centre
Project Location: 1 Sirius Road, Lane Cove
Work Request: 3912
Sample Number: 18-3912D
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH8 (7.1x7.55m)**
Material: Clay

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Lujia Wu

Approved Signatory: Lujia Wu
soil technician
NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	62		
Plastic Limit (%)	19		
Plasticity Index (%)	**43**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Sydney Laboratory
96 Hermitage Road West Ryde NSW 2114
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Email: lujia.wu@douglaspartners.com.au

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Lujia Wu

Approved Signatory: Lujia Wu
soil technician

NATA Accredited Laboratory Number: 828

WORLD RECOGNISED ACCREDITATION

Report Number: **86621.00-1**
Issue Number: 1
Date Issued: 12/12/2018
Client: AW Edwards Pty Ltd
Unit 6/35 Merrigal Road, Port Macquarie NSW 2444
Contact: Justin Smith
Project Number: 86621.00
Project Name: Proposed Data Centre
Project Location: 1 Sirius Road, Lane Cove
Work Request: 3912
Sample Number: 18-3912B
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH10 (0.9x1.0m)**
Material: Sandy Clay Filling

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	18		
Plasticity Index (%)	**16**		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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Phone: (02) 9809 0666
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Email: lujia.wu@douglaspartners.com.au

Report Number: **86621.00-1**
Issue Number: 1
Date Issued: 12/12/2018
Client: AW Edwards Pty Ltd
Unit 6/35 Merrigal Road, Port Macquarie NSW 2444
Contact: Justin Smith
Project Number: 86621.00
Project Name: Proposed Data Centre
Project Location: 1 Sirius Road, Lane Cove
Work Request: 3912
Sample Number: 18-3912A
Date Sampled: 04/12/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **BH10 (1.7-1.8m)**
Material: Saturated Sandy Clay

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Accredited for compliance with ISO/IEC 17025 - Testing

Lujia Wu

Approved Signatory: Lujia Wu
soil technician
NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	15		
Plasticity Index (%)	**19**		