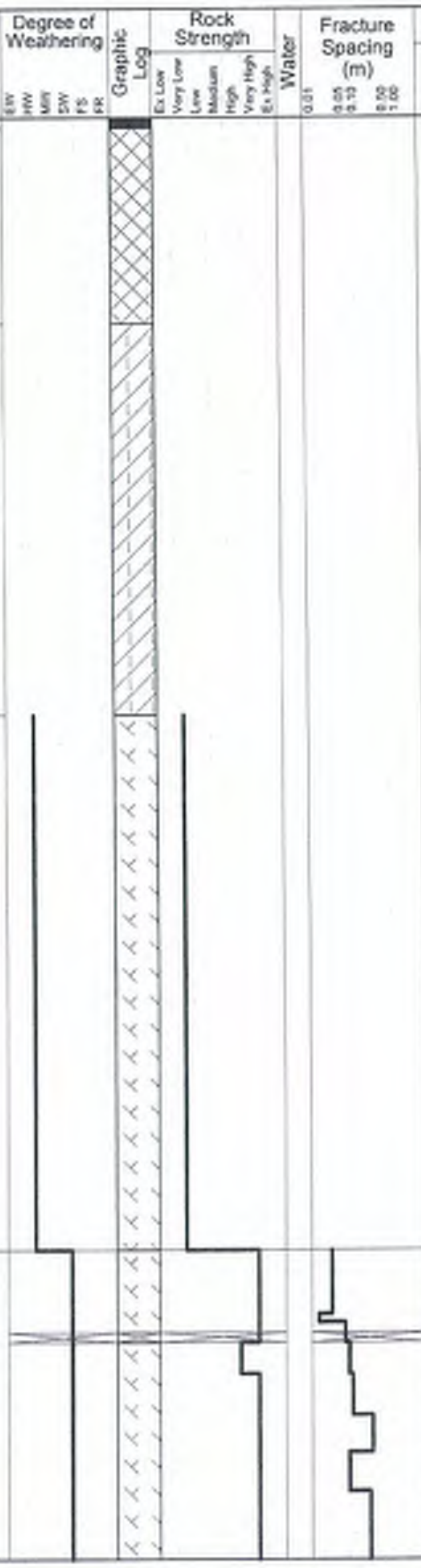
BOREHOLE LOG

CLIENT: John Holland Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
SHEET 1 OF 3



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
	0.05	ASPHALT					
26		FILLING - compact dark brown and grey sandy gravel with some clay filling		S			3,2,4 N = 6
25	1.0	SILTY CLAY - firm red brown silty clay, moist		A			
24		- becoming stiff, yellow brown and red brown below 1.9m		S			8,7,7 N = 14
23	2.9	BASALT - very low strength, highly weathered, yellow brown orange brown and grey basalt		D			
				S			30/130mm
22				D			PL(A) = 0.68
21				S			30/30mm
	5.5	BASALT - very high strength, slightly weathered, highly fractured grey basalt with abundant clay infilled fractures throughout	5.81m: crush zone 5.9m: CORE LOSS: 50mm	C	88	0	PL(D) = 4.39 Rock chips tested for point load
	5.95	- interbedded very low and low strength, highly weathered, fractured, bands typically between 3mm and 50mm thick		C	100	0	PL(A) = 6.5 PL(D) = 4.75
20			6.2m: high fractured 6.3m: J, 90°, un, ro, cl, vn 6.5m: J, 90°, st, ro, cl, vn	C	100	30	
			6.63m: J, 45°, pl, sm, cl, vn 6.74m: J, 30°, pl, sm, cl 6.78m: J, 0°, un, ro, cl,	C	100	21	PL(A) = 5.89 PL(D) = 4.45 PL(A) = 3.68

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole
WATER OBSERVATIONS: No groundwater observation possible
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,	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

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BORE No: 8
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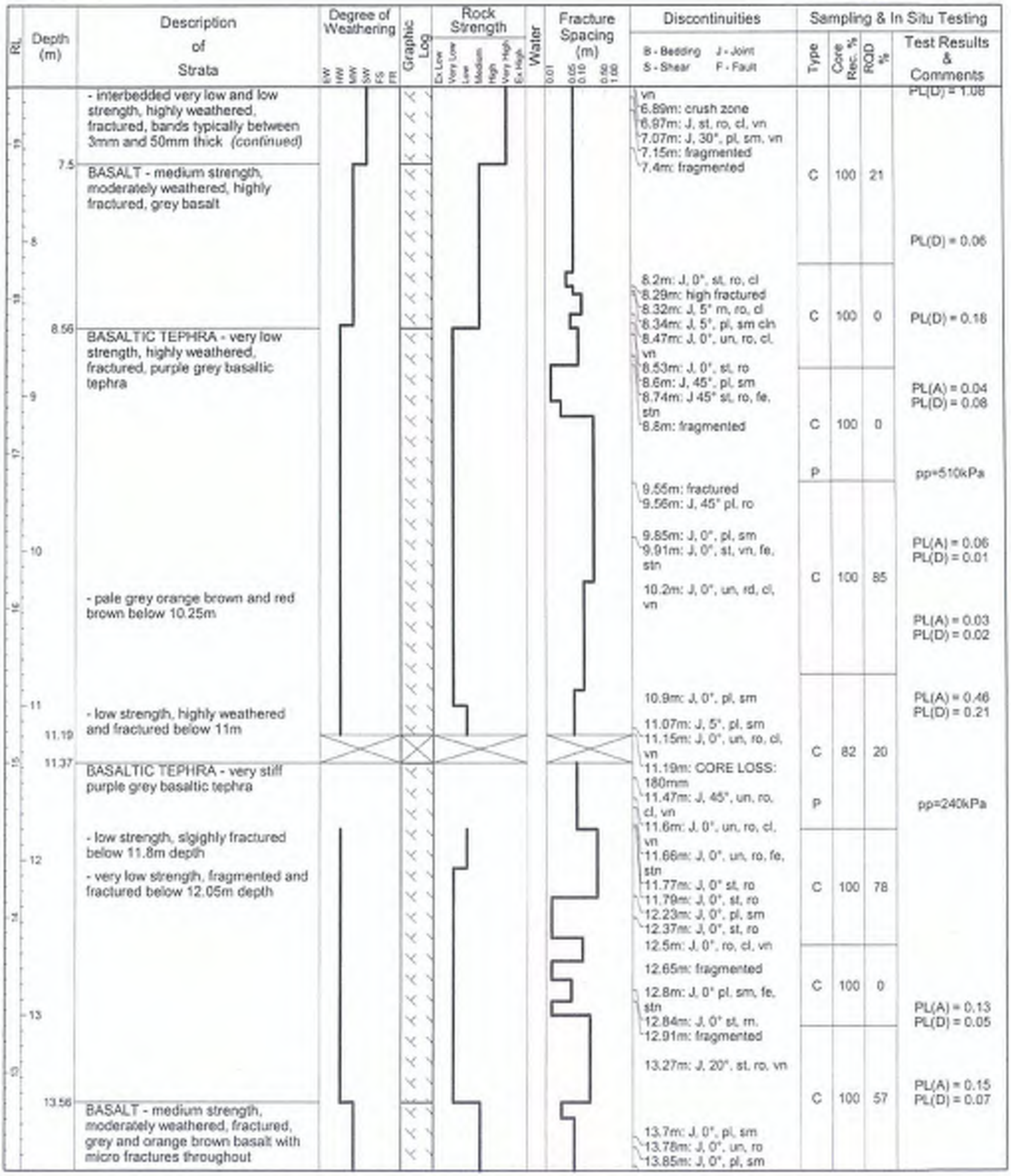
SHEET 2 OF 3



Depth (m)	Description of Strata
	- interbedded very low and low strength, highly weathered, fractured, bands typically between 3mm and 50mm thick *(continued)*
7.5	BASALT - medium strength, moderately weathered, highly fractured, grey basalt
8.56	BASALTIC TEPHRA - very low strength, highly weathered, fractured, purple grey basaltic tephra - pale grey orange brown and red brown below 10.25m - low strength, highly weathered and fractured below 11m
11.19	
11.37	BASALTIC TEPHRA - very stiff purple grey basaltic tephra - low strength, sigighly fractured below 11.8m depth - very low strength, fragmented and fractured below 12.05m depth
13.56	BASALT - medium strength, moderately weathered, fractured, grey and orange brown basalt with micro fractures throughout

Discontinuities

B - Bedding J - Joint
S - Shear F - Fault

vn
6.89m: crush zone
6.97m: J, st, ro, cl, vn
7.07m: J, 30°, pl, sm, vn
7.15m: fragmented
7.4m: fragmented
8.2m: J, 0°, st, ro, cl
8.29m: high fractured
8.32m: J, 5° m, ro, cl
8.34m: J, 5°, pl, sm cln
8.47m: J, 0°, un, ro, cl, vn
8.53m: J, 0°, st, ro
8.6m: J, 45°, pl, sm
8.74m: J 45° st, ro, fe, stn
8.8m: fragmented
9.55m: fractured
9.56m: J, 45° pl, ro
9.85m: J, 0°, pl, sm
9.91m: J, 0°, st, vn, fe, stn
10.2m: J, 0°, un, rd, cl, vn
10.9m: J, 0°, pl, sm
11.07m: J, 5°, pl, sm
11.15m: J, 0°, un, ro, cl, vn
11.19m: CORE LOSS: 180mm
11.47m: J, 45°, un, ro, cl, vn
11.6m: J, 0°, un, ro, cl, vn
11.66m: J, 0°, un, ro, fe, stn
11.77m: J, 0° st, ro
11.79m: J, 0°, st, ro
12.23m: J, 0°, pl, sm
12.37m: J, 0°, st, ro
12.5m: J, 0°, ro, cl, vn
12.65m: fragmented
12.8m: J, 0° pl, sm, fe, stn
12.84m: J, 0° st, m.
12.91m: fragmented
13.27m: J, 20°, st, ro, vn
13.7m: J, 0°, pl, sm
13.78m: J, 0°, un, ro
13.85m: J, 0°, pl, sm

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
			PL(D) = 1.08
C	100	21	PL(D) = 0.06
C	100	0	PL(D) = 0.18
C	100	0	PL(A) = 0.04 PL(D) = 0.08
P			pp=510kPa
C	100	85	PL(A) = 0.06 PL(D) = 0.01 PL(A) = 0.03 PL(D) = 0.02
C	82	20	PL(A) = 0.46 PL(D) = 0.21
P			pp=240kPa
C	100	78	
C	100	0	PL(A) = 0.13 PL(D) = 0.05
C	100	57	PL(A) = 0.15 PL(D) = 0.07

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REMARKS:

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D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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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		BASALT - medium strength, moderately weathered, fractured, grey and orange brown basalt with micro fractures throughout *(continued)*	13.97m: J, 0° un, ro 14.04m: J, 0° st, ro 14.21m: J, 0°, pl, sm, fe, stn				PL(A) = 0.04
				C	100	0	PL(A) = 0.23
	14.61	BASALT - very high strength, fresh stained, slightly fractured, grey and orange brown basalt					PL(A) = 3.89 PL(D) = 0.92
	15		14.76m: J, 0°, pl, sn 14.85m: J, 0°, pl, sn 14.88m: J, 0°, pl, sn 14.94m: J, 0°, pl, sm				
11							PL(A) = 4.83 PL(D) = 1.32
			15.69m: J, 0°, pl, sn 15.74m: J, 0°, pl, sn				
	16		16.05m: J, 10°, pl, sn				PL(A) = 4.51 PL(D) = 1.57
10			16.31m: J, 5°, pl, sn				
			16.58m: J, 0°pl, sm	C	100	97	PL(A) = 5.16
	17						PL(A) = 1.44 PL(D) = 1.81
9			17.2m: J, 0°st, ro				
	18						PL(D) = 3.54
	18.1	Bore discontinued at 18.1m. Target depth reched					
8							
	19						
7							
	20						
6							

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5

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WATER OBSERVATIONS: No groundwater observation possible

REMARKS:

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A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
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Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Maternity Ward Building (Building 3B2)
Little Uralba Street, Lismore

Prepared for
Arcadis Pty Ltd

Project 90317.00
September 2016

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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Revision 0	1	-	Mr Glenn Barton, Arcadis Pty Ltd

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	D. Qualischefski	20 September 2016
Reviewer		20 September 2016

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Appendix C:	Borehole Logs 7 and 8 and Core Photographs
Appendix D:	Arcadis Foundation Plan
Appendix E:	Previous Borehole Logs

Report on Geotechnical Investigation
Proposed Maternity Ward Building (Building 3B2)
Little Uralba Street, Lismore

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed maternity ward building (Building 3B2) at Little Uralba Street, Lismore. The investigation was commissioned in an email dated 17 May 2016 by Mr Glenn Barton of Arcadis Pty Ltd and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal GLD150259 dated 9 December 2015.

It is understood that the construction of a seven storey maternity ward building denoted Building 3B2 is proposed. It is further understood that the building is to be 'future proofed' by designing the foundations to allow for an additional five storeys to be constructed in the future if required. All construction will be from approximately existing site levels.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide comments on:

- subsurface conditions, including commentary on the presence and strength of a basalt tephra layer, and the likely presence of groundwater;
- earthworks and site preparation requirements including excavatability and trafficability;
- allowable bearing pressures and settlements for upper level footings;
- suitable pile types, founding strata, and ultimate shaft and end bearing pressures;
- assessment of earthquake site sub-soil class to AS1170.4-2007 Part 4; and
- amendment of the global stability analysis prepared as part of DPs September 2015 Foundation Options report.

The investigation comprised the drilling and sampling of two test bores, laboratory testing, engineering analysis and reporting. Details of the field work and laboratory testing are presented in this report together with comments and recommendations on the items listed above.

This report must be read in conjunction with the notes entitled *'About This Report'* in Appendix A and other explanatory notes, and should be kept in its entirety without separation of individual pages or sections.

2. Site Description

The proposed 3B2 building development site comprises a rectangular shaped area located near the north-eastern corner of the Lismore Base Hospital complex, as indicated on Drawing 1 in Appendix B.

At the time of the investigation, the site area was relatively flat but sloping. It was predominantly covered by asphalt and concrete slabs and the existing maternity ward building (ie. elevated single storey building).

Based on survey information provided by the client to DP, ground surface levels generally rise in an easterly direction from RL24.5 m to RL27.5 m along the top of the slope toward Little Uralba Street.

The northern site boundary is delineated by a steeply dipping, soil nailed, shotcrete covered slope up to about 7 m high with the mental health building below at RL19 m. The western site boundary is delineated by the existing biomedical centre, the southern site boundary by an 11 storey building and the eastern site boundary by Little Uralba Street.

3. Regional Geology

The Geological Survey of New South Wales state wide geodatabase, 1:250,000 scale or better, 2003 indicates that the site lies on a 'peninsula' of early Miocene age Lamington volcanics comprising *"basalt, sub-alkali basalt with members of rhyolite, trachyte, tuff, agglomerate, conglomerate and andesite"*.

The natural subsurface conditions encountered during the field work are generally consistent with the published Lamington volcanics geology.

4. Background and Previous Investigations

A number of geotechnical investigations have been undertaken across the Lismore Base Hospital site, some of which date back to the 1980's. Prior to July 2013, the investigations were exclusively undertaken by Coffey Geotechnics Pty Ltd (CG), and after July 2013 DP was commissioned to undertake a geotechnical investigation for the proposed Stage 3A development.

Prior to this current DP investigation, three previous investigations undertaken by CG and DP included boreholes that were drilled close to the proposed Building 3B2 site. It should be noted however, that the CG information, and in particular the accuracy of the borehole records, cannot be verified by DP. The borehole logs from the following three investigations are presented in Appendix E.

The earliest of these investigations was undertaken in April 2006 by CG and the results are presented in "Geotechnical and Environmental Investigation: Lismore Base Hospital Mental Health Unit Upgrade", prepared for NSW Health Infrastructure, (Reference: NR1618/1-AC). The investigation comprised nine bores drilled mainly to the south of the site, however two boreholes (designated Bores 3 and 5) were drilled along the crest of the aforementioned soil nailed batter. It should be noted that no reference is made to rock strengths on the Bore 3 log.
A second investigation was undertaken in January 2013 by CG and the results presented in "Geotechnical Investigation: New 11-Floor Building at Lismore Base Hospital", prepared for NSW Health Infrastructure, (Reference: GEOTALST01618AN-AF, March 2012 (*sic*)). The investigation comprised the drilling of three boreholes (designated Bores 1 to 3). Bore 2 was drilled close to the

centre of the existing maternity ward building. The other two bores were drilled some distance away from the site and are therefore omitted from this current report.

The third investigation was undertaken at the site in July 2013 by DP and the results are presented in the "Report on Geotechnical Investigation: Proposed Eleven Storey Building, Lismore Base Hospital, Uralba Street, Lismore", prepared for NSW Health Infrastructure (DP Project No. 80243.00). The DP investigation comprised the drilling of three bores (designated Bores 4 to 6). Bore 5 (denoted as DP Bore 5 in this report) was drilled close to the south eastern corner of the existing maternity building and the remaining boreholes were drilled some distance away. Therefore, reference is only made to DP Bore 5 in this report.

Based on the information provided in the previous investigations, a summary of the ground conditions encountered is as follows:

The basalt was found to be in excess of 20.8 m thick (limit of the investigation in DP Bore 5) and comprised two basalt flows that were separated by a 1.4 m to 7.1 m thick tephra layer. It should be noted that the tephra layer is not noted on the CG Bores 3 or 5 log.

The upper basalt flow in CG Bores 3 and 5 typically comprised bands of extremely low strength to medium strength basalt to approximately RL15.7 m in CG Bore 5, and to the termination of CG Bore 3 at RL13.7 m. Below 15.7 m in CG Bore 5 a clay stratum underlain by very low strength basalt was encountered to the termination of the bore at RL15.15 m.

The upper basalt flow in CG Bore 2 and DP Bore 5 appear to display a more typical weathering profile which increased in strength with depth, from initially very low strength to very high strength and fresh with some medium strength bands to RL18.2 m and RL18.5 m in CG Bore 2 and DP Bore 5 respectively. However, it should be noted that the upper basalt flow was typically highly fractured with abundant clay seams.

Below the upper basalt flow in CG Bore 2 and DP Bore 5, a tephra layer was encountered and comprised very stiff to hard clay, which typically increased to very low strength with depth. The tephra layer was encountered to approximately RL15.5 m in CG Bore 2 and RL11.4 m in CG Bore 5.

The lower basalt flow was initially low to medium high strength (CG Bore 2 only) to approximately RL13.15 m where it became very high and extremely high strength and fresh to the base of the borehole at RL8.2 m. In DP Bore 5, the lower basalt flow was very high strength and fresh to the base of the bore at RL9.9 m.

In summary, all the boreholes undertaken as part of the previous investigations encountered basalt rock at shallow depth, however the upper basalt flow was found to vary considerably across the site in terms of weathering and strength. The tephra layer was also found to vary significantly in thickness across the site.

5. Field Work Methods

The current field work was undertaken between 30 May and 3 June 2016 and comprised the drilling and sampling of two boreholes (designated Bores 7 and 8, numbered sequentially from the previous boreholes). These bores were drilled to depths of 20.1 m and 18.1 m respectively using a track-mounted P160 drilling rig.

The drilling commenced using continuous solid flight auger techniques to refusal depths of 1.5 m and 2.0 m in Bores 7 and 8 respectively. Following auger refusal, Bore 8 was advanced using wash boring techniques to 5.5 m depth. NMLC rock coring techniques were then employed to the termination depths of the bores.

Standard penetration tests (SPT) were also carried out where possible in the near surface strata to provide an indication of soil strength and to collect samples for visual identification and laboratory testing.

The test locations were set out by an engineering geologist in drill rig accessible locations and the coordinates of the bores were recorded using a hand-held GPS accurate to within approximately 5 m, with reference to MGA94 datum. The bore elevations were interpolated from a survey plan provided by the client to Australian height datum (AHD).are shown on Drawing 1 in Appendix B.

The geologist also logged, sampled, photographed and performed point load strength testing on the rock core.

On completion of drilling, the bores were backfilled with drill spoil, then a plastic bore spider was installed near the surface and the hole reinstated with asphalt.

6. Field Work Results

The subsurface conditions encountered in Bores 7 and 8 are described in detail on the borehole logs in Appendix C. Notes defining the classification methods and descriptive terms are given in Appendix A. Photographs of the recovered core follow the respective borehole log sheets in Appendix C.

The subsurface conditions encountered in Bores 7 and 8 initially comprised soils then a variably weathered upper basalt flow overlying a basaltic tephra layer encountered at between approximately 9 m depth and 12 m to 13.5 m depth. The tephra layer was underlain by a lower basalt flow which was generally more competent and uniform than the upper flow, to the termination of both Bores 7 and 8 at 18.1 m and 20.0 m depth respectively.

The degree of weathering and fracturing in the above stratigraphic sequence varies across the site as below:

- **Filling:** Beneath up to 0.1 m of asphalt, the apparently compacted filling comprised either gravelly clay or sandy gravel with some clay to approximately 1.5 m and 1 m depth in Bores 7 and 8 respectively. In the absence of documentation to confirm the filling was controlled and placed under engineering supervision it should be considered as "uncontrolled".
- **Silty Clay:** firm, becoming stiff residual silty clay was encountered below the filling in Bore 8 to 2.9 m depth.
- **Upper Basalt Flow:** The upper basalt flow in Bores 7 and 8 was noted to have weathered considerably differently. Bore 8 comprised a typical weathering profile with very low strength

basalt encountered below the residual silty clay. The basalt became high and very high strength below 5.5 m depth and then medium strength between 7.5 m and 8.56 m depth. A more varied weathering profile was encountered in Bore 7 which initially comprised extremely high strength fresh basalt rock fragments within a matrix of stiff clay to extremely low strength basalt. Below this layer the flow generally comprised interbedded bands of extremely low, very low, low and high strength basalt to 9.0 m depth.

- **Tephra:** A tephra layer was encountered below the upper basalt flow in both boreholes. The tephra in Bore 8 was initially very low strength with locally low strength bands and bands of very stiff clay to the base of the tephra layer at 13.6 m depth. In Bore 7, the tephra layer was typically very low strength to its base at 12.0 m depth.
- **Lower Basalt Flow:** Underlying the tephra layer in both boreholes, high strength, becoming very high strength, fresh, slightly fractured, dark grey basalt was encountered to borehole termination at 20.05 m and 18.1 m depth in Bore 7 and 8 respectively.

The above described layers are presented on interpreted geological profiles on Geological Cross Sections A-A' and B-B' (ie. Drawings 2 and 3) in Appendix B.

Groundwater ingress was not observed below 1.5 m to 2.0 m depth during the drilling of the boreholes, due to the use of drilling fluids which may have masked any potential groundwater ingress. Due to the locations of the bores, they were backfilled immediately on completion of drilling and therefore it was not possible to monitor the groundwater levels.

No groundwater levels were provided within the previous DP or CG Report for the boreholes undertaken within the proximity of the proposed 3B2 building. However, the CG report indicates that "groundwater seeps were not observed at the soil nail wall to the north of the site during construction during 2007. This indicates that standing, long term groundwater levels are likely to be below RL23 m, not accounting for any perched water tables or short term groundwater flows during or after rainfall or otherwise."

It should be noted, however, that groundwater depths and ground moisture conditions are affected by climatic conditions and soil permeability, and will therefore vary with time

7. Rock Strength Testing

Selected lengths of rock core recovered from the boreholes were tested in the field for point load index (I_S), both in axial and diametral orientations, to assess intact rock strength. The results [corrected to $I_{S(50)}$] are given on the borehole log report sheets and are in the range 0.01 MPa to 13.09 MPa, indicating variable conditions of extremely low strength to very high strength rock.

8. Proposed Development

It is understood that the development will comprise a seven storey maternity ward hospital building. It is further understood that the building is to be 'future proofed' by designing the foundations to allow for an additional five storeys to be constructed in the future if required.

It is anticipated that the proposed building will comprise a reinforced concrete framed structure with suspended concrete floor slabs and precast or cast in-situ concrete walls.

It is understood that minor earthworks will be required to achieve design subgrade level of approximately RL25 m to RL27 m across the gently sloping site.

Information provided by Arcadis indicates that foundations for the new building are anticipated to comprise a combination of pad and strip footings and bored piles as indicated on Level 3 Foundation Plan attached in Appendix D. New pad and strip footings along Building Grids 5 and 6 east of Grid D are proposed to support working column loads in the order of 7500 kN to 8000 kN. Existing pad footings are being reused west of Grid D. Bored piles are proposed along Grids 7 and 7.5 near the crest of the soil nailed batter slope to support columns loads of in the order of 4800 kN to 6250 kN

Based on the information provided, it is anticipated that the proposed 3B2 building will be constructed at or close to existing grade, therefore it is expected that only excavations for footings, service trenches and possibly lift overrun pits will be undertaken to maximum depths of about 1.5 m.

9. Comments

9.1 Appreciation of Ground Conditions

The subsurface profile encountered in Bores 7 and 8 from the current investigation, Bores 4 to 6 from the previous DP investigation, and Bore 2 from the previous CG investigation generally comprise a 0.4 m to 1.5 m thick surficial filling layer overlying an upper basalt flow which varied between very low strength to very high strength. This was underlain by a tephra layer which varied between residual clay and very low strength basalt, and then a lower basalt flow below 12.5 m to 20.5 m depth. The above layers are estimated from the bores and presented on Geological Cross Sections AA' and B-B' on Drawings 2 and 3 in Appendix B.

Based on the 2007 CG report and reference to groundwater seepages being encountered in the soil nail wall during its construction, it is anticipated that groundwater could be encountered below RL23 m.

Due to the subsurface conditions encountered and the requirement to build close to the soil nailed batter slope at the northern boundary of the site, there will be implications for the design and construction of the proposed building as follows:

- Excavatability;
- Stability of excavated faces during construction;
- Potential for water ingress into footing and bored pile excavations at or below approximately RL 23 m;
- Stability of the soil nail wall during construction; and
- Compatibility of new building footings with the existing soil nailed batter slope.

9.2 Excavatability

Excavation of the filling, natural clay soils and extremely low to low strength basalt should be readily achieved using conventional medium sized earthmoving plant (ie. 20-25 tonne hydraulic excavators with toothed buckets and ripping tynes etc).

Where medium to high strength, highly fractured rock is encountered heavy rock breakers will be required to facilitate excavation.

Excavation in high strength (or stronger), slightly fractured rock will require blasting (unlikely to be allowed), pattern drilling, gas splitting or chemical pre-splitting, to loosen the rock in conjunction with heavy rock breaking.

It should be recognised that the above excavatability estimates are based on materials encountered at test locations only and that excavation conditions may prove more difficult (or easier) between and beyond these test locations.

9.3 Construction Vibration and Noise

Vibration will result from excavation, earthworks and construction work on this site. There is significant debate as to the maximum amount of vibration that buildings can accommodate; however, vibration restrictions must be set with a realistic appreciation for the normal operational environment of the site. Tolerance to vibration will also depend upon the nature of the materials used in construction (ductile or brittle), the age of the buildings, and whether or not the buildings are already cracked or in disrepair.
Development of a peak particle velocity (PPV) criterion in conjunction with a frequency component is considered essential to enable adequate monitoring and control of demolition and construction vibrations. The development of a site-specific vibration monitoring program is outside the scope of this report, but it is anticipated that the following could be adopted as an initial guide:

Type of Building or Structure	Historical/Heritage	Sound Construction
Maximum PPV (mm/sec)	2 – 3$^{(1)}$	10
Frequency range (Hz)	<10	10 – 50

Note: $^{(1)}$ or below background levels.

A properly designed vibration monitoring program will need to be implemented during demolition, excavation and new construction phases of the project. Demolition and construction noise and its impact upon nearby tenants and residents will also need to be considered.

A movement monitoring program is suggested to ensure excavation, earthworks and construction works do not affect adjacent structures. A dilapidation/building condition survey of the adjacent buildings prior to commencing site work, coupled with vibration, noise monitoring, is also suggested. DP can undertake the vibration monitoring works if required.

9.4 Temporary Slope Batters

Full height battering of excavation faces may not be suitable due to the close proximity of the adjoining buildings and in ground services.

If space permits, however, non-surcharged dry batter slopes cut into the various soil profiles encountered during the field work, may be designed for short and long term conditions, using the ratios of horizontal (H) to vertical (V) measurements as presented in Table 1 below.

Table 1: Temporary Batter Slopes

Material	Safe Batter Slope (H:V)	
	Short Term	Long Term
Controlled filling and natural stiff (or stronger) clays	1:1	2:1
Uncontrolled filling	2:1	2.5:1
Very low to low strength basalt	1:1	1:1
Medium to high strength (or stronger) highly fractured to fragmented basalt	0.75:1 to 1:1(1)	
High strength (or stronger), slightly fractured to fractured basalt	0.75:1 to 1:1(1)	
High strength (or stronger), slightly fractured (or less) basalt	Vertical(2)	

Notes: (1) Design using 1:1 but may be steepened to 0.75:1 following geotechnical inspection and analysis.
(2) Geotechnical inspection required to confirm there are no adversely orientated joints or shear planes, which could lead to wedge of block failure.

It is strongly recommended that any batters be inspected and geologically mapped during excavation to identify the condition and orientation of rock mass defects along the rock faces. Measured orientations and representative averages should then be plotted and analysed to assess the potential for wedge or block failure. All batters where rock is exposed, particularly the fractured and highly fractured basalt, which contained numerous clay filled fractures, joints and seams some near vertical, will need to be scaled back in a controlled manner to remove any loose blocks or wedges of rock.

All batters should be completed with lined open drains across the top of cut batter slopes to prevent overland water flow down the batters and subsequent erosion of the near surface soils.

9.5 Re-Use of Cut Materials

The field work results indicate that the materials won from excavations on the site would vary from near surface gravelly clay filling, to weathered very low and low strength basalt or very high strength basalt. It is considered that the majority of these materials would be suitable for reuse as structural or general filling, subject to meeting minimum placement and compaction requirements

The existing gravelly clay filling (if required) could be reused as controlled filling provided that any oversized inert material (e.g. gravel, rock, brick, concrete etc greater than 75 mm) is crushed or removed or any deleterious material (e.g. organic matter, steel, plastic etc), if encountered, is removed.

The weathered very low strength basalt is expected to be recovered as a gravelly clay mixture and would be suitable for reuse. Where the 'fresher' medium strength (or stronger) basalt is encountered, its suitability for 'immediate' reuse will depend on both the excavation method and fracturing. It is anticipated that the near surface highly fractured basalt would be suitable for reuse following the removal of any oversized material, although this would need to be assessed on site. The slightly fractured high strength (or stronger) basalt encountered at depth is likely to require crushing prior to reuse.

9.6 Site Preparation

Based on the bores, the existing subgrade is anticipated to comprise filling, residual clay soils and very low strength basalt. The exposed subgrade should be inspected and test rolled in order to detect any soft or loose zones, which should be removed and replaced with approved and suitably compacted filling. Test rolling should be carried out with a smooth drum roller with a minimum static weight of 12-tonnes.

Any new filling, if required to achieve design levels, but not used for pavement/structural support should be undertaken under 'Level 2' supervision and testing as detailed in AS 3798–2007 (Ref 3). Filling should be placed in layers not exceeding 300 mm 'loose' thickness, with each layer compacted to a minimum dry density ratio of 100% Standard compaction within 2% of optimum moisture content.

The filling, residual clay and weathered basalt may soften during and after periods of rainfall or other increases in subgrade moisture content. It will be essential to keep the lower part of the site well drained during construction. A granular working platform is recommended to reduce potential lost time during or following wet weather, and to reduce wetting or drying of the subgrade soils.

9.7 Foundations

Arcadis indicates that foundations for the new building will comprise a combination of pad and strip footings and bored piles as indicated on Level 3 Foundation Plan attached in Appendix D. New pad and strip footings along Grids 5 and 6 east of Grid D will support working column loads in the order of 7500 kN to 8000 kN. Existing pad footings are being re-used west of Grid D and will be required to support a working bearing pressure of 400 KPa. Bored piles are proposed along Grids 7 and 7.5 near the crest of the soil nailed batter slope to support working loads of in the order of 4800 kN to 6250 kN.

Unless confirmed by soil structure interaction analysis (ie. 3D *Plaxis* or 3D *FLAC*), high level pad and strip footings will need to be located below and behind a plane of 45 degrees extending upward from the toe of the adjacent soil nail supported slope.

9.7.1 Pad and Strip Footings

The use, performance and associated bearing pressures of pad and strip footings on this site will be controlled by both the strength and fracturing of the basalt rock. However, the governing factors for the use of large pad or strip footings will be the presence and influence of clay seams, any underlying lower strength stratum and the resulting settlement rather than rock strength.

Pad or strip footings could be sized using the allowable bearing pressures given in Table 2.

Table 2: Maximum Allowable Bearing Pressures for Pad and Strip Footings

Material	**Maximum Allowable Bearing Pressure (kPa)**
Very low to low strength, highly fractured to fragmented basalt	1000(1)
Medium to high strength, highly fractured to fragmented basalt	1500(2)
High strength, slightly fractured to fractured basalt	3000(2)
Very high strength, slightly fractured basalt	6000(2)

Notes: (1) possibly suitable for strip footings along Building Grids 7 and 7.5 but subject to 3D soil structure interaction analysis (ie. 3D *Plaxis* or *FLAC* analysis).

(2) for high level footings located below and behind a plane of 45° extending upward from the toe of the soil nail supported slope.

DP can provide further advice and assistance with surcharging of the wall and the interaction between the soil nails and the proposed footings (if required), once a final footing design has been determined. DP would, however, require the 'as built drawings' of the wall to enable detailed modelling.

At the above allowable bearing pressures, total settlements would not be expected to exceed 1% of footing width. However, some allowance should be made for differential settlement (possibly through the use of movement joints and careful articulation of the structure) due to both the lateral and vertical variation in basalt weathering profile.

All footing excavations will need to be inspected by a qualified geotechnical engineer/engineering geologist prior to casting of concrete to confirm rock quality. As part of the inspection process, probe drilling and spoon testing will need to be carried out in high and very high strength rock to ensure the percentage of clay seams and highly fractured zones present beneath footings do not exceed that assumed in the design.

9.7.2 Bored Piles Founded in Rock

Bored piles will need to be sleeved permanently through the upper section of the slope (ie. above RL19 m) so they do not transmit downward forces into the soil nail supported slope.

Bored piles founding a minimum of one pile diameter into the nominated founding strata and below the basaltic tephra layer (see DP Bores 5, 7 and 8, and CG Bores 2 and 5, and Drawings 2 and 3 attached), can be designed using the ultimate geotechnical strengths (R_{d-ug}) given in Table 3.

Pile capacities and suitable pile types should be confirmed by prospective piling contractors. Contractors should also be made aware of the potential for high groundwater inflow at depth.

Table 3: Bored Pile Design Geotechnical Parameters (Ultimate Unfactored)

Material	Ultimate Unfactored Shaft Adhesion (MPa)	Ultimate Unfactored End Bearing (MPa)
High strength (or stronger) slightly fractured to fractured basalt	0.8(1)	25(1)
Very high strength slightly fractured to unbroken basalt	2(1)	60(1)

Note: (1) below the base of the soil nailed slope (ie. RL19 m) and the tephra basalt layer, whichever is deeper.

Where limit state methods are used to design the piles, the ultimate geotechnical strength ($R_{d,ug}$) must be multiplied by a suitable geotechnical strength reduction factor (ϕ_g) to obtain the design geotechnical strength ($R_{d,g}$). The geotechnical strength reduction factor is dependent upon several factors which were unknown at the time of preparation of this report, including incorporation of pile testing (if any) into the construction sequence and method of pile testing. As a guide, where the average risk rating is assessed to be high, there is no pile testing and the system has low redundancy, a ϕ_g value of 0.45 would apply. Guidance on the choice of ϕ_g factor is provided in Section 4 of AS2159-2009.

Where working stress methods are used to design piles and no pile testing is carried out, the above ultimate values should be divided by a factor of safety of 2.5.

Experience indicates that settlements of properly designed and constructed piles designed using suitably factored shaft adhesion and end bearing values, are unlikely to exceed 1% of the pile diameter.

It should be noted that the ability to drill bored piles in rock is not only dependent on the rock characteristics (strength, fracture spacing etc) but also the type (power and size) of the drilling rig and the size (diameter) of piles. Bored pile installation in high strength or stronger rock will require the use of heavy drilling plant such as Casagrande, Soilmec or Bauer rigs with more than about 220 kNm of drilling torque. It is recommended that the drilling contractors allow for slow drilling rates, the use of coring buckets, very high bit wear and also confirm the size of equipment required prior to commencing works on the site.

9.8 Verification of Design Pressures

It is essential that both pile and pad/strip foundation excavations be inspected by experienced geotechnical personnel to ensure the design parameters adopted are suitable for the ground conditions and to ensure that there is no soft or loose material remaining at the base of the excavations or smear on the side walls.

9.9 Earthquake Site Factor

In accordance with AS 1170.4 (Ref 2), it is recommended that a site sub-soil classification of "Class B_e – Rock Site" be adopted, in accordance with the definitions presented in *Section 4.2 – Class Definitions*.
A site hazard factor (z) of 0.05 has been assessed for the site based on the above standard.

9.10 Erodability and Erosion Control

Fine grained soils are prevalent at the site surface and would generally be susceptible to erosion and dispersivity. It is therefore expected that there is a moderate to high erosion risk associated with surface water flow, as the soils exposed to water runoff will be susceptible to running over the soil nailed batter.

Surface erosion control measures will require detailed design. It is expected, however, that as a minimum, silt fences, hay bales and other measures to limit water runoff velocity (such as swales or benches) will be needed.

It is recommended that, adequately lined collector drainage be installed at the crest of the soil nail batters and that all clean drainage is discharged off-site via pipes or lined channels.

9.11 Existing Soil Nail Wall

It is understood that CG designed and supervised the installation of the soil nail wall located along the northern site boundary.

DP has carried out slope stability analysis to assess the impact of a temporary piling rig surcharge at the top of the slope, the full results of which are presented in our letter report entitled "*Slope Stability Analysis Report, Proposed Building 3B2, Lismore Hospital, Little Uralba Street, Lismore*" dated 25 August 2016.

9.12 Geotechnical Inspection

Based on the subsurface conditions encountered and the findings of this report it is recommended that all batters, excavations and footing excavations (particularly those personnel are to enter) are inspected by an experienced geotechnical engineer / engineering geologist. Inspection is particularly required along excavation faces and batters to ensure that there are no adversely orientated joints or shear planes, which could lead to failure especially within the highly fractured to fractured basalt which contained numerous clay filled fractures, joints and some near vertical seams.

10. References

1. Australian Standard AS 2159–2009 "*Piling – Design and Installation*", Standards Australia.
2. Australian Standard AS 1170.4–2007, "*Structural Design Actions, Part 4: Earthquake actions in Australia*", Standards Australia.
3. Australian Standard AS 3798–2007 "*Guidelines on Earthworks for Commercial and Residential Developments*", Standards Australia.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at Little Uralba Street, Lismore in accordance with DP's proposal GLD150259 dated 9 December 2015 and acceptance received from Arcadis Pty Ltd dated 17 May 2016. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Arcadis Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Soil Descriptions
Rock Descriptions
Sampling Methods
Symbols & Abbreviations

About this Report

Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

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.

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, 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 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx 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 $Is_{(50)}$

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 loner 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:

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

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

Sampling Methods

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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.

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

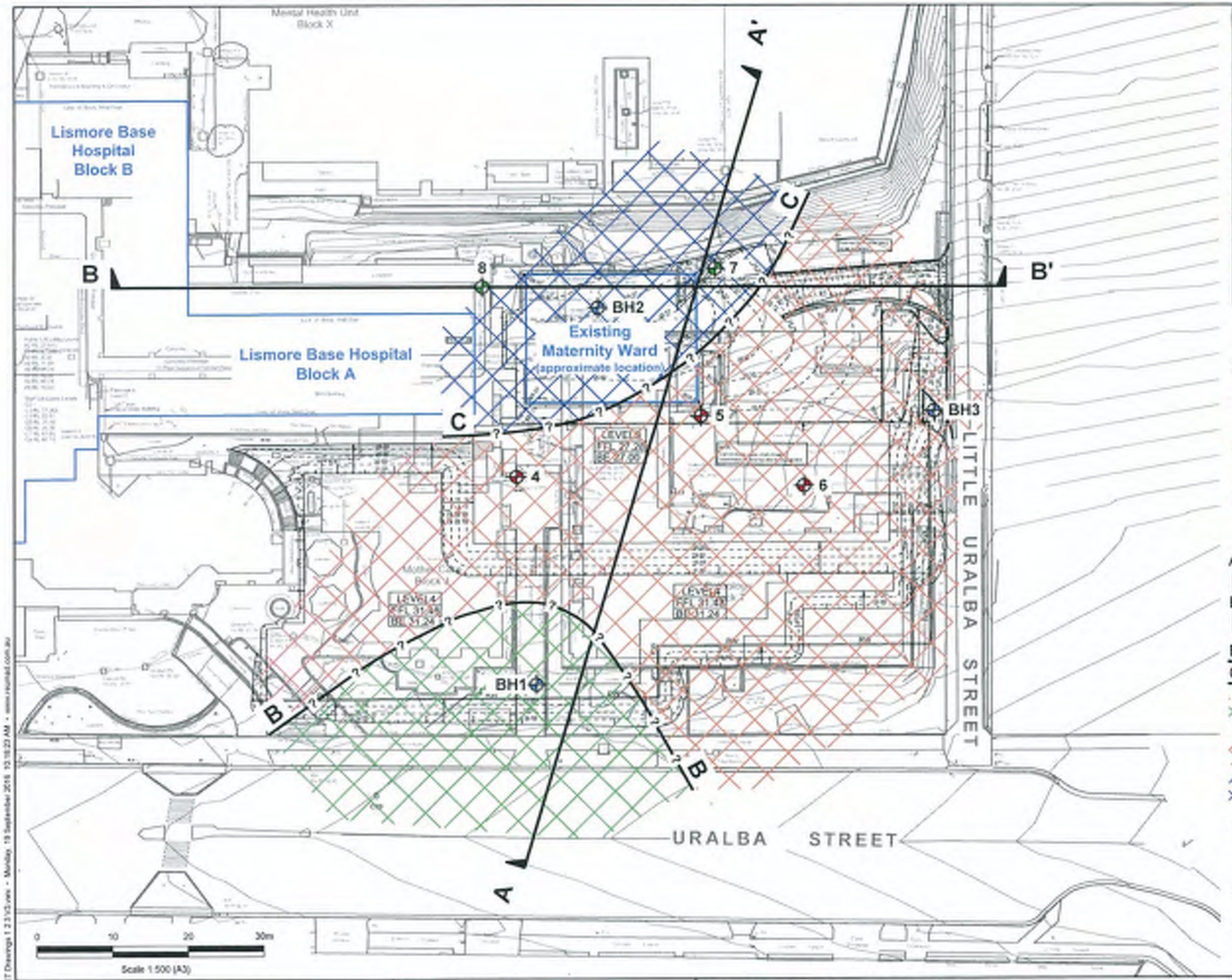
- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks

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

Appendix B

Drawings 1 - 3



Locality Plan

LEGEND:-

- Bores 7 and 8 Designation and Approximate Location. Undertaken by DP June 2016 - Reference 90317.00.
- Bores 4, 5 and 6 Designation and Approximate Location. Undertaken by DP May 2013 - Reference 80248.00.
- Borehole BH1, BH2 and BH3 Designation and Approximate Location. Undertaken by Coffey Geotechnics Pty Ltd January 2013 - Report Reference GEOTALST01618AN.
- A – A' Geological Cross-Section Location (See Drawing 2).
- B – B' Geological Cross-Section Location (See Drawing 3).
- B –?–?– B / C –?–?– C Denote Interpreted Weathering Extents of Basalt and Tephra.
- Zone 1
- Zone 2
- Zone 3

NOTE:-

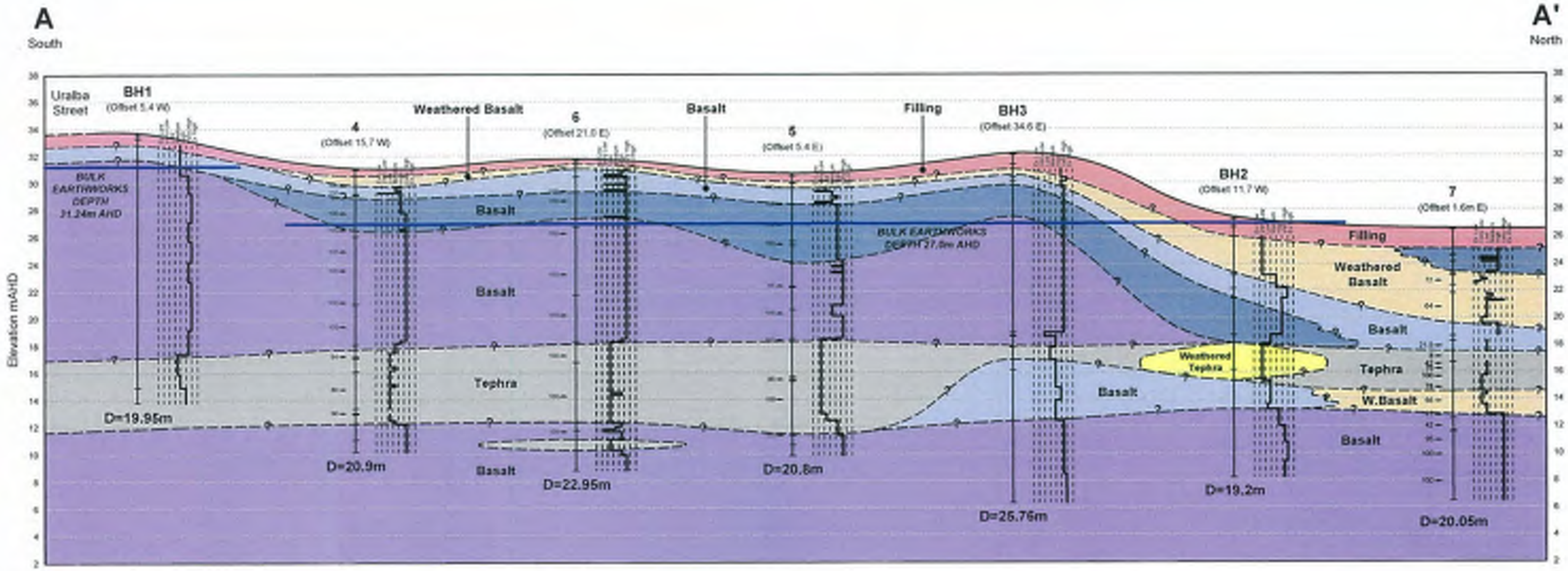
1. Plan adapted from drawing 3A-C23-P1.dwg not dated supplied by client.
2. Test locations are approximate only and are shown with reference to existing site features.
3. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Arcadis Pty Ltd
OFFICE: Brisbane
DRAWN BY: LDW
SCALE: As shown
DATE: 19 September 2016

TITLE: **Site Locality and Test Locations Plan**
Proposed Building 3B2
Lismore Base Hospital, Little Uralba Street, Lismore NSW

PROJECT No: 90317.00
DRAWING No: 1
REVISION: 0



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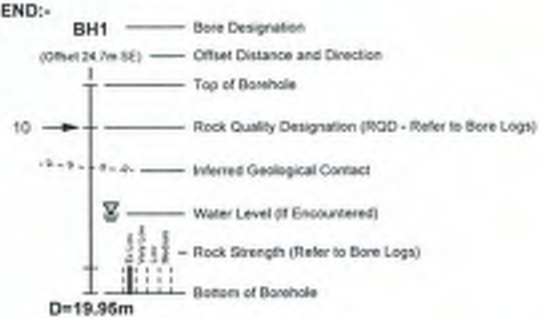


KEY:-

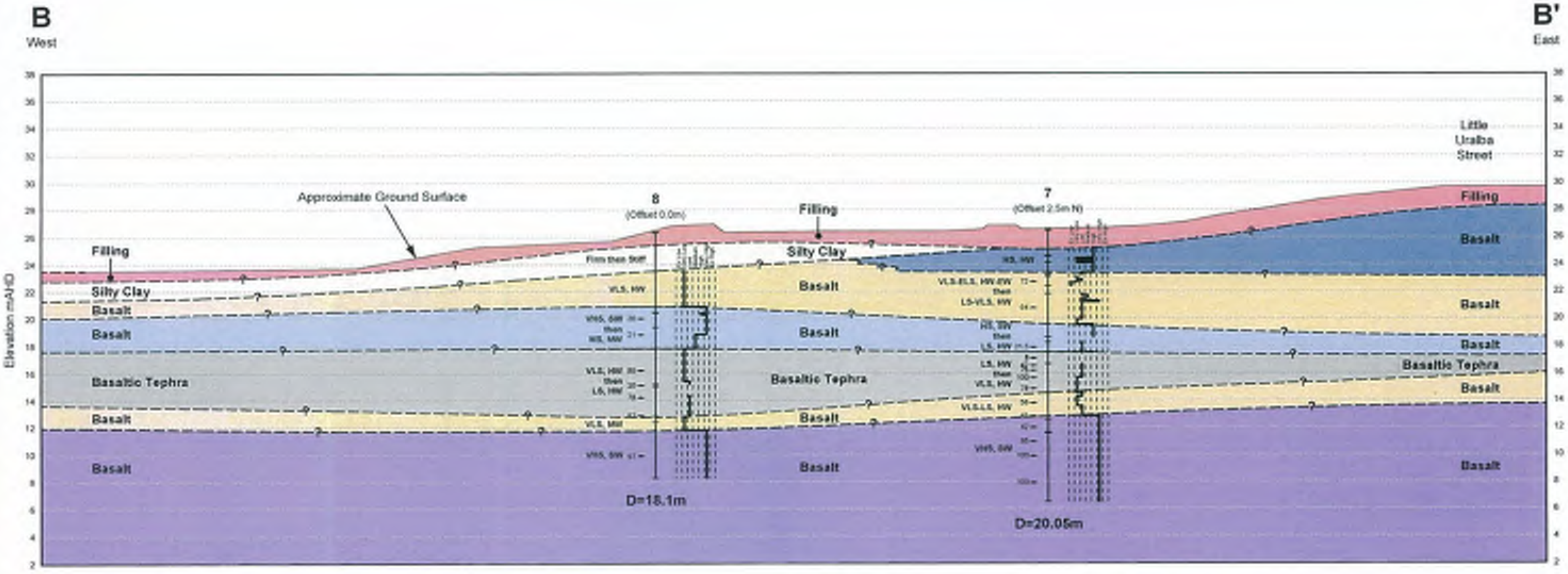
🟥	Filling.
🟨	Weathered Basalt - variable strength highly fractured / fragmented, with clay seams
🟦	Basalt - medium to high strength highly fractured to fragmented
🟦	Basalt - high strength (or stronger) fractured to slightly fractured
🟪	Basalt - high strength (or stronger) slightly fractured (or less)
⬜	Tephra - very low to low strength
🟨	Weathered Tephra - with soil like properties

NOTES:-

1. Test locations have been evenly spaced along length of the cross section. Stratum lines are based on interpretation of the subsurface conditions disclosed in the explorations and interpolation between adjacent explorations. Actual conditions could vary from the subsurface condition interpretations presented on this summary cross-section.
2. See report text for descriptions of geological units.
3. For cross-section location see the Site Locality and Test Locations Plan (Drawing 1).
4. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Arcadis Pty Ltd		TITLE: Geological Cross-Section A-A' Proposed Building 3B2 Lismore Base Hospital, Little Uralba Street, Lismore NSW	PROJECT No: 90317.00
OFFICE: Brisbane	DRAWN BY: LDW		DRAWING No: 2
SCALE: As shown	DATE: 19 September 2016		REVISION: 0



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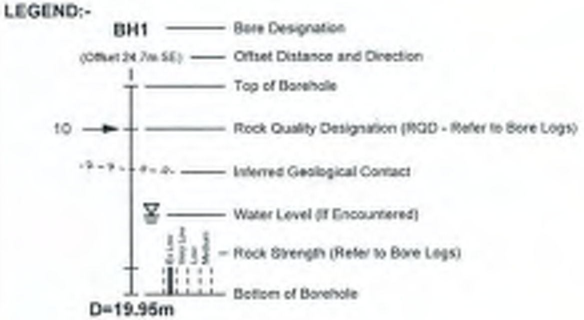


BH1 — Bore Designation
(Offset 24.7m SE) — Offset Distance and Direction
Top of Borehole
Rock Quality Designation (RQD - Refer to Bore Logs)
Inferred Geological Contact
Water Level (If Encountered)
Rock Strength (Refer to Bore Logs)
Bottom of Borehole

KEY:-

🟥	Filling
	Silty CLAY - firm then stiff
🟦	Basalt - high strength (HS) highly weathered (HW)
🟨	Basalt - very low strength (VLS) to low strength (LS) extremely weathered (EW) to highly weathered (HW)
🟦	Basalt - very high strength (VHS) to low strength (LS) slightly weathered (SW) to highly weathered (HW)
⬜	Basaltic Tephra - very low strength (VLS) to low strength (LS) highly weathered (HW)
🟪	Basalt - very high strength (VHS) slightly weathered (SW)

NOTES:-

1. Stratum lines are based on interpretation of the subsurface conditions disclosed in the explorations and interpolation between adjacent explorations. Actual conditions could vary from the subsurface condition interpretations presented on this summary cross-section.
2. See report text for descriptions of geological units.
3. For cross-section location see the Site Locality and Test Locations Plan (Drawing 1).
4. Black and white reproduction of this colour original may reduce its effectiveness and lead to incorrect interpretation.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Arcadis Pty Ltd		TITLE: Geological Cross-Section B-B' Proposed Building 3B2 Lismore Base Hospital, Little Uralba Street, Lismore NSW	PROJECT No: 90317.00
OFFICE: Brisbane	DRAWN BY: LDW		DRAWING No: 3
SCALE: As shown	DATE: 19 September 2016		REVISION: 0

Appendix C

Borehole Logs 7 and 8
Core Photographs

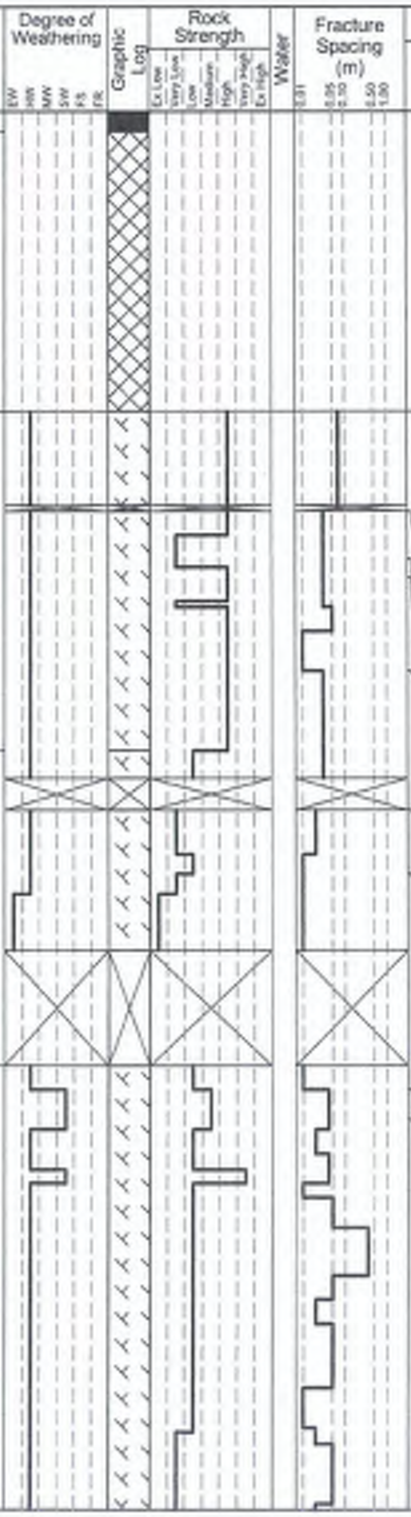
BOREHOLE LOG

CLIENT: Arcadis Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 1 OF 3

RL	Depth (m)	Description of Strata
	0.1	ASPHALT
26		FILLING - compacted orange brown gravelly clay. Gravel of sub-rounded to rounded quartz and basalt
25	1.5	BASALT - high strength fresh dark grey basalt fragments set within a matrix of highly weathered, orange brown clay and extremely weathered rock seams. Fractures randomly orientated and up to approximately 30mm thick
24	2.0	- very low strength, highly weathered bands at 2.12m to 2.18m and 2.45m to 2.48m depth
23	3.2	BASALT - low then very low strength, highly weathered orange brown and grey basalt
	3.5	- extremely low strength, extremely weathered grey and orange brown basalt below 3.92 m depth
22	4.2	
21	4.78	BASALT - generally low strength, highly weathered, orange brown and grey basalt - medium or high strength,slightly weathered bands from 4.9m to 5.1m and 5.3m to 5.5m depth
20		- very low strength below 6.61m depth
	7.0	



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

- 1.5m: J, 60° and 10°, pl, ro, fe, st
- 1.73m: J, 20° pl, sm, cl,
- 1.97m: CORE LOSS: 30mm
- 2m: J, 10°, 30° and 90°, pl, sm, clay, inv between 1mm and 7mm thick
- 2.24m: J, 5° pl, sm, cl, int 10mm thick
- 2.33m: J, 20° pl, sm, cl, int 5mm thick
- 2.8m: J, 40°, pl, sm, cl, inf approx 2mm thick
- 3.34m: CORE LOSS: 160mm
- 3.5m: J, 0°, pl, sm, fe, stn
- 3.72m: J. 0°, pl, sm, fe, stn
- 3.82m: J. 40° pl, sm cl, inf
- 4.2m: CORE LOSS: 580mm
- 4.78m: J. 5° pl, sm, fe, stn
- 4.9m: J, 5°, pl, sm, fe, stn
- 5.05m: J, 5°pl, sm, fe, stn
- 5.47m: J, 15°, pl, sm, cly vn
- 5.83m: J, 0°, un, ro, fe, stn
- 6.12m: J, 0°, pl, sm, fe, stn
- 6.74m: J. 10°, pl, sm, fe, stn

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
S			5,4,3 N = 7
C	100	0	PL(A) = 13.09 FR Fragment tested
C	100	0	
C	100	0	
C	100	0	PL(A) = 4.19 PL(D) = 2.05 FR Fragment tested
C	72	0	PL(A) = 5.43 FR Fragment tested PL(D) = 4.01 PL(D) = 0.27
C	87	12	
C	50	0	PL(D) = 0.74
C	100	0	PL(D) = 0.19
C	100	34	PL(D) = 3.54 PL(D) = 1.25
C	100	0	
S			30/70mm
C	71	0	PL(D) = 0.04
C	100	0	
C	100	0	

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
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,	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

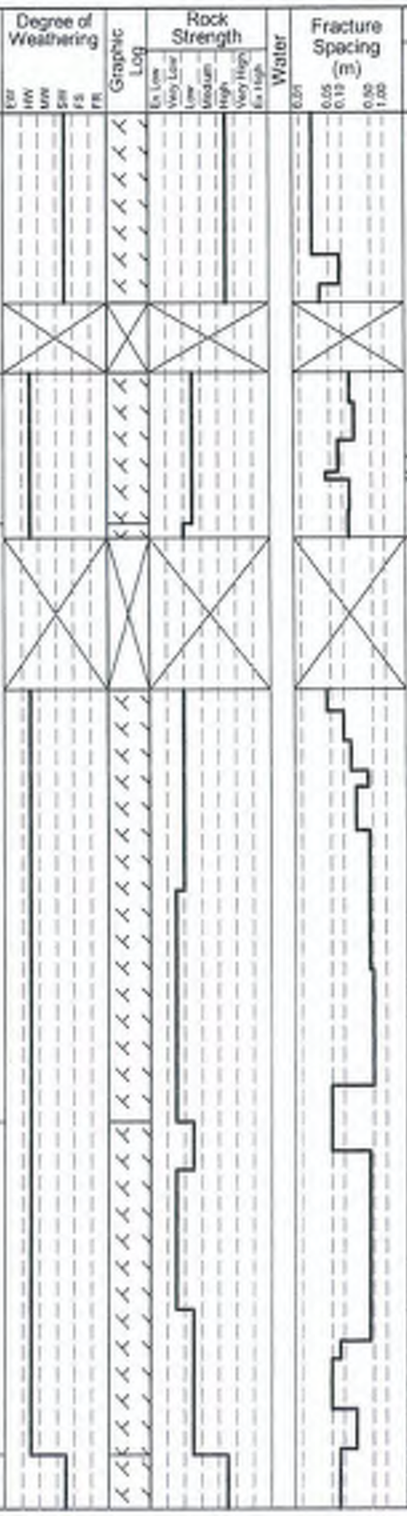
BOREHOLE LOG

CLIENT: Arcadis Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 2 OF 3

RL	Depth (m)	Description of Strata
		BASALT - high strength, slightly weathered, highly fractured grey basalt. Fractures typically 3 to 5mm thick
19		
	8	- core loss possibly corresponds with clay infill in highly fractured zone
	8.3	BASALT - low strength, highly weathered, fractured, grey and orange brown basalt
18		
	9 9.06	BASALTIC TEPHRA - very low to low strength, highly weathered, fractured, purple grey and orange brown basaltic tephra
17		
	9.89 10	
16		
	11	- very low strength, highly weathered below 10.9m depth
15		
	12 12.06	BASALT - very low and low strength, highly weathered, orange brown and grey basalt
14		
	13	
13		
	13.73	



Discontinuities

B - Bedding J - Joint
S - Shear F - Fault

7m: J, 0°, 5° and 90° pl, sm, cl inf
7.95m: CORE LOSS: 350mm
8.45m: J, 0°, pl, sm, st
8.64m: J, 0°, pl, sm, fe stn
8.72m: J, 5°, pl, sm, cl vn
8.8m: J, 0°, pl, sm, cly vn
8.84m: J, 5°, pl, sm, cly vn
9.13m: CORE LOSS: 760mm
9.94m: J, 0°, fl, sm
10.36m: J, 0°, pl, sm
10.88m: J, 45°, st, ro, fe, stn
11.34m: J, 0°, pl, sm
11.87m: J, 0°, st, rb
12.03m: J, 0° st, ro
12.2m: J, 0°, st, ro, un
12.28m: J, 0°, pl, sm
13.16m: J, 45°, pl, sm, fe, stn
13.21m: J, 0°, pl, sm, fe, stn
13.32m: J, 0°, ro, st, stn
13.36m: J, 0°, ro, fe, stn
13.43m: J, 0°, st, fe, stn
13.5m: J, 0°, pl, sm
13.7m: J, 0°, sm, fe, stn

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
C	100	0	PL(D) = 1.47
C	100	0	
C	100	21.5	PL(A) = 0.18 PL(D) = 0.06
C	8	8	
C	100	42	PL(A) = 0.12 PL(D) = 0.06
C	100	75	
C	100	100	PL(A) = 0.08 PL(D) = 0.02
C	100	78	PL(A) = 0.07 PL(D) = 0.05 PL(A) = 0.1 PL(D) = 0.13
C	100	56	PL(A) = 0.15 PL(D) = 0.15
C	100	41	PL(A) = 2.29 PL(D) = 1.65

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016
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,	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: Arcadis Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.62 AHD
EASTING: 528520
NORTHING: 6813177
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 90317
DATE: 30/5 - 1/6/2016
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering EW HW MW SW FS FR	Graphic Log	Rock Strength Ex Low, Very Low, Low, Medium, High, Very High, Ex High	Water	Fracture Spacing (m) 0.01 0.05 0.10 0.50 1.00	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
12		BASALT - high strength, slightly weathered then fresh stained, fractured, orange brown and grey basalt *(continued)*						13.74m: J, 5°, un, ro, fe, stn 13.84m: J, 0°, fc, sm 13.936m: J, 0°, pl 14.15m: J, 0°, ro, cly vn 14.29m: J, 5°, st, ro, fe, stn 14.36m: J, 0°, cn, ro, stn 14.41m: J, 0°, un, ro, 14.45m: 14.45m to 14.47m CZ	C C C	100 100	41 12	PL(A) = 1.61 PL(D) = 1.34 PL(D) = 0.77
	15 14.94 15.0	SILTY CLAY - stiff, dark grey and orange brown silty clay						14.54m: J, 45°, st, sm 14.6m: Cz 14.73m: J, 45°, st, stn, 14.81m: Cz 14.94m: J, 0°, st, sm, cly vn				PL(A) = 1.92 PL(D) = 1.55
11		BASALT - very high strength, fresh stained, sigihtly fractured to unbroken, dark grey basalt						15.05m: J, st, ro 15.45m: J, 45° V qtz	C	100	95	
	16							16.06m: J, 5°, vn, st				PL(A) = 4.14 PL(D) = 3.51
10								16.59m: J, 5°, pl, sm, cl, vln	C	100	100	
	17											
9												
	18											PL(A) = 3.51 PL(D) = 3.53
8								18.66m: J, 45° pl, sm	C	100	100	
	19											PL(A) = 3.24 PL(D) = 3.91
								19.22m: J, 0°, pl, sm				
7												
	20 20.05											PL(A) = 3.1 PL(D) = 3.43
		Bore discontinued at 20.05m. Target depth reched										
6												

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5

TYPE OF BORING: Auger to 1.5m, then NMLC coring to base of hole

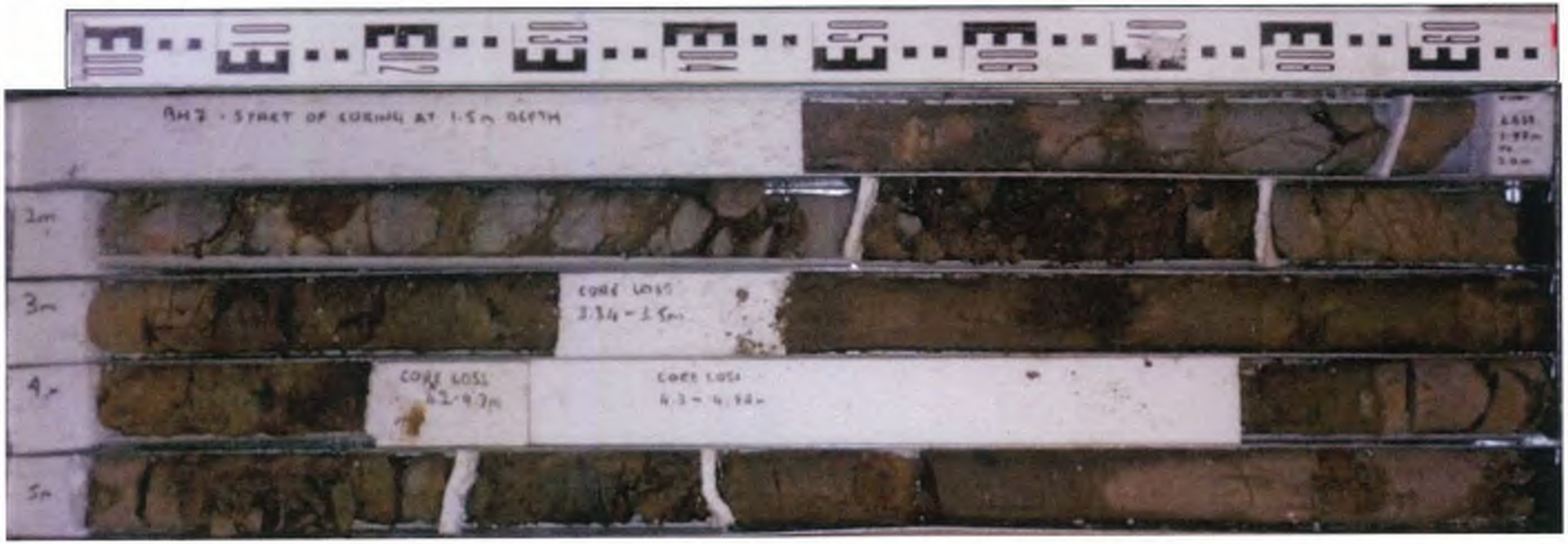
WATER OBSERVATIONS: Groundwater @ 5.68m depth when measured on 2 June 2016

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,	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 7 – 1.5 m to 6.0 m depth

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
	OFFICE:	Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	1
	DATE:	June 2016	**Little Uralba Street, Lismore**	REVISION:	0

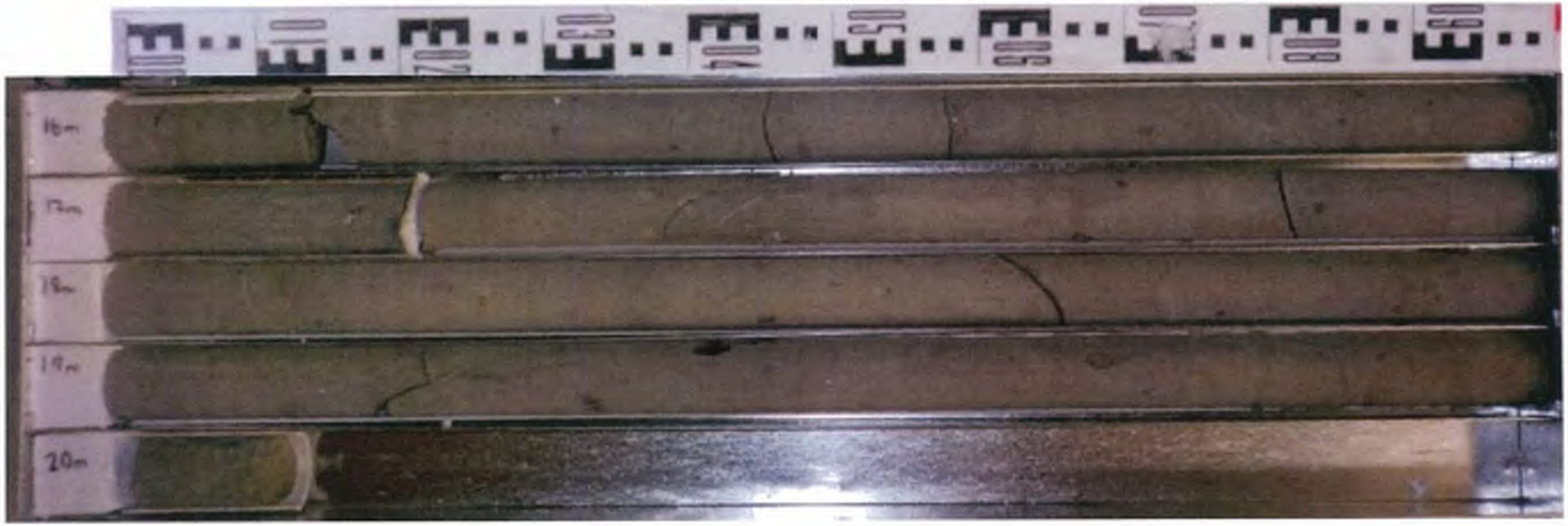
Borehole 7 – 6.0 m to 11.0 m depth

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
OFFICE: Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	2
DATE: June 2016	**Little Uralba Street, Lismore**	REVISION:	0

Borehole 7– 11.0 m to 16.0 m depth

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
	OFFICE:	Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	3
	DATE:	June 2016	**Little Uralba Street, Lismore**	REVISION:	0



Borehole 7– 16.0 m to 20.1 m depth

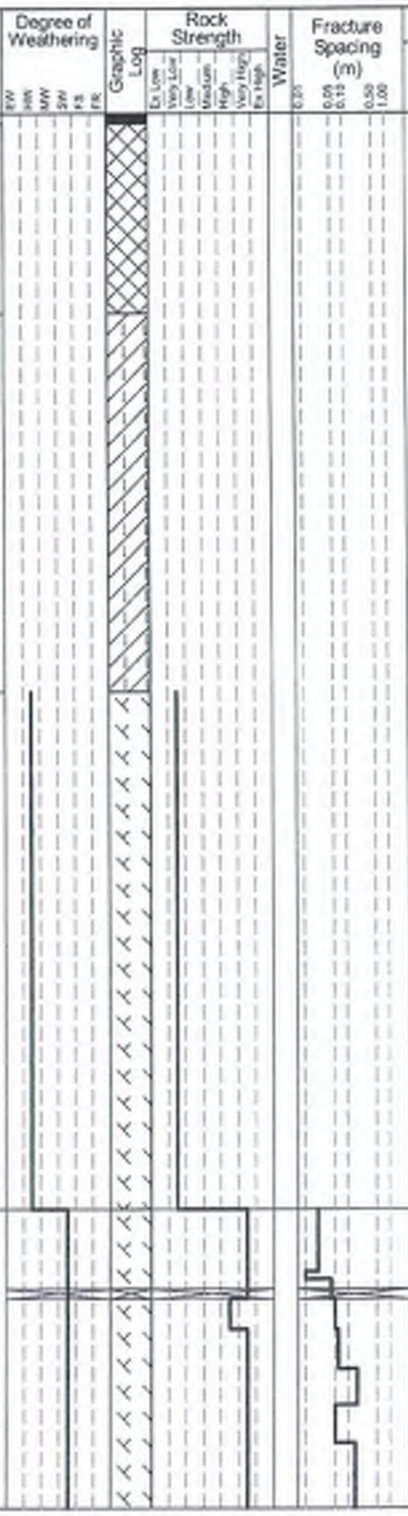
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
	OFFICE:	Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	4
	DATE:	June 2016	**Little Uralba Street, Lismore**	REVISION:	0

BOREHOLE LOG

CLIENT: Arcadis Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
SHEET 1 OF 3



Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
0.05	ASPHALT					
	FILLING - compact dark brown and grey sandy gravel with some clay filling		S			3,2,4 N = 6
1.0	SILTY CLAY - firm red brown silty clay, moist		A			
	- becoming stiff, yellow brown and red brown below 1.9m		S			8,7,7 N = 14
2.9	BASALT - very low strength, highly weathered, yellow brown orange brown and grey basalt		D			
			S			30/130mm
			D			PL(A) = 0.68
			S			30/30mm
5.5	BASALT - very high strength, slightly weathered, highly fractured grey basalt with abundant clay infilled fractures throughout	5.81m: crush zone 5.9m: CORE LOSS: 50mm	C	88	0	PL(D) = 4.39 Rock chips tested for point load
5.95	- interbedded very low and low strength, highly weathered, fractured, bands typically between 3mm and 50mm thick		C	100	0	PL(A) = 6.5 PL(D) = 4.75
		6.2m: high fractured 6.3m: J, 90°, un, ro, cl, vn 6.5m: J, 90°, st, ro, cl, vn	C	100	30	
		6.63m: J, 45°, pl, sm, cl, vn 6.74m: J, 30°, pl, sm, cl	C	100	21	PL(A) = 5.89 PL(D) = 4.45 PL(A) = 3.66

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5

TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole

WATER OBSERVATIONS: No groundwater observation possible

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: Arcadis Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
SHEET 2 OF 3

Depth (m)	Description of Strata
	- interbedded very low and low strength, highly weathered, fractured, bands typically between 3mm and 50mm thick *(continued)*
7.5	BASALT - medium strength, moderately weathered, highly fractured, grey basalt
8.56	BASALTIC TEPHRA - very low strength, highly weathered, fractured, purple grey basaltic tephra - pale grey orange brown and red brown below 10.25m - low strength, highly weathered and fractured below 11m
11.19	
11.37	BASALTIC TEPHRA - very stiff purple grey basaltic tephra - low strength, sligighly fractured below 11.8m depth - very low strength, fragmented and fractured below 12.05m depth
13.56	BASALT - medium strength, moderately weathered, fractured, grey and orange brown basalt with micro fractures throughout

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

6.78m: J, 0°, un, ro, cl, vn
6.89m: crush zone
6.97m: J, st, ro, cl, vn
7.07m: J, 30°, pl, sm, vn
7.15m: fragmented
7.4m: fragmented
8.2m: J, 0°, st, ro, cl
8.29m: high fractured
8.32m: J, 5° m, ro, cl
8.34m: J, 5°, pl, sm cln
8.47m: J, 0°, un, ro, cl, vn
8.53m: J, 0°, st, ro
8.6m: J, 45°, pl, sm
8.74m: J 45° st, ro, fe, stn
8.8m: fragmented
9.55m: fractured
9.56m: J, 45° pl, ro
9.85m: J, 0°, pl, sm
9.91m: J, 0°, st, vn, fe, stn
10.2m: J, 0°, un, rd, cl, vn
10.9m: J, 0°, pl, sm
11.07m: J, 5°, pl, sm
11.15m: J, 0°, un, ro, cl, vn
11.19m: CORE LOSS: 180mm
11.47m: J, 45°, un, ro, cl, vn
11.6m: J, 0°, un, ro, cl, vn
11.66m: J, 0°, un, ro, fe, stn
11.77m: J, 0° st, ro
11.79m: J, 0°, st, ro
12.23m: J, 0°, pl, sm
12.37m: J, 0°, st, ro
12.5m: J, 0°, ro, cl, vn
12.65m: fragmented
12.8m: J, 0° pl, sm, fe, stn
12.84m: J, 0° st, m,
12.91m: fragmented
13.27m: J, 20°, st, ro, vn
13.7m: J, 0°, pl, sm
13.78m: J, 0°, un, ro
13.85m: J, 0°, pl, sm

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
C	100	21	PL(D) = 1.08 PL(D) = 0.06
C	100	0	PL(D) = 0.18
C	100	0	PL(A) = 0.04 PL(D) = 0.08
P			pp=510kPa
C	100	85	PL(A) = 0.06 PL(D) = 0.01 PL(A) = 0.03 PL(D) = 0.02
C	82	20	PL(A) = 0.46 PL(D) = 0.21
P			pp=240kPa
C	100	78	
C	100	0	PL(A) = 0.13 PL(D) = 0.05
C	100	57	PL(A) = 0.15 PL(D) = 0.07

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole
WATER OBSERVATIONS: No groundwater observation possible
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,	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: Arcadis Pty Ltd
PROJECT: Proposed Maternity (3B2) Building
LOCATION: Little Uralba Street, Lismore

SURFACE LEVEL: 26.37 AHD
EASTING: 528492
NORTHING: 6813164
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 90317
DATE: 2 - 3/6/2016
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		BASALT - medium strength, moderately weathered, fractured, grey and orange brown basalt with micro fractures throughout (continued)	13.97m: J, 0° un, ro 14.04m: J, 0° st, ro 14.21m: J, 0°, pl, sm, fe, stn				PL(A) = 0.04
				C	100	0	PL(A) = 0.23
	14.61	BASALT - very high strength, fresh stained, slightly fractured, grey and orange brown basalt	14.76m: J, 0°, pl, sn 14.85m: J, 0°, pl, sn 14.88m: J, 0°, pl, sn 14.94m: J, 0°, pl, sm				PL(A) = 3.89 PL(D) = 0.92
	15						
11							PL(A) = 4.83 PL(D) = 1.32
			15.69m: J, 0°, pl, sn 15.74m: J, 0°, pl, sn				
	16		16.05m: J, 10°, pl, sn				PL(A) = 4.51 PL(D) = 1.57
10			16.31m: J, 5°, pl, sn				
			16.58m: J, 0°pl, sm	C	100	97	PL(A) = 5.16
	17						PL(A) = 1.44 PL(D) = 1.81
			17.2m: J, 0°st, ro				
9							
	18						PL(D) = 3.54
	18.1	Bore discontinued at 18.1m. Target depth reched					
8							
	19						
7							
	20						
6							

RIG: P160-Track Rig **DRILLER:** North Coast Drilling **LOGGED:** AS **CASING:** 2.5
TYPE OF BORING: Auger to 2.0m, then washbore to 5.5m depth and NMLC coring to the base of the hole
WATER OBSERVATIONS: No groundwater observation possible
REMARKS:

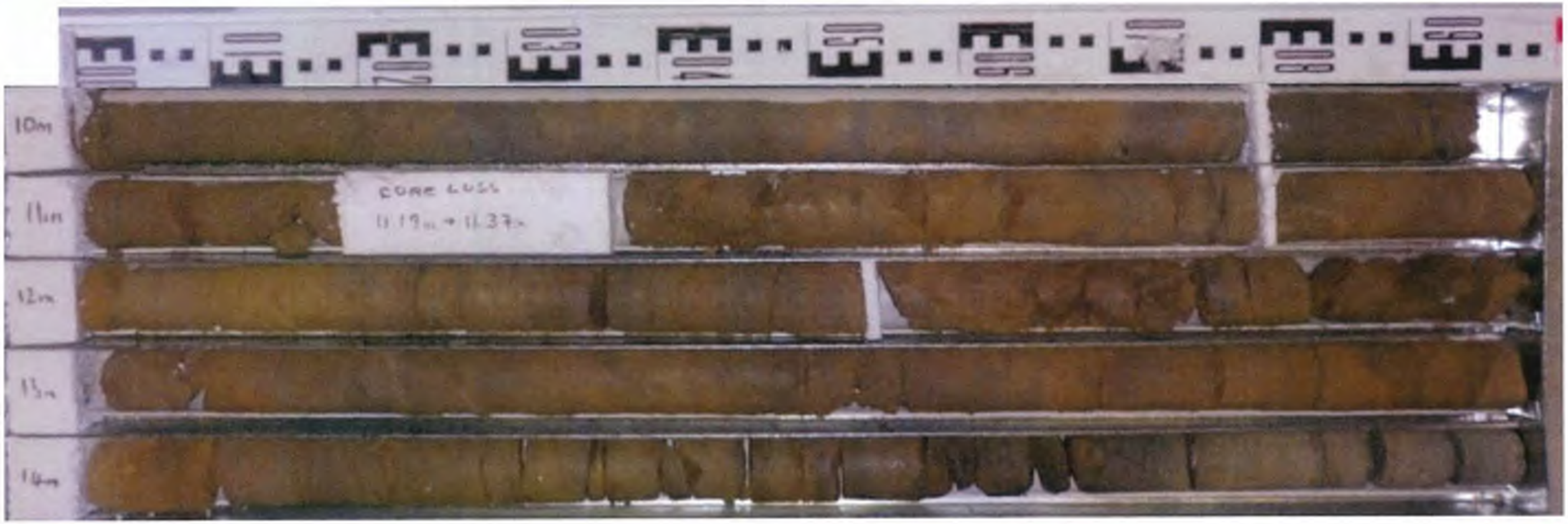
SAMPLING & IN SITU TESTING LEGEND

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 8 – 5.5 m to 10.0 m depth

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
	OFFICE:	Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	5
	DATE:	June 2106	**Little Uralba Street, Lismore**	REVISION:	0



Borehole 8 – 10.0 m to 15.0 m depth

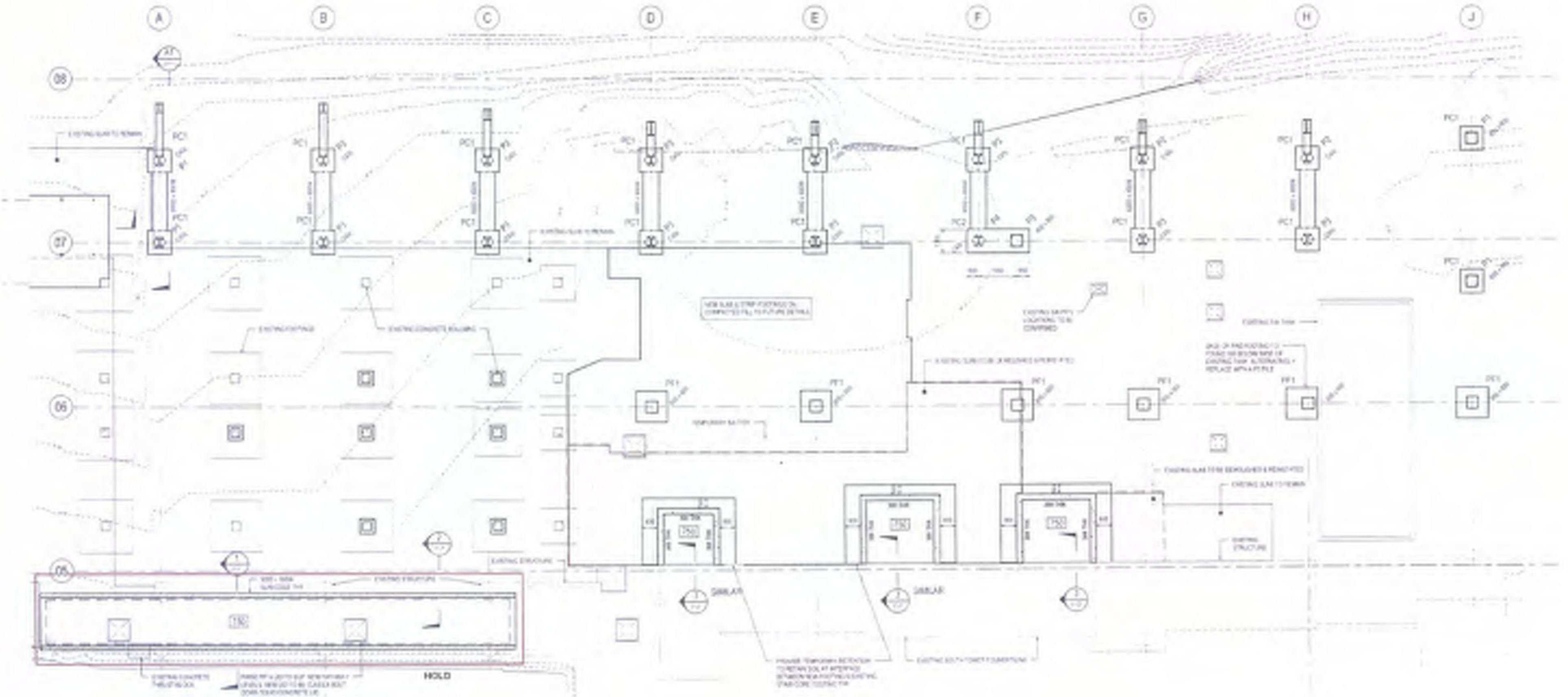
Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
	OFFICE:	Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	6
	DATE:	June 2106	**Little Uralba Street, Lismore**	REVISION:	0

Borehole 8– 15.0 m to 18.05 m depth

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Arcadis Pty Ltd	**Core Photographs**	PROJECT No:	90317.00
	OFFICE:	Gold Coast	**Proposed Maternity Ward Building (3B2)**	PLATE No:	7
	DATE:	June 2106	**Little Uralba Street, Lismore**	REVISION:	0

Appendix D

Arcadis Foundation Plan



LEVEL 3 LINK PASSAGE WAY

1. [illegible]
2. 150 DENOTES SLAB THICKNESS

FOUNDATION PLAN

1 : 100

1. [illegible]
2. FOOTINGS f'c = 40MPa U.N.O.
3. [illegible]
4. [illegible]
5. REINFORCEMENT RATE = 100kg/m³ FOR SLAB ON GRADE

FOOTING SCHEDULE

MARK	SIZE
PC1	[illegible]
PC2	[illegible]
PF1	[illegible]

PILE SCHEDULE

MARK	PILE DIA.	PILE REINF.	PILE f'c	[illegible]	[illegible]
P1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PILE SCHEDULE ALTERNATIVE (750 DIA.)

MARK	PILE DIA.	PILE REINF.	PILE f'c	[illegible]	[illegible]
P1	750	[illegible]	[illegible]	[illegible]	[illegible]
P2	750	[illegible]	[illegible]	[illegible]	[illegible]
P3	750	[illegible]	[illegible]	[illegible]	[illegible]
P4	750	[illegible]	[illegible]	[illegible]	[illegible]

STEEL COLUMN SCHEDULE

MARK	SIZE
[illegible]	[illegible]

RC COLUMN SCHEDULE

LEVEL	SIZE	REINFORCEMENT	f'c
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

PRELIMINARY

John Holland aurora NSW Health Infrastructure ARCADIS

REV	REVISION DESCRIPTION	DATE	APV
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	

CLIENT
HEALTH INFRASTRUCTURE

DRAWING
LEVEL 3 FOUNDATION PLAN

PROJECT
LISMORE BASE HOSPITAL STAGE 3B2

AA008927 DD 3B2_S101-NB D 1 : 100

Appendix E

Previous Borehole Logs

coffey geotechnics

Engineering Log - Borehole

Borehole No.	BH2
Sheet	1 of 4
Project No:	GEOTALST01618AN
Client:	NEW SOUTH WALES HEALTH INFRASTRUCTURE
Principal:	
Project:	LISMORE BASE HOSPITAL - NEW 11 FLOOR BUILDING
Borehole Location:	LANE N OF MORTUARY
Date started:	15.1.2013
Date completed:	16.1.2013
Logged by:	MH
Checked by:	

drill model and mounting:	MD100 Track	Easting:	528507.3	slope:	-90°	R.L. Surface:	27.46
hole diameter:	100 mm	Northing	6813166.7	bearing:		datum:	AHD, MGA

drilling information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
DT		C							FILL:CONCRETE				CONCRETE
ADT									FILL: Gravel, coarse, angular, trace clay.	>Wp			FILL
				Ex2 SPT 3,3,7 N*=10	27				FILL:CLAY, high plasticity, brown and dark grey, some gravel.				RODS ANGLED AWAY DURING SPT TEST - NOT REPRESENTATIVE
RR		M		Ex2	26	1			BASALT: Black, dark grey and dark brown, with gravel and clay seams.				EXTREMELY WEATHERED TO MODERATELY WEATHERED BASALT
			Water not observed	SPT 25/60mm N*=R	25 24 23 22 21 20	2 3 4 5 6 7 8			Borehole BH2 continued as cored hole				

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit
*bit shown by suffix	
e.g.	ADT

support

M mud N nil

C casing

penetration

1 2 3 4 no resistance ranging to refusal

water

10/1/98 water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

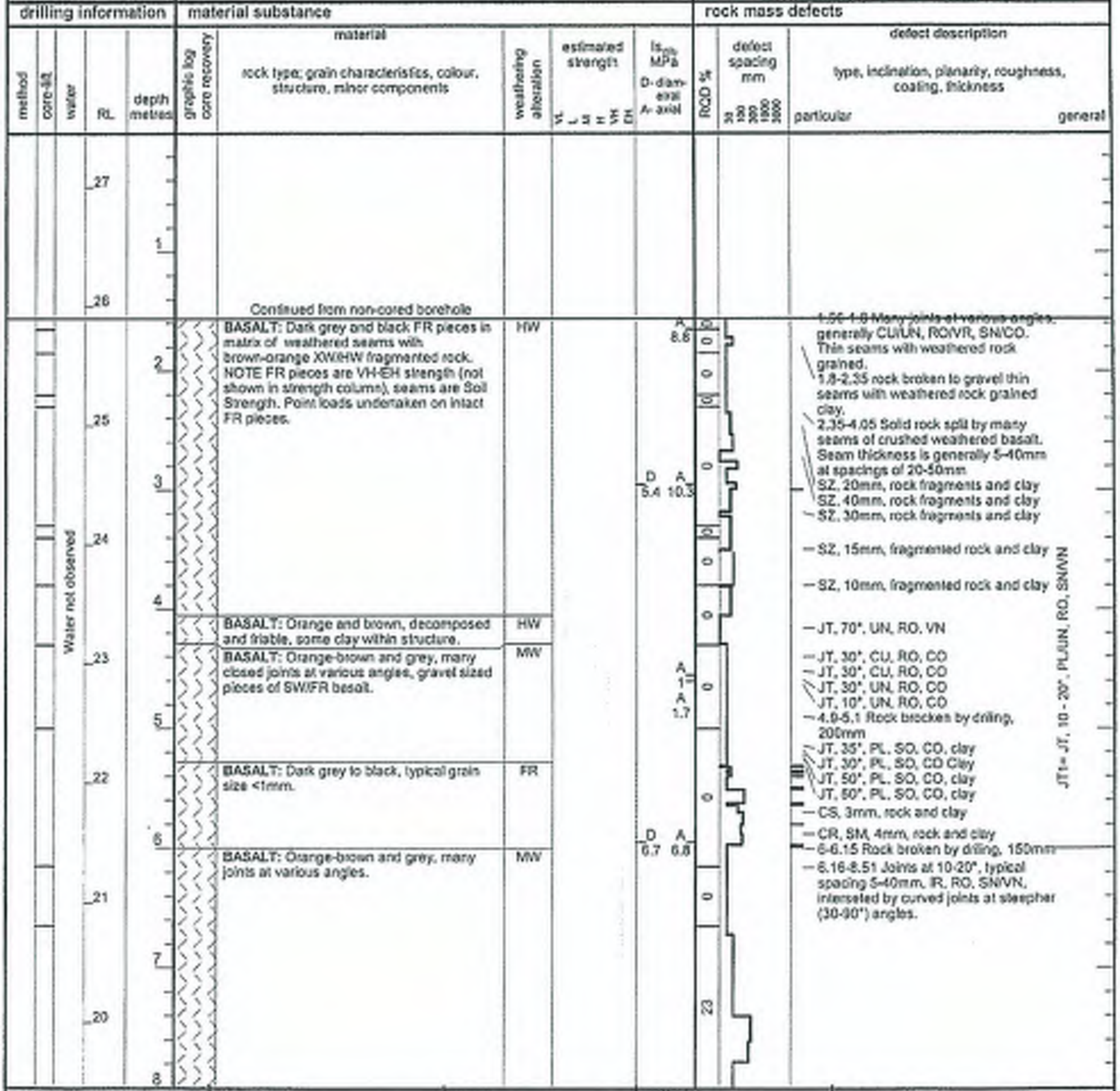
Engineering Log - Cored Borehole

Borehole No. **BH2**
Sheet 2 of 4
Project No: **GEOTALST01618AN**

Client: **NEW SOUTH WALES HEALTH INFRASTRUCTURE**
Principal:
Project: **LISMORE BASE HOSPITAL - NEW 11 FLOOR BUILDING**
Borehole Location: **LANE N OF MORTUARY**

Date started: **15.1.2013**
Date completed: **16.1.2013**
Logged by: **MH**
Checked by:

drill model & mounting: MD100 Track
hole diameter: 100 mm
Drilling fluid:
Easting: 528507.3
Northing: 6813106.7
slope: -90°
bearing:
R.L. Surface: 27.46
datum: AHD, MGA



Continued from non-cored borehole

material	weathering alteration	$Is_{(50)}$ MPa
BASALT: Dark grey and black FR pieces in matrix of weathered seams with brown-orange XW/HW fragmented rock. NOTE FR pieces are VH-EH strength (not shown in strength column), seams are Soil Strength. Point loads undertaken on intact FR pieces.	HW	A 8.8 D 5.4 A 10.3
BASALT: Orange and brown, decomposed and friable, some clay within structure.	HW	
BASALT: Orange-brown and grey, many closed joints at various angles, gravel sized pieces of SW/FR basalt.	MW	A 1 A 1.7
BASALT: Dark grey to black, typical grain size <1mm.	FR	D 6.7 A 6.8
BASALT: Orange-brown and grey, many joints at various angles.	MW	

Defect description (particular):

- 1.56-1.8 Many joints at various angles, generally CU/UN, RO/VR, SN/CO. Thin seams with weathered rock grained.
- 1.8-2.35 rock broken to gravel thin seams with weathered rock grained clay.
- 2.35-4.05 Solid rock split by many seams of crushed weathered basalt. Seam thickness is generally 5-40mm at spacings of 20-50mm
- SZ, 20mm, rock fragments and clay
- SZ, 40mm, rock fragments and clay
- SZ, 30mm, rock fragments and clay
- SZ, 15mm, fragmented rock and clay
- SZ, 10mm, fragmented rock and clay
- JT, 70°, UN, RO, VN
- JT, 30°, CU, RO, CO
- JT, 30°, CU, RO, CO
- JT, 30°, UN, RO, CO
- JT, 10°, UN, RO, CO
- 4.9-5.1 Rock brocken by driling, 200mm
- JT, 35°, PL, SO, CO, clay
- JT, 30°, PL, SO, CO Clay
- JT, 50°, PL, SO, CO, clay
- JT, 50°, PL, SO, CO, clay
- CS, 3mm, rock and clay
- CR, SM, 4mm, rock and clay
- 6-6.15 Rock broken by driling, 150mm
- 6.16-8.51 Joints at 10-20°, typical spacing 5-40mm, IR, RO, SN/VN, interseted by curved joints at steepher (30-90°) angles.

Defect description (general): JT1= JT, 10 - 20°, PL/UN, RO, SN/VN

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

coffey geotechnics

Engineering Log - Cored Borehole

Borehole No.	**BH2**
Sheet	3 of 4
Project No:	*GEOTALST01618AN*
Client:	*NEW SOUTH WALES HEALTH INFRASTRUCTURE*
Principal:	
Project:	*LISMORE BASE HOSPITAL - NEW 11 FLOOR BUILDING*
Borehole Location:	*LANE N OF MORTUARY*
Date started:	*15.1.2013*
Date completed:	*16.1.2013*
Logged by:	*MH*
Checked by:	

drill model & mounting:	MD100 Track	Easting:	528507.3	slope:	-90°
R.L. Surface:	27.46				
hole diameter:	100 mm	Drilling fluid:		Northing:	6813166.7
bearing:		datum:	AHD, MGA		

drilling information: method, core-lift, water, RL, depth metres — material substance: graphic log / core recovery; material (rock type; grain characteristics, colour, structure, minor components); weathering / alteration; estimated strength (VL L M H VH EH); $Is_{(50)}$ MPa (D- diametral, A- axial) — rock mass defects: RQD %; defect spacing mm (30 100 300 1000 3000); defect description (type, inclination, planarity, roughness, coating, thickness) particular / general

water: Water not observed

RL: 19, 18, 17, 16, 15, 14, 13, 12

depth metres: 9, 10, 11, 12, 13, 14, 15, 16

material	weathering alteration	$Is_{(50)}$ MPa	RQD %	defect description: particular
BASALT: Orange-brown and grey, many joints at various angles. (continued)	MW		23	
BASALT: Orange, orange-brown and dark grey, massive.	HW		0	JT, 10°, UN, SO, CO clay JT, 15°, UN, SO VN CLAY SM, 4mm, clay SM, 5mm, clay SM, 10mm, clay JT, 15°, PL, SO, CO CLAY JT, 60°, ST, SO, CO CLAY
TEPHRA: Purple-grey, red-brown and orange. As clay, high plasticity, hard consistency. Red-brown sections approaching very low rock strength.	XW HW XW		12	PP=<600 kPA PP=>500 kPa PP=>500 kPa PP=>600 kpa
TEPHRA: Orange with some purple-grey, approx. 10-20% as hard clay.	HW			XW SM, clay 40mm XW SM, hard clay 110mm
BASALT: Yellow-grey, brown and orange, grain size is typically <1mm.	HW		35	XW SM, CLAY 3mm XW SM, clay 3MM XW SM, CLAY 5mm XW SM, CLAY 5mm 13.54 to 13.65 rock broken to clay and gravel, 110mm XW SM, CLOY 5mm
BASALT: Dark grey and black, typical grain size <1mm.	FR	D 2.8 A 2.2	79	XW SM, CLAY 30MM XW SM, CLAY 4mm JT, 45°, UN, SO, CN

general: JT2= JT, 0 - 20°, UN, SO, VN-CO clay

CORED BOREHOLE 01618AN_LOGS_BH1_BH2_BH3.GPJ COFFEY.GDT 15.2.13

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

Form GEO 5.5 Issue 3 Rev. 3

coffey geotechnics

Engineering Log - Cored Borehole

Borehole No. *BH2*

Sheet 4 of 4

Project No: *GEOTALST01618AN*

Client: *NEW SOUTH WALES HEALTH INFRASTRUCTURE*

Principal:

Project: *LISMORE BASE HOSPITAL - NEW 11 FLOOR BUILDING*

Borehole Location: *LANE N OF MORTUARY*

Date started: *15.1.2013*

Date completed: *16.1.2013*

Logged by: *MH*

Checked by:

drill model & mounting: MD100 Track

hole diameter: 100 mm

Drilling fluid:

Easting: 528507.3

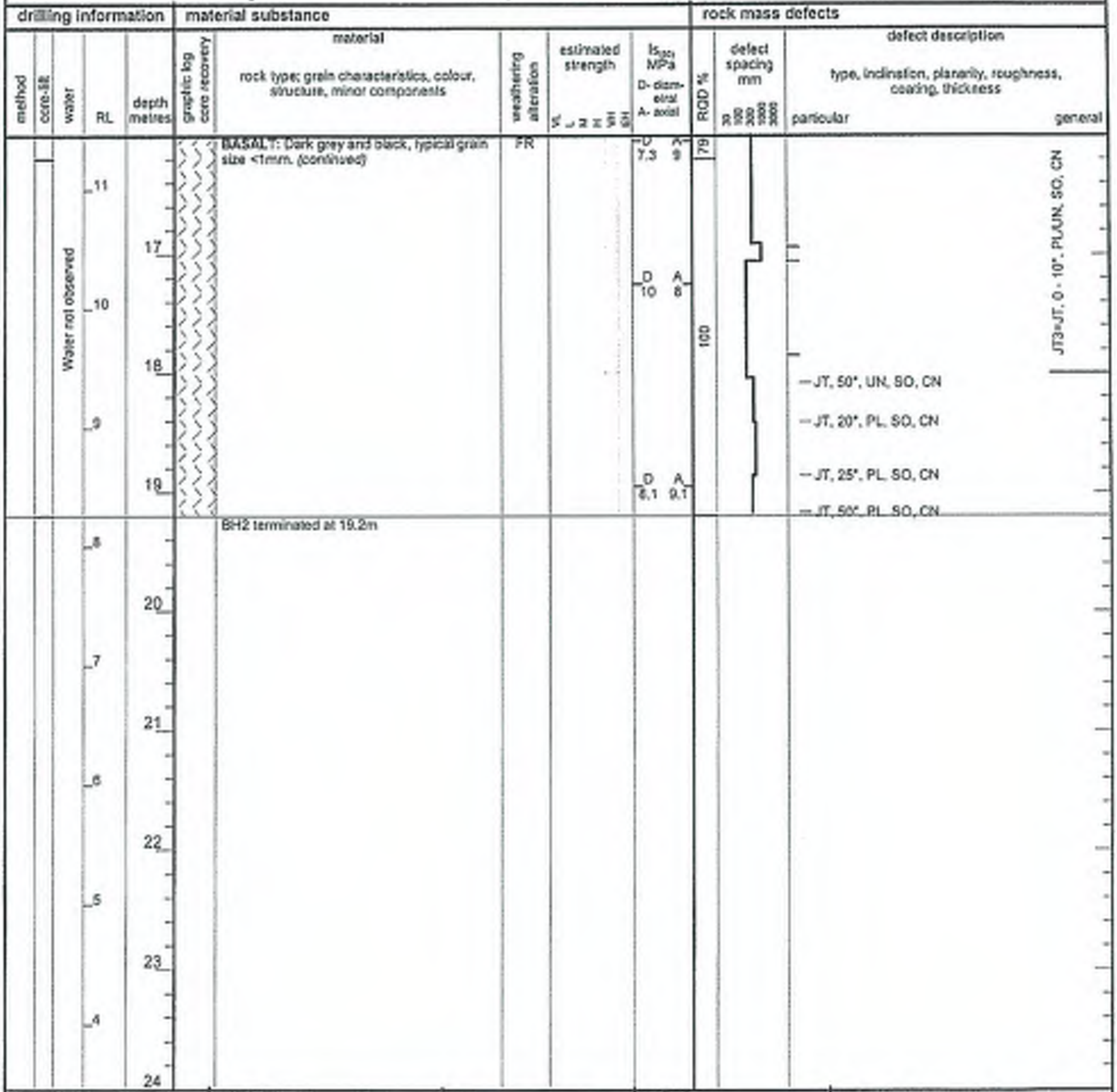
Northing: 6813166.7

slope: -90°

bearing:

R.L. Surface: 27.46

datum: AHD, MGA



BASALT: Dark grey and black, typical grain size <1mm. (continued)

JT3=JT, 0 - 10°, PL/UN, SO, CN

- JT, 50°, UN, SO, CN
- JT, 20°, PL, SO, CN
- JT, 25°, PL, SO, CN
- JT, 50°, PL, SO, CN

BH2 terminated at 19.2m

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

coating

CN	clean
SN	stained
VN	veneer
CO	coating

CORED BOREHOLE 01618AN_LOGS_BH1_BH2_BH3.GPJ COFFEY.GDT 15.2.13

Form GEO 5.5 Issue 3 Rev. 3

drawn	RV	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client	NEW SOUTH WALES HEALTH INFRASTRUCTURE
approved			project	LISMORE BASE HOSPITAL NEW 11 FLOOR STRUCTURE
date	2013.02.14		title	CORE PHOT[illegible]PHS - BH2
scale	NTS		project no: GEOTALST01618AN-AD	figure no: FIGURE 5
original size	A3			

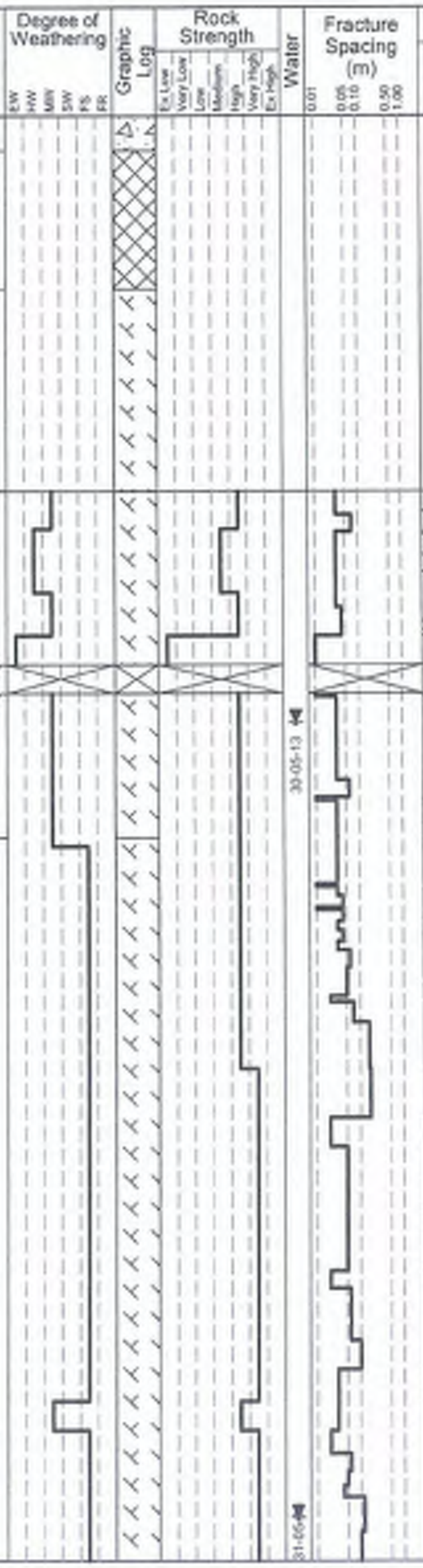
BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.09 AHD
EASTING: 528505
NORTHING: 6813142
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 80243.00
DATE: 28 - 29/5/2013
SHEET 1 OF 5

RL	Depth (m)	Description of Strata
31		CONCRETE
	0.12	FILLING - moderately well compacted, medium plasticity, brown sandy clay filling, medium to coarse grained sand fraction, with some silt, fine to medium grained gravel, with trace cobbles, moist
	0.6	BASALT - low strength, moderately weathered, highly fractured, dark grey basalt with clay infill, (drill cuttings recovered as clay and gravel)
30	1	
	1.3	BASALT - high strength, moderately weathered, highly fractured, dark grey basalt 220mm medium strength, highly weathered and fragmented zone - extremely low strength and extremely weathered
	1.9	CORE LOSS
29	2.0	- fractured, grey and brown with some clay seams <5mm to 40mm
	2.5	BASALT - very high strength, fresh stained, slightly fractured, dark grey basalt with some clay seams
28	3	- fractured
		- highly fractured
		- 15mm clay seam
27	4	- fractured, with a 20mm clay seam at 4 m
		- 4mm clay seam - 8mm clay seam - 100mm high strength, moderately weathered and fragmented zone
	5.0	



Discontinuities

B - Bedding J - Joint
S - Shear F - Fault

(see "Symbols & Abbreviations" sheet)

- 1.3m: to 1.38m: 3xJ, 30-45°
- 1.37m: J, 20°, un, sm, fe stn, & at 1.43m, 3.66m, 4.11m, 4.19m, 4.23m
- 1.44m: J, 30°, pl, sm, fe stn, & at 2m, 3.89m
- 1.45m: J, sv, un, cly inf 5mm, to 1.64m
- 1.52m: J, 45°, un, sm, cly inf 5mm
- 1.58m: J, 30°, un, sm, fe stn, & at 1.67m, 1.69m, 1.71m, 2.43m, 2.48m, 3.52m, 3.53m, 3.56m
- 1.75m: J, 45°, un, sm, fe stn
- 1.78m: 20mm cly seam
- 1.8m: els, ew zone to 1.9m
- 1.9m: CORE LOSS: 100mm
- 30° joints every 10-30mm to 2.3m
- 2.01m: J, sv, un, sm, fe stn, cly inf 5mm, to 2.2m
- 2.36m: J, 45°, pl, sm, fe stn, cly vn, & at 2.45m, 2.56m, 2.61m
- 2.37m: J, 10°, un, ro, fe stn
- every 1-50mm to 2.66m
- 2.49m: J, 60°, pl, sm, cly vn
- 2.67m: J, 30°, pl, sm, cly vn, & 2.7m, 2.74m, 2.79m, 2.86m, 2.89m, 2.95m
- 2.75m: J, sv, un, ro, fe stn, to 2.95m
- 2.82m: J, 30°, un, ro, fe stn, cly vn
- 3m: J, 45°, un, sm, cly vn, & at 3.05m
- 3.07m: J, 10°, un, sm, cly vn, & at 3.14m
- 3.3m: J, 60°, un, sm, fe stn
- 3.47m: J, 15°, ir, ro, fe stn
- 3.57m: J, sv, un, ro, fe stn, to 3.64m
- 3.58m: J, 45°, un, sm, fe stn, cly co

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
D			
D			
D			
S			30/90mm
C	100	0	
C	100	0	
C	93	10	
			PL(A) = 2.38 PL(D) = 2.29
C	100	22	
C	100	35	

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.0m

TYPE OF BORING: Concrete Core 0.0 m - 0.12 m, Auger 0.12 m - 1.09 m, Rotary Rock Roller 1.09 m - 1.3 m, NMLC Core 1.3 m - 20.9 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

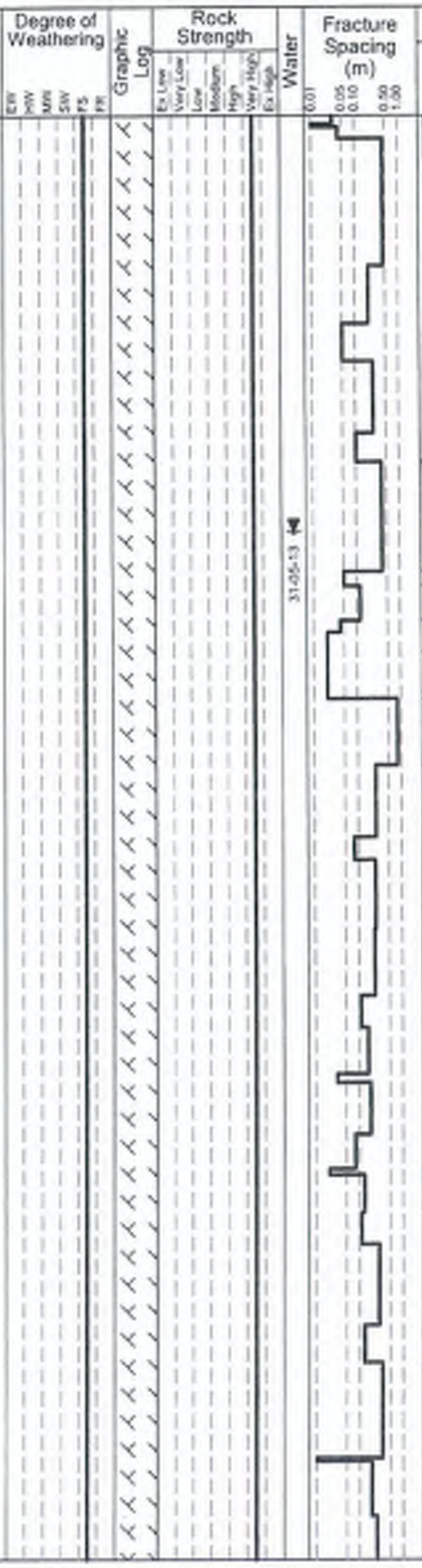
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.09 AHD
EASTING: 528505
NORTHING: 6813142
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 80243.00
DATE: 28 - 29/5/2013
SHEET 2 OF 5



RL	Depth (m)	Description of Strata	Discontinuities	Sampling & In Situ Testing			
			B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
26		BASALT (as before) - 3 x clay seams 10-30mm - slightly fractured	3.68m: J, 45°, pl, sm, fe stn, cly inf 15mm 3.76m: J, 45°, pl, sm, fe stn, cly inf 5mm 3.8m: J, 25°, un, sm, fe stn 3.85m: J, 45°, pl, sm, fe stn				
		- fractured	3.92m: J, 15°, un, sm, fe stn, & at 3.94m	C	100	35	
		- 40mm clay seam	4m: J, 20°, un, sm, fe stn, cly inf 20mm 4.01m: J, sv, un, sm, fe stn, to 4.12m 4.33m: J, 25°, un, sm, fe stn				
25	6		4.37m: J, 15°, un, sm, fe stn, cly inf 4mm 4.4m: J, 30°, pl, sm, cly inf 8mm 4.45m: 100mm fg zone, numerous J's 30-60° 6.2m: J, 20°, pl, sm, fe stn				
		- highly fractured	6.58m: J, 50°, pl, sm, cly vn 6.63m: J, 30°, pl, sm, fe stn, & at 6.8m, 6.94m	C	100	78	
24	7	- fractured	6.75m: J, 45°, pl, sm, fe stn, 6.87m, 6.91m 6.86m: J, 45°, un, ro, fe stn 7m: J. 45°, un, sm, fe stn 7.02m: J, 10°, ir, sm, fe stn 7.25m: J, 10°, un, sm, fe stn				
		- 20mm clay seam	7.59m: 20mm cly seam				
			7.82m: J, 10°, pl, sm, cly vn, 8.06m, 8.16m, 8.35m, 8.53m, 8.91m				
23	8						
			8.32m: J, 30°, pl, sm, cly vn				
							PL(A) = 8.58 PL(D) = 8.22
		- 20mm clay seam	8.65m: J, 45°, un, sm, cly vn 8.67m: J, 30°, un, sm, cly inf 20mm 8.8m: J, 15°, un, sm, cln	C	100	80	
22	9						
			9.19m: J, 15°, un, sm, cly inf 3mm 9.32m: J, sh, pl, sm, cly inf 5mm				
			9.65m: J, sv, un, sm, fe stn 9.66m: J, sh, un, sm, cly inf 3mm				
	10.0	- becoming slightly fractured		C	100	91	

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.0m

TYPE OF BORING: Concrete Core 0.0 m - 0.12 m, Auger 0.12 m - 1.09 m, Rotary Rock Roller 1.09 m - 1.3 m, NMLC Core 1.3 m - 20.9 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

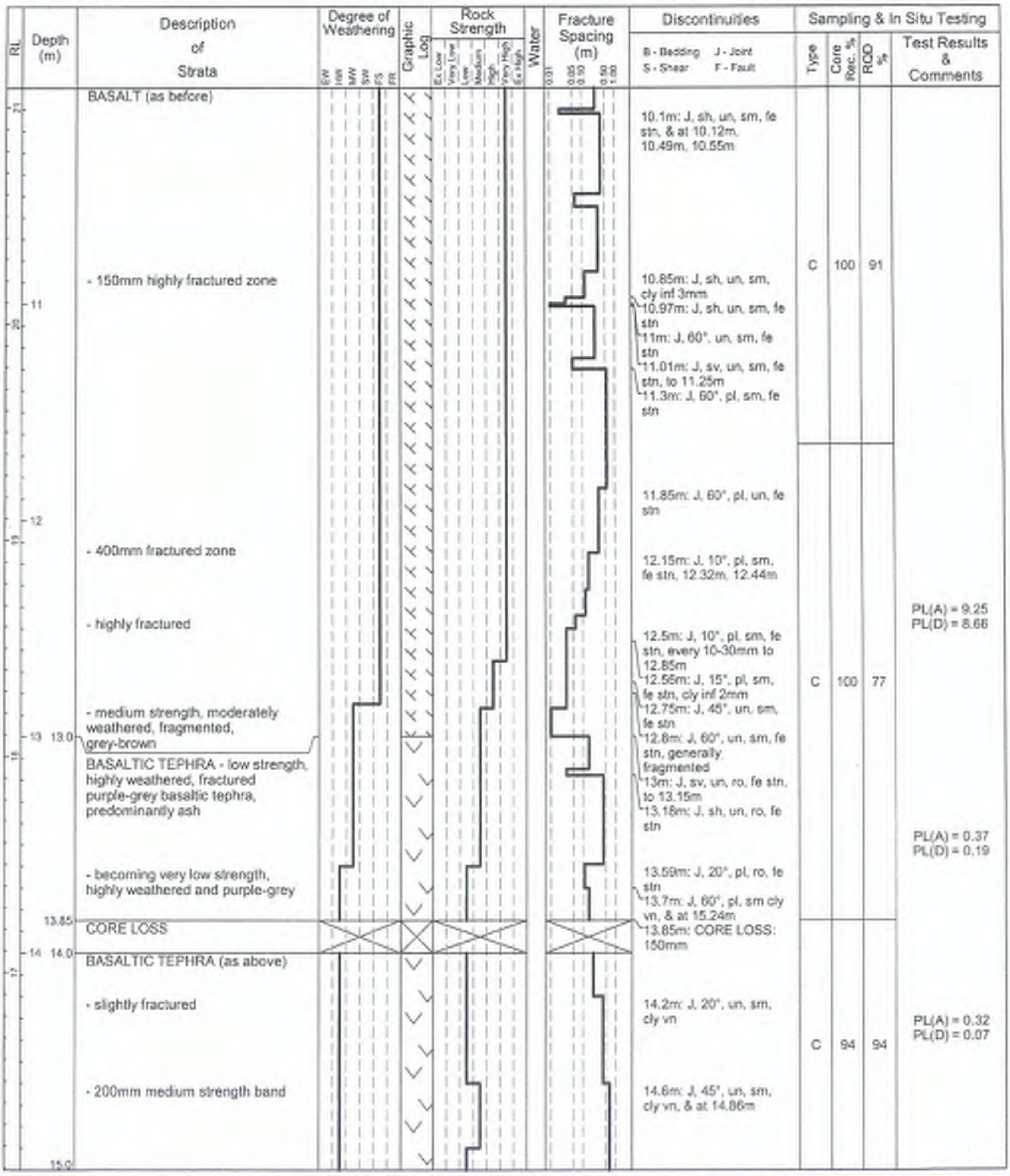
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.09 AHD
EASTING: 528505
NORTHING: 6813142
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 80243.00
DATE: 28 - 29/5/2013
SHEET 3 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
21		BASALT (as before)	10.1m: J, sh, un, sm, fe stn, & at 10.12m, 10.49m, 10.55m				
20	11	- 150mm highly fractured zone	10.85m: J, sh, un, sm, cly inf 3mm 10.97m: J, sh, un, sm, fe stn 11m: J, 60°, un, sm, fe stn 11.01m: J, sv, un, sm, fe stn, to 11.25m 11.3m: J, 60°, pl, sm, fe stn	C	100	91	
19	12	- 400mm fractured zone	11.85m: J, 60°, pl, un, fe stn 12.15m: J, 10°, pl, sm, fe stn, 12.32m, 12.44m				
		- highly fractured					PL(A) = 9.25 PL(D) = 8.66
		- medium strength, moderately weathered, fragmented, grey-brown	12.5m: J, 10°, pl, sm, fe stn, every 10-30mm to 12.85m 12.56m: J, 15°, pl, sm, fe stn, cly inf 2mm 12.75m: J, 45°, un, sm, fe stn 12.8m: J, 60°, un, sm, fe stn, generally fragmented 13m: J, sv, un, ro, fe stn, to 13.15m 13.18m: J, sh, un, ro, fe stn	C	100	77	
18	13 13.0	BASALTIC TEPHRA - low strength, highly weathered, fractured purple-grey basaltic tephra, predominantly ash					PL(A) = 0.37 PL(D) = 0.19
		- becoming very low strength, highly weathered and purple-grey	13.59m: J, 20°, pl, ro, fe stn 13.7m: J, 60°, pl, sm cly vn, & at 15.24m				
	13.85	CORE LOSS	13.85m: CORE LOSS: 150mm				
17	14 14.0	BASALTIC TEPHRA (as above)					
		- slightly fractured	14.2m: J, 20°, un, sm, cly vn	C	94	94	PL(A) = 0.32 PL(D) = 0.07
		- 200mm medium strength band	14.6m: J, 45°, un, sm, cly vn, & at 14.86m				
	15.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.0m

TYPE OF BORING: Concrete Core 0.0 m - 0.12 m, Auger 0.12 m - 1.09 m, Rotary Rock Roller 1.09 m - 1.3 m, NMLC Core 1.3 m - 20.9 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

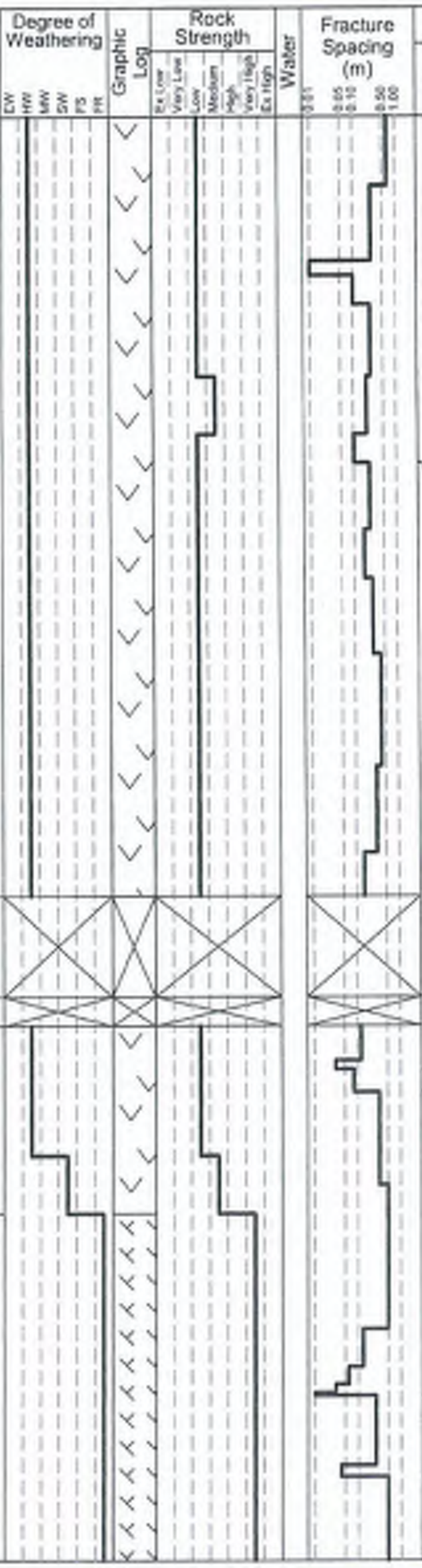
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.09 AHD
EASTING: 528505
NORTHING: 6813142
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 80243.00
DATE: 28 - 29/5/2013
SHEET 4 **OF** 5



RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
16		BASALTIC TEPHRA (as before)	15.24m: J, 60°, pl, sm, cly vn 15.5m: J, 75°, un, sm, cly vn, fg 50mm 15.65m: J, 65°, pl, sm, cly vn	C	94	94	
15	16	- becoming blue-grey, locally low strength, predominantly volcanic bombs with ash layers	15.9m: J, 15°, pl, sm, cly vn 16.1m: J, 65°, pl, sm, cly vn 16.2m: J, 25°, un, sm, cly vn				
14	17	- fractured	16.43m: J, 65°, un, sm, cly vn 16.6m: J, 55°, pl, sm, cly vn 16.86m: J, 45°, un, sm, cly vn 17.25m: J, 10°, un, sm, cly vn 17.55m: J, 65°, un, sm, cly vn	C	80	79	PL(A) = 0.1 PL(D) = 0.17
	17.7	CORE LOSS	17.7m: CORE LOSS: 350mm				
13	18 18.05	CORE LOSS	18.05m: CORE LOSS: 100mm				
	18.15	BASALTIC TEPHRA (as above) - medium strength and slightly weathered	18.27m: J, 30°, pl, sm, cly vn 18.3m: J, 35°, un, sm, cly vn 18.38m: J, 20°, un, sm, cly vn, 18.44m 18.7m: J, 20°, un, sm, cln				PL(A) = 6.68 PL(D) = 7.22
12	18.8 19	BASALT - very high stength, fresh, slightly fractured, grey basalt	19.2m: J, 20°, ir, sm, cln 19.33m: J, 10°, pl, sm, cly vn, 19.39m, 19.42m 19.43m: J, 30°, pl, sm, cln 19.67m: J, 10°, pl, sm, cln 19.71m: J, 20°, pl, sm, cln, & at 19.75m	C	96	89	
	20.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.0m

TYPE OF BORING: Concrete Core 0.0 m - 0.12 m, Auger 0.12 m - 1.09 m, Rotary Rock Roller 1.09 m - 1.3 m, NMLC Core 1.3 m - 20.9 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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)

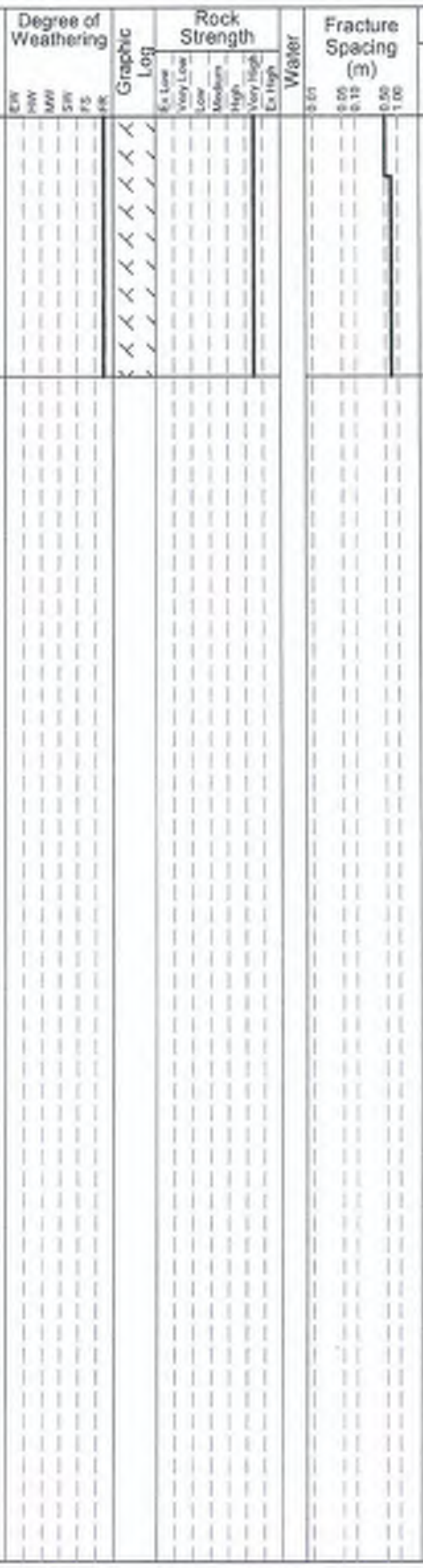
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.09 AHD
EASTING: 528505
NORTHING: 6813142
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 80243.00
DATE: 28 - 29/5/2013
SHEET 5 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
11		BASALT (as before)	20.21m: J, 10°, pl, sm, cln, & at 20.55m	C	96	89	
10	20.9 21	Bore discontinued at 20.9m					
9	22						
8	23						
7	24						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.0m

TYPE OF BORING: Concrete Core 0.0 m - 0.12 m, Auger 0.12 m - 1.09 m, Rotary Rock Roller 1.09 m - 1.3 m, NMLC Core 1.3 m - 20.9 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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)

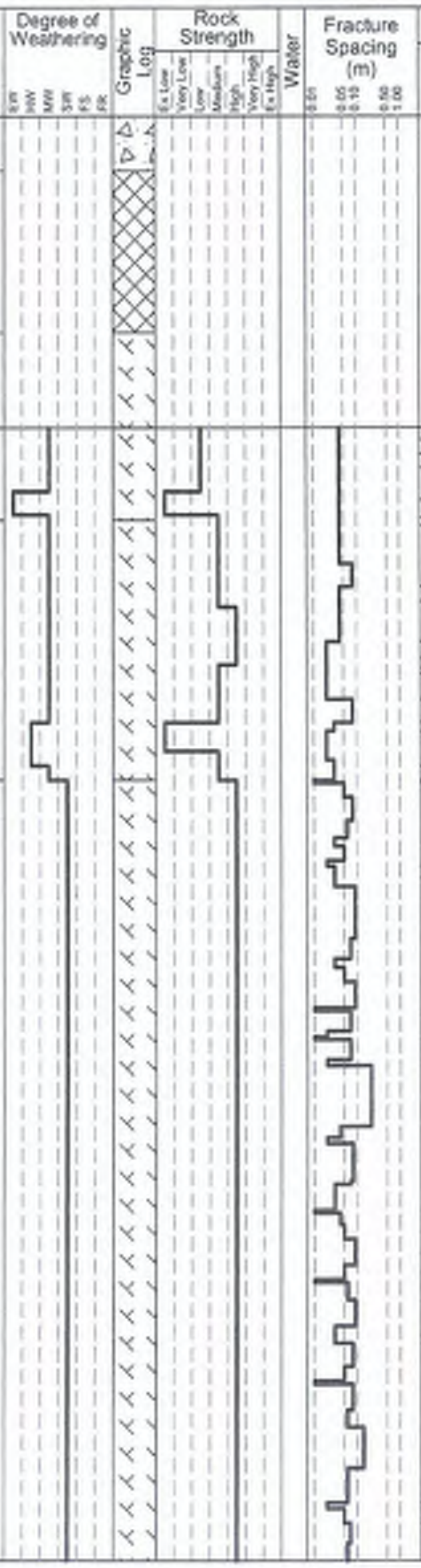
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 30.7 AHD
EASTING: 528525
NORTHING: 6813158
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 80243.00
DATE: 31/5/2013
SHEET 1 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		CONCRETE					
30	0.19	FILLING - well compacted grey-brown clayey gravel filling, fine to medium grained gravel fraction with some medium to coarse grained sand, moist	(see "Symbols & Abbreviations" sheet)	D D D			
	0.75	BASALT - very low strength, highly weathered grey-brown basalt		D S			30/80mm
	1.08	BASALT - low strength, moderately weathered, highly fractured, brown-grey basalt, with some claye filled fractures (up to 40 mm)	1.08m: J, sv, un, sm, fe stn, cly inf 3mm, to 1.22m 1.12m: J, 10°, un, sm, fe stn, & at 1.29m, 2.23m, 3.27m, 4.1m, 4.19m, 4.33m, 4.38m, 4.39m, 4.54m, 4.94m	C	100	0	
29	1.4	BASALT - medium to high strength, moderately weathered, highly fractured, grey basalt with 100mm band of extremely low strength basalt at 2.1m and some micro fractures	1.17m: J, 20°, un, sm, fe stn, & at 2.53m, 3.79m, 3.8m 1.22m: J, 60°, pl, sm, fe stn 1.33m: J, 10°, pl, sm, fe stn, cly inf 40mm 1.39m: J, 10°, pl, sm, fe stn, cly inf 3mm, & at 1.46m, 1.55m				
28 27 26	2.3	BASALT - high strength, slightly weathered, highly fractured, grey-brown basalt, with tight micro fractures to 3.8m (0.01-0.03 spacing)	1.42m: J, 60°, un, sm, fe stn 1.63m: J, 80°, pl, sm, fe stn, cly inf 3mm 1.68m: J, 20°, pl, sm, fe stn, & at 1.74m, 1.79m 1.82m: J, 30°, pl, sm, fe stn, cly vn 1.88m: J, 10°, pl, sm, fe stn, cly inf 20mm 1.91m: J, sv, un, sm, cly inf 5mm, to 2.2m 1.93m: J, 10°, pl, sm, fe stn, & at 2.58m, 3.54m, 3.69m, 3.76m, 3.84m, 3.89m 2.02m: J, 20°, pl, sm, fe stn 2.1m: J, 45°, pl, sm, fe stn, & at 2.76m, 2.44m, 2.5m, 4.48m, 4.6m, 7.15m 2.13m: J, 10°, pl, sm, fe stn, cly inf 30mm 2.25m: J, 65°, pl, sm, fe stn 2.3m: J, 25°, pl, sm, fe stn, & at 2.36m 2.31m: J, sv, un, sm, fe stn, cly vn, to 2.6m 2.6m: J, 30°, pl, sm, fe stn, & at 3.19m, 4.03m, 4.04m, 4.68m 2.64m: J, 30°, un, sm, fe stn, & at 2.67m, 2.85m, 2.92m, 2.95m, 3m, 3.09m, 3.17m 3.1m: J, sv, un, sm, cly inf 10mm, to 3.65m 3.2m: J, 10°, pl, sm, cly	C C	100 100	0 23	PL(A) = 0.58 PL(D) = 0.22 Point load test failed on pre-existing defect
	5.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.1m

TYPE OF BORING: Concrete Core 0.0 m - 0.19 m, Auger 0.19 m - 1.12 m, NMLC Core 1.12 m - 20.80 m

WATER OBSERVATIONS: No free groundwater encountered

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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)

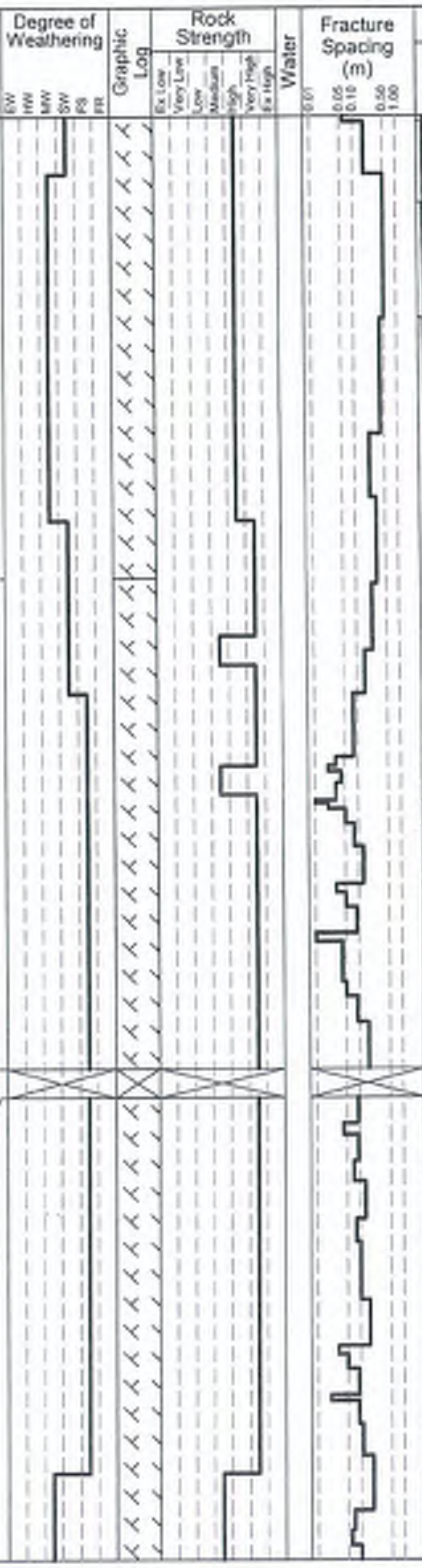
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 30.7 AHD
EASTING: 528525
NORTHING: 6813158
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 80243.00
DATE: 31/5/2013
SHEET 2 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Sampling & In Situ Testing Type	Core Rec. %	RQD %	Test Results & Comments
		BASALT (as before)	inf 3mm 3.29m: J, 35°, un, sm, fe stn 3.5m: J, 45°, un, sm, fe stn	C	100	23	
25	6	- sub-vertical (80°) joint with 8mm clay infill to 6.6m, moderately weathered	3.98m: J, 60°, pl, sm, fe stn 4.22m: J, 20°, pl, sm, fe stn 4.25m: J, 30°, ir, sm, fe stn 4.74m: J, 50°, pl, sm, fe stn 4.8m: J, 45°, ir, sm, fe stn 4.82m: J, 30°, un, sm, fe stn, & at 6.1m 4.87m: J, 10°, pl, sm, fe stn, & at 6.32m, 6.62m, 6.85m, 7m, 7.07m 5.02m: J, 50°, un, sm, fe stn 5.3m: J, sv, un, sm, fe stn, cly inf 8mm, to 6.6m				
24	6.6	BASALT - very high strength, slightly weathered, fractured grey-brown basalt - 100 mm medium strength band	5.7m: J, 30°, pl, sm, fe stn, & at 7.22m, 7.25m, 7.4m	C	100	52	PL(A) = 0.31 PL(D) = 0.19 Point load test failed on pre-existing defect
	7	- fresh stained					
		- 100 mm medium strength band, highly fractured	7.27m: J, 55°, un, sm, fe stn 7.31m: J, 10°, pl, sm, fe stn, cly vn, & at 7.34m 7.37m: J, 80°, un, sm, fe stn 7.38m: J, 10°, pl, sm, fe stn, & at 7.53m, 7.69m, 8.49m, 8.53m, 8.69m, 8.9m, 11.07m 7.45m: J, 10°, un, sm, fe stn, cly inf 5mm 7.66m: J, 40°, un, sm, fe stn				
23	8	- fractured					PL(A) = 7.23 PL(D) = 6.49
	8.3	CORE LOSS - possibly occured at 10.2m	8.3m: CORE LOSS: 100mm				
22	8.4	BASALT (as before)	8.62m: J, 35°, pl, sm, fe stn, cly inf 10mm 8.82m: J, 30°, un, sm, fe stn, & at 9m, 9.34m, 9.45m				
	9		9.1m: J, 10°, pl, sm, cly 5mm, & at 9.26m, 9.29m	C	95	31	
21		- medium strength, moderately weathered	9.43m: J, sh, un, sm, fe stn 9.54m: J, 10°, un, sm, fe stn, & at 9.64m, 10.62m, 10.7m, 13m 9.63m: J, 45°, un, sm, fe stn, & at 9.68m, 9.72m 9.83m: J, 60°, un, sm, fe				
	10.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.1m

TYPE OF BORING: Concrete Core 0.0 m - 0.19 m, Auger 0.19 m - 1.12 m, NMLC Core 1.12 m - 20.80 m

WATER OBSERVATIONS: No free groundwater encountered

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

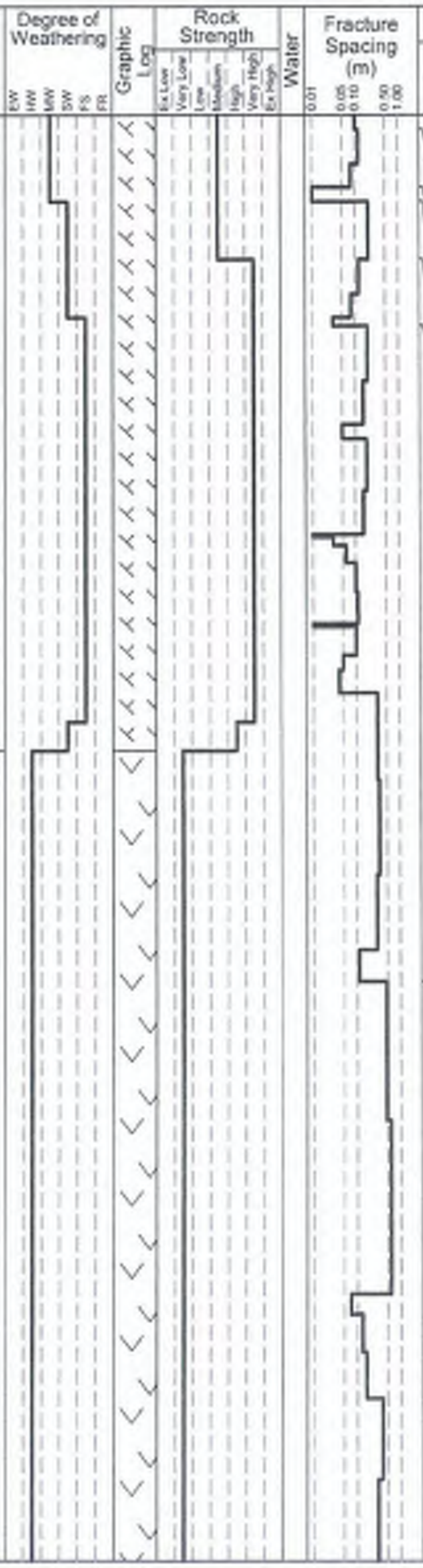
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 30.7 AHD
EASTING: 528525
NORTHING: 6813158
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 80243.00
DATE: 31/5/2013
SHEET 3 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		BASALT (as before)	stn, & at 9.9m, 9.95m, 10.17m 10.05m: J, sv , un, sm, fe stn, cly inf 4mm, to 10.4m	C	95	31	
		- slightly weathered	10.25m: J, 45°, un, sm, fe stn, fg 50mm 10.3m: J, sv, un, sm, fe stn, cly inf 3mm, to 10.64m				
		- very high strength and fresh stained	10.5m: J, 45°, ir, sm, fe stn 10.73m: J, 20°, un, sm, fe stn, & at 10.92m				
20							
	11						
			11.12m: J, 15°, pl, sm, fe stn				
			11.3m: J, 5°, un, sm, fe stn, & at 11.45m, 11.46m, 11.49m, 11.55m, 11.65m, 11.76m, 11.77m, 11.87m, 11.92m, 11.96m, 12m	C	100	70	
19			12.0m - numerous tight defects, fe stn, most 5-15°, pl, some at 45° and 60°				PL(A) = 6.69 PL(D) = 9.03
	12						
	12.2	- high strength and slightly weathered					
		BASALTIC TEPHRA - very low strength, highly weathered, slightly fractured, purple grey and orange-brown basaltic tephra, predominantly ash	12.3m: J, 30°, un, sm, fe stn, & at 12.63m				
18							PL(A) = 0.05 PL(D) = 0.16
	13		12.89m: J, 30°, pl, sm, fe stn 13m: J, 10°, un, sm, fe stn				
							PL(A) = 0.08 PL(D) = 0.16
			13.48m: J, 30°, un, sm, fe stn				
17				C	100	98	
	14	- becoming red-brown, fractured					
			14.08m: J, 40°, pl, sm, cly vn, & at 14.15m, 14.28m, 14.4m, 14.72m				PL(A) = 0.12 PL(D) = 0.08
16							
	15.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.1m

TYPE OF BORING: Concrete Core 0.0 m - 0.19 m, Auger 0.19 m - 1.12 m, NMLC Core 1.12 m - 20.80 m

WATER OBSERVATIONS: No free groundwater encountered

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 30.7 AHD
EASTING: 528525
NORTHING: 6813158
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 80243.00
DATE: 31/5/2013
SHEET 4 OF 5

RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		BASALTIC TEPHRA (as before)	15.02m: J, 45°, pl, sm, cly vn	C	100	98	PL(A) = 0.18 PL(D) = 0.24
	15.2	CORE LOSS	15.2m: CORE LOSS: 150mm				
	15.35	BASALTIC TEPHRA - very low strength, moderately weathered, slighly fractured, blue-green basaltic tephra, alternating ash layers with some volcanic bombs					
15							
			15.8m: J, 10°, un, sm, cly vn, & at 16.32m, 16.63m, 16.66m	C	90	85	
	16						
							PL(A) = 0.14 PL(D) = 0.07
		- fractured					
14							
			16.77m: J, 10°, pl, sm, cf inf 20mm, & at 17.05m 16.82m: J, 10°, pl, sm, cly vn, & at 16.85m, 17.28m, 18.50m, 18.53m				
	17						
							PL(A) = 0.21 PL(D) = 0.04
			17.4m: J, 20°, pl, sm, cly vn, & at 17.48m, 17.53m, 17.57m, 17.73m, 17.94m, 18.05m, 18.17m, 18.19m, 18.23m 17.64m: J, 30°, pl, sm, cly vn, & at 17.87m, 18.35m				
13		- low strength and slightly weathered					
	18			C	100	72	
		- high strength, predominantly volcanic bombs					
			18.27m: J, 45°, pl, sm, cly inf 4mm 18.37m: J, 50°, pl, sm, cly vn				
							PL(A) = 1.99 PL(D) = 0.59
12							
			18.82m: J, 40°, pl, sm, cly vn 18.85m: J, sv, un, sm, cly inf 3mm to 19.00m				
	19						
			19.12m: J, 10°, pl, sm, cly vn 19.15m: J, sv, un, sm, cly vn to 19.60m 19.3m: J, 60°, pl, sm, cln				
	19.3	BASALT - very high strength, fresh, slightly fractured, grey basalt					
				C	100	100	
11							
	20.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.1m

TYPE OF BORING: Concrete Core 0.0 m - 0.19 m, Auger 0.19 m - 1.12 m, NMLC Core 1.12 m - 20.80 m

WATER OBSERVATIONS: No free groundwater encountered

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 30.7 AHD
EASTING: 528525
NORTHING: 6813158
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 80243.00
DATE: 31/5/2013
SHEET 5 OF 5

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
		BASALT (as before)						20.38m: J, 10°, pl, sm, cln 20.68m: J, 45°, un, sm, cln	C	100	100	PL(A) = 4.12 PL(D) = 6.07
	20.8	Bore discontinued at 20.8m										
	21											
	22											
	23											
	24											

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 1.1m

TYPE OF BORING: Concrete Core 0.0 m - 0.19 m, Auger 0.19 m - 1.12 m, NMLC Core 1.12 m - 20.80 m

WATER OBSERVATIONS: No free groundwater encountered

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

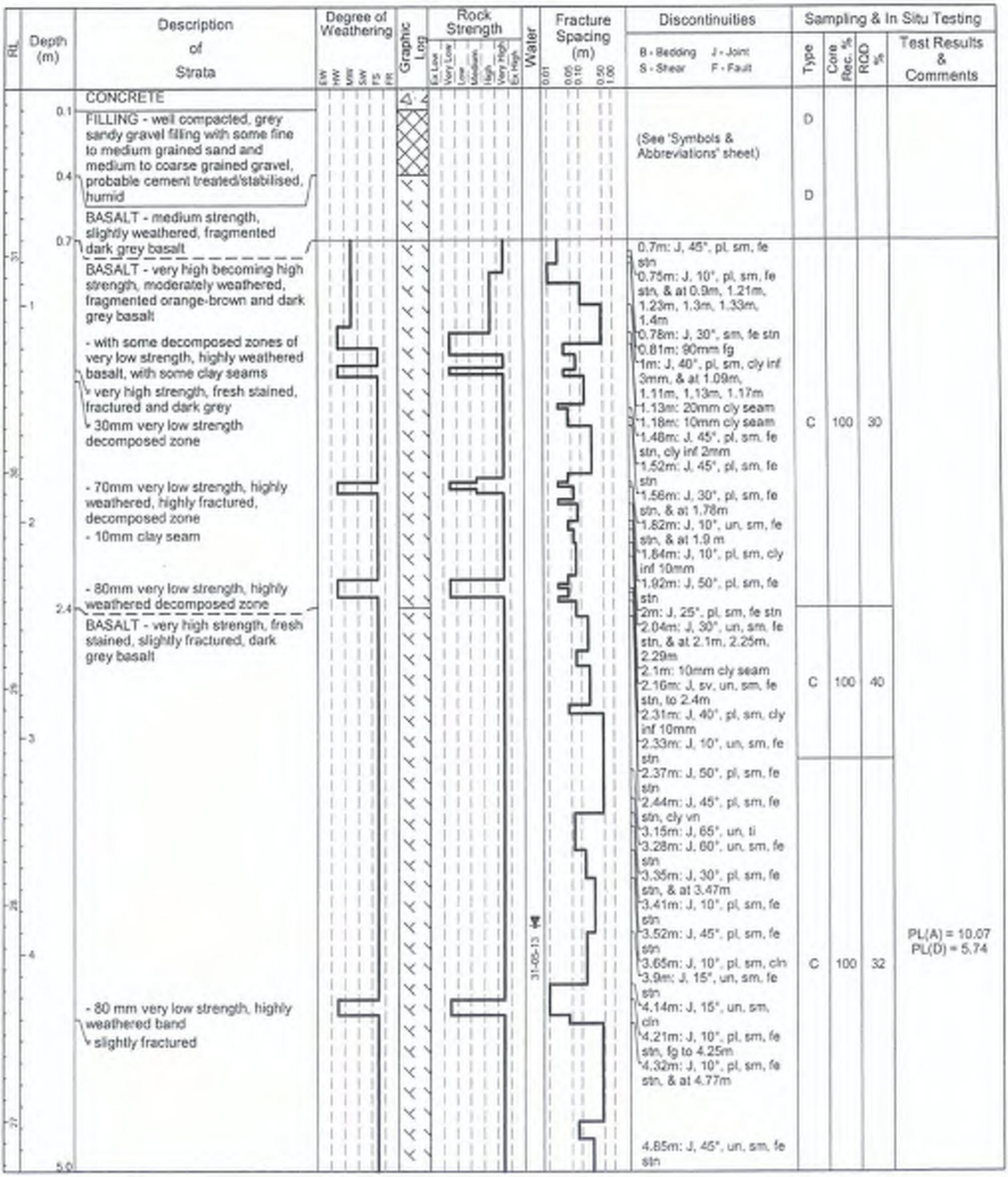
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.77 AHD
EASTING: 528541
NORTHING: 6813154
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 80243.00
DATE: 30/5/2013
SHEET 1 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		CONCRETE					
	0.1	FILLING - well compacted, grey sandy gravel filling with some fine to medium grained sand and medium to coarse grained gravel, probable cement treated/stabilised, humid	(See 'Symbols & Abbreviations' sheet)	D			
	0.4	BASALT - medium strength, slightly weathered, fragmented dark grey basalt		D			
31 30	0.7 1 2	BASALT - very high becoming high strength, moderately weathered, fragmented orange-brown and dark grey basalt - with some decomposed zones of very low strength, highly weathered basalt, with some clay seams - very high strength, fresh stained, fractured and dark grey - 30mm very low strength decomposed zone - 70mm very low strength, highly weathered, highly fractured, decomposed zone - 10mm clay seam - 80mm very low strength, highly weathered decomposed zone	0.7m: J, 45°, pl, sm, fe stn 0.75m: J, 10°, pl, sm, fe stn, & at 0.9m, 1.21m, 1.23m, 1.3m, 1.33m, 1.4m 0.78m: J, 30°, sm, fe stn 0.81m: 90mm fg 1m: J, 40°, pl, sm, cly inf 3mm, & at 1.09m, 1.11m, 1.13m, 1.17m 1.13m: 20mm cly seam 1.18m: 10mm cly seam 1.48m: J, 45°, pl, sm, fe stn, cly inf 2mm 1.52m: J, 45°, pl, sm, fe stn 1.56m: J, 30°, pl, sm, fe stn, & at 1.78m 1.82m: J, 10°, un, sm, fe stn, & at 1.9 m 1.84m: J, 10°, pl, sm, cly inf 10mm 1.92m: J, 50°, pl, sm, fe stn 2m: J, 25°, pl, sm, fe stn 2.04m: J, 30°, un, sm, fe stn, & at 2.1m, 2.25m, 2.29m 2.1m: 10mm cly seam 2.16m: J, sv, un, sm, fe stn, to 2.4m 2.31m: J, 40°, pl, sm, cly inf 10mm 2.33m: J, 10°, un, sm, fe stn	C C	100 100	30 40	
29 28 27	2.4 3 4 5.0	BASALT - very high strength, fresh stained, slightly fractured, dark grey basalt - 80 mm very low strength, highly weathered band - slightly fractured	2.37m: J, 50°, pl, sm, fe stn 2.44m: J, 45°, pl, sm, fe stn, cly vn 3.15m: J, 65°, un, ti 3.28m: J, 60°, un, sm, fe stn 3.35m: J, 30°, pl, sm, fe stn, & at 3.47m 3.41m: J, 10°, pl, sm, fe stn 3.52m: J, 45°, pl, sm, fe stn 3.65m: J, 10°, pl, sm, cln 3.9m: J, 15°, un, sm, fe stn 4.14m: J, 15°, un, sm, cln 4.21m: J, 10°, pl, sm, fe stn, fg to 4.25m 4.32m: J, 10°, pl, sm, fe stn, & at 4.77m 4.85m: J, 45°, un, sm, fe stn	C	100	32	PL(A) = 10.07 PL(D) = 5.74

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 0.7m

TYPE OF BORING: Concrete Core 0.0 m - 0.10 m, Auger 0.10 m - 0.70 m, NMLC Core 0.70 m - 22.95 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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)

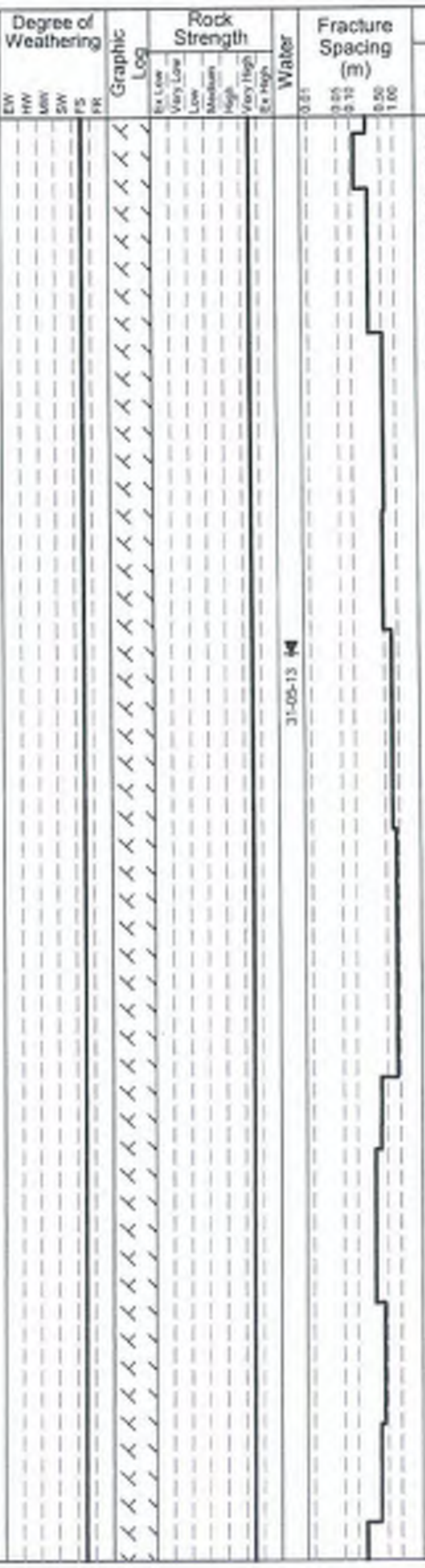
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.77 AHD
EASTING: 528541
NORTHING: 6813154
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 80243.00
DATE: 30/5/2013
SHEET 2 **OF** 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		BASALT (as before)	5.05m: J, 10°, pl, sm, fe stn	C	100	32	
			5.25m: J, 65°, pl, sm, fe stn				
			5.5m: J, 45°, un, sm, fe stn				
26			5.75m: J, 5°, pl, sm, fe stn				
	6						
			6.27m: J, 10°, pl, sm, fe stn				
25			6.76m: J, 10°, pl, sm, fe stn				
	7	- flow banding at 30°		C	100	100	
			7.47m: J, 30°, pl, sm, 3mm cly inf				
24							
	8						
			8.33m: J, 10°, un, sm, fe stn				
		- flow banding sub-horizontal (5°)	8.58m: J, 10°, pl, sm, fe stn, & at 8.75m, 8.34m, 9.11m, 9.53m, 9.87m				
23							
	9			C	100	97	
22							
	10.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 0.7m

TYPE OF BORING: Concrete Core 0.0 m - 0.10 m, Auger 0.10 m - 0.70 m, NMLC Core 0.70 m - 22.95 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

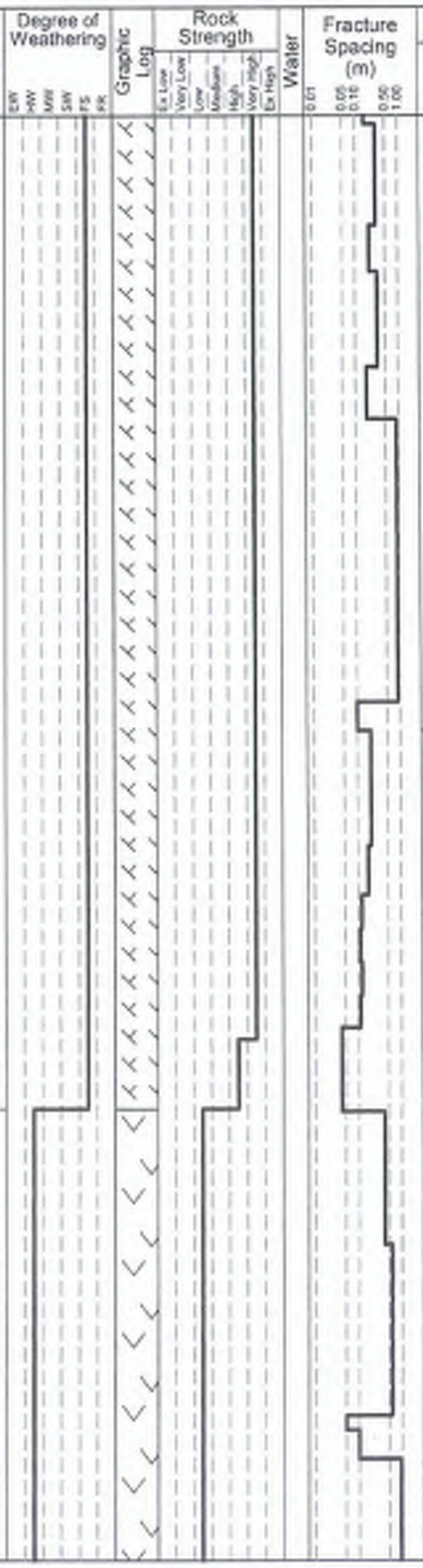
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.77 AHD
EASTING: 528541
NORTHING: 6813154
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 80243.00
DATE: 30/5/2013
SHEET 3 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		BASALT (as before)	10.03m: J, 10°, pl, sm, cln				
			10.36m: J, 30°, pl, sm, fe stn				
			10.54m: J, 25°, un, sm, fe stn				
21				C	100	97	
			10.87m: J, 10°, un, sm, fe stn				
	11		11.05m: J, 15°, pl, sm, fe stn				
							PL(A) = 7.2 PL(D) = 8.55
20							
	12	- fractured	12.03m: J, 30°, un, sm, fe stn 12.13m: J, 10°, pl, sm, fe stn, & at 12.33m, 12.53m, 12.7m, 12.82m, 12.93m, 13.05m				
19							
	13			C	100	90	
		- high strength and highly fractured	13.16m: J, 20°, un, sm, fe stn, & at 13.25m, 13.37m 13.2m: J, 20°, pl, sm, fe stn 13.29m: J, 10°, un, sm, fe stn, & at 13.31m 13.41m: J, 40°, un, fe stn, & at 13.45m				
	13.44	BASALTIC TEPHRA - low strength, highly weathered, slightly fractured purple-grey and orange-brown basaltic tephra, predominantly ash					
18							PL(A) = 0.41 PL(D) = 0.33
		- becoming purple-grey					
	14		13.91m: J, 45°, pl, sm, clay vn				
			14.55m: J, 65°, pl, sm, fe stn 14.65m: J, 10°, un, sm				
17				C	100	97	
							PL(A) = 0.18 PL(D) = 0.37
	15.0						

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 0.7m

TYPE OF BORING: Concrete Core 0.0 m - 0.10 m, Auger 0.10 m - 0.70 m, NMLC Core 0.70 m - 22.95 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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)

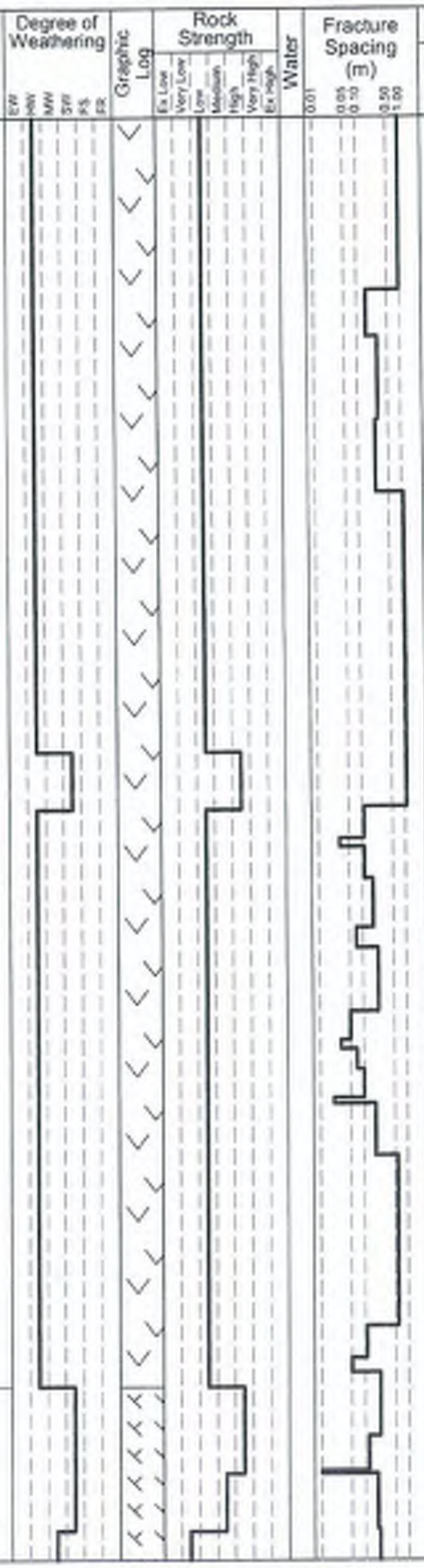
Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.77 AHD
EASTING: 528541
NORTHING: 6813154
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 80243.00
DATE: 30/5/2013
SHEET 4 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		BASALTIC TEPHRA (as before)					
			15.6m: J, 10°, un, sm				PL(A) = 0.22 PL(D) = 0.21
16			15.76m: J, 35°, pl, sm				
	16						
			16.05m: J, 70°, un, sm				
		- becoming blue-grey, alternating ash bands and volcanic bombs/flows		C	100	97	
			16.3m: J, 10°, un, sm				
15							PL(A) = 0.17 PL(D) = 0.16
	17						
		- 200mm high strength, slightly weathered zone					
		- fractured	17.39m: J, 35°, pl, sm				
		- becoming predominantly volcanic bombs	17.53m: J, 20°, un, sm, cly vn				
			17.64m: J, 40°, pl, sm, cly vn				
14			17.81m: J, 10°, pl, sm, cly vn, & at 17.88m				PL(A) = 0.23 PL(D) = 0.19 PL(A) = 0.18 PL(D) = 0.24
	18						
			18.1m: J, 10°, un, sm, cly vn, & at 18.15m				
			18.2m: J, 20°, un, sm, cly vn				
		- some 50 mm to 150 mm medium strength bands to 19.4 m	18.23m: J, 35°, un, sm, cly vn				
			18.3m: J, 45°, un, sm, cly vn				
			18.4m: J, 15°, un, sm, cly vn, fg 30mm				
13			18.42m: J, sv, un, sm, cly vn, to 18.6m	C	100	60	
			18.6m: J, sv, un, sm, cly vn, to 18.9m				
	19						
			19.19m: J, 10°, un, sm, cly vn				
			19.34m: J, 80°, un, sm, cly vn				
	19.4	BASALT - high strength, slightly weathered, fractured, grey basalt	19.35m: J, 50°, sm, cly vn				
			19.57m: J, 30°, pl, sl, cly vn, & at 20.18m				
12		- medium strength	19.69m: J, 60°, un, sl, cly vn, & at 19.7m				
	20.0	- very low strength and moderately weathered	19.89m: fg 210mm				

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 0.7m

TYPE OF BORING: Concrete Core 0.0 m - 0.10 m, Auger 0.10 m - 0.70 m, NMLC Core 0.70 m - 22.95 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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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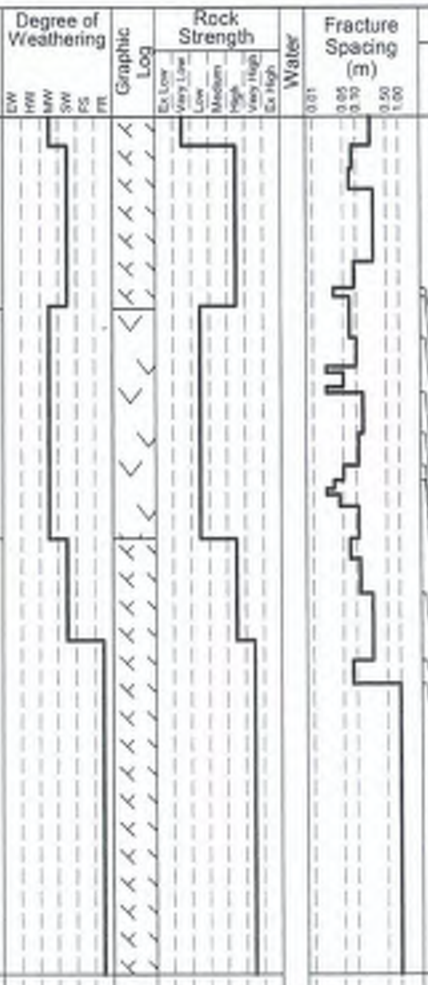
BOREHOLE LOG

CLIENT: NSW Health Infrastructure
PROJECT: Lismore Base Hospital
LOCATION: Uralba Street, Lismore

SURFACE LEVEL: 31.77 AHD
EASTING: 528541
NORTHING: 6813154
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 80243.00
DATE: 30/5/2013
SHEET 5 OF 5



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
		BASALT (as before) - high strength and slightly weathered	20.25m: J, 20°, un, sm, cly vn, & at 20.40m 20.5m: J, 45°, un, sm, cly vn	C	100	60	PL(A) = 2.58 PL(D) = 4.38
11	20.66 21	BASALTIC TEPHRA - low strength, moderately weathered, fractured, grey basaltic tephra, alternating ash layers and volcanic bombs	20.59m: J, 30°, un, sm, cln 20.62m: J, 30°, pl, sm, cly vn, & at 20.69m 20.76m: J, 10°, pl, sm, cly vn, & at 20.86m, 20.93m 20.95m: J, 60°, un, sm, cly vn 21.09m: J, 15°, pl, sm, cly vn 21.2m: J, 20°, un, sm, cly vn, & at 21.28m				PL(A) = 0.29 PL(D) = 0.39
10 9	21.45 22	BASALT - high strength, slightly weathered, fractured, grey basalt - becoming very high strength, fresh and slightly fractured	21.25m: J, 10°, pl, sm, cly vn, & at 21.30m, 21.34m, 21.45m, 21.52m 21.64m: J, 70°, un, sm, cln 21.87m: J, 10°, pl, sm, cln 21.95m: J, 30°, pl, sm, cln	C	100	74	PL(A) = 9.01 PL(D) = 8.98
8 7	22.95 23 24	Bore discontinued at 22.95m					

RIG: P160 **DRILLER:** North Coast Drilling **LOGGED:** MH **CASING:** HWT to 0.7m

TYPE OF BORING: Concrete Core 0.0 m - 0.10 m, Auger 0.10 m - 0.70 m, NMLC Core 0.70 m - 22.95 m

WATER OBSERVATIONS: Refer to Geotechnical Report

REMARKS: Location coordinates are in MGA94 Zone 56J.
Bore elevation surveyed relative to bore positions undertaken by others

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,	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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APPENDIX D

6.12 Arcadis -Lismore Hospital Northern Wing Vibration Analysis

MEMO

ARCADIS
Design & Consultancy
for natural and
built assets

Date 23/09/2016
To Daniel Schaefer (John Holland)
From Timothy Small
Subject Lismore Hospital Northern Wing Vibration Analysis – **Rev B**

Dear Daniel,

Arcadis has undertaken analysis of the northern wing of Lismore Hospital to determine structural requirements of the building to meet footfall vibration criteria. The analysis was performed for the proposed northern wing of the building (grids 05 to 08, A to J).

Arcadis has analysed the slab to meet the following footfall vibration criteria:

- Medical/ward areas: response factor 2
- MRI machine: information as per "Philips Ingenia 3.0T OmegaHP" specification (dated 01-10-2014)

The MRI machine vibration requirements have been checked for the resonant analysis case for peak acceleration. The vibration limit for transient excitation has been taken as being four times higher (i.e. less sensitive) than for resonant excitation, taking RMS acceleration. This is the case with other similar pieces of equipment, but needs to be confirmed with the manufacturer.

A specification for the CT scanner titled "Biograph mCT" (dated 10-09-2015) was received, but this document does not include any vibration requirements. We have typically designed medical equipment areas the vibration requirements for a vibration-sensitive CT scanner titled "SOMATOM Definition Flash" (dated 27-06-2012).

Some non-medical areas (e.g. corridors, offices) have response factors higher than 2, as they are not vibration-sensitive.

It has been assumed that the level 7 structure (to be built at a later date, except for its floor) will be the same as level 6.

Two analysis cases were used for the assessment of all floors in the hospital:

1. Non-corridors have a vibration excitation frequency of 1Hz to 1.8Hz
2. Corridors have a vibration excitation frequency of 1Hz to 2.2Hz

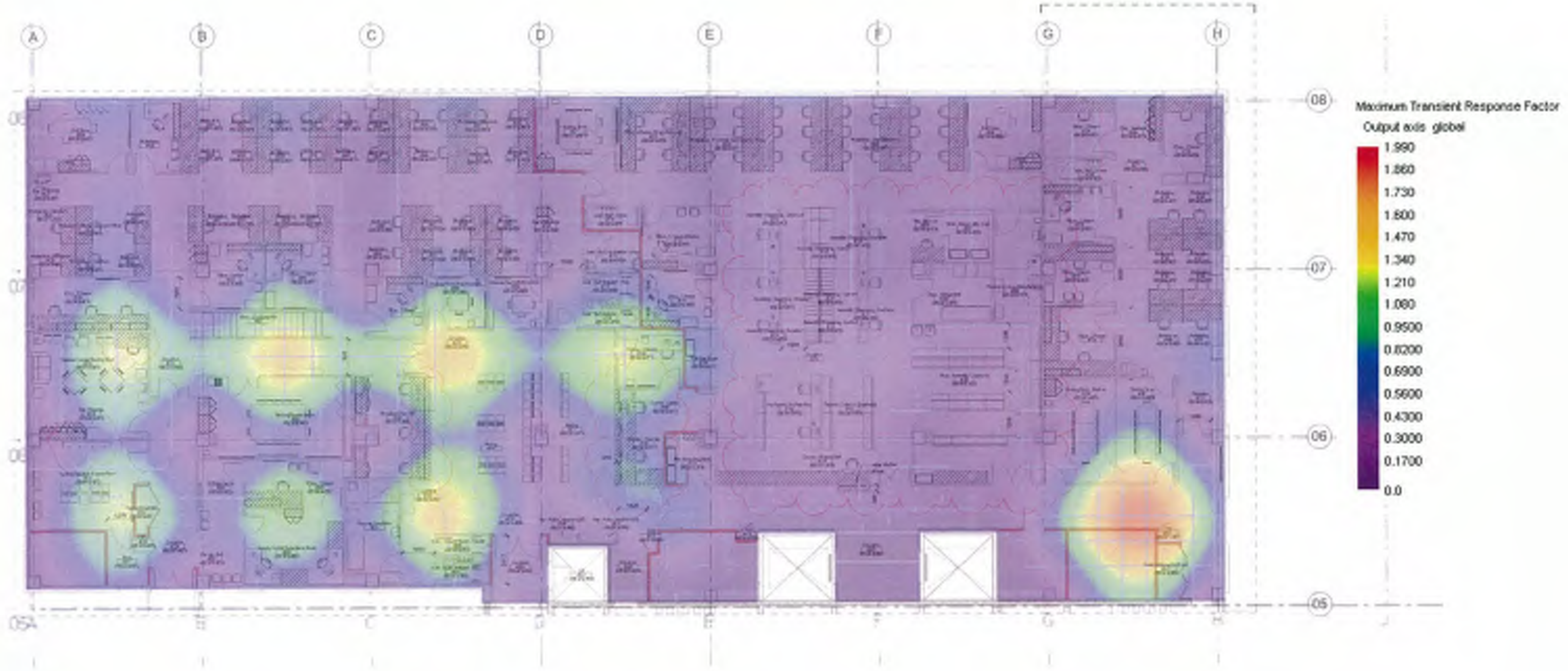
Refer Appendix A for screenshots of vibration output, Appendix B for the constants adopted for the analysis, Appendix C for medical equipment vibration requirements and Appendix D for adopted locations of corridors.

Regards,

Timothy Small
BE(Hons 1), Dip Eng Prac, MIEAust
Structural Engineer

Appendix A – Analysis Output

RC Option



1 Level 04 - 3B2 - FFE

Corridor Excitation

Transient Analysis

PRELIMINARY

John Holland aurora NSW Health Infrastructure CONRAD GARGETT

HEALTH
INFRASTRUCTURE

FF&E Level 4 3B2 NB

LISMORE BASE
HOSPITAL

15427 DD A26041 C 1 : 100