REPORT

TO
HEALTH INFRASTRUCTURE

ON
ADDITIONAL GEOTECHNICAL INVESTIGATION

FOR
NEPEAN HOSPITAL AND INTEGRATED AMBULATORY SERVICES REDEVELOPMENT SSDA

AT
NEPEAN HOSPITAL
DERBY STREET, KINGSWOOD, NSW

19 March 2018
Ref: 29845L2rptRev1

JK Geotechnics
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

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Date: 19 March 2018
Report No: 29845L2rpt
Revision No: 1

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For and on behalf of
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TABLE OF CONTENTS

1 INTRODUCTION

This report presents the results of an additional geotechnical investigation for proposed the main works area as part of the redevelopment works at Nepean Hospital, Derby Street, Kingswood, NSW. A site location plan is presented as Figure 1. The commission was by email acceptance by Mr Cameron McClement, Project Manager, of CBRE dated 20 November 2017 on behalf of Health Infrastructure. The investigation was carried out in accordance with our fee proposal P46156L dated 15 November 2017.

The main works area will comprise a new multi-storey hospital building in the central portions of the site. Working column loads up to about 12,000kN have been indicated and basements may or may not be required.

JK Geotechnics produced a previous geotechnical investigation report for the main works area (Report Reference 29845L1rpt MWCDB, dated 24 February 2017). We understand that the main works area has been moved further to the east and as such two additional boreholes were requested to provide further information on the geotechnical subsurface conditions.

The purpose of the investigation was to obtain geotechnical factual information on subsurface conditions at the two additional locations on the eastern side of the proposed main works area. No additional comments and recommendations are provided herein.

Reference should be made to our previous above referenced geotechnical report for specific details and the results of previous boreholes drilled across the main works area. The previous relevant boreholes have been included in Appendix A of this report for completeness.

2 INVESTIGATION PROCEDURE

Prior to commencement of the fieldwork, the investigation locations were electromagnetically scanned by a specialist subcontractor so that all borehole locations could be located clear of buried services. Reference to 'Dial Before You Dig' plans was also carried out. Safe work measures and traffic control procedures were implemented during the course of the fieldwork.

The fieldwork for these additional investigations comprised the drilling of two boreholes, BH201 and BH202, to total depths of 17.67m and 21.86m below existing surface levels, respectively. The boreholes were drilled using our track-mounted JK308 rig. Both boreholes were initially advanced

by spiral auger drilling techniques and a Tungsten Carbide (TC) bit until reasonably competent bedrock was encountered. The boreholes were then extended to their final depth by rotary diamond coring techniques, using an NMLC triple tube core barrel and water flush.

The borehole locations are shown on the attached Figure 2 (which is based on survey plans by Cardno – Drawing No. 118117502 Rev 3 dated 22 November 2016), and these were set out by taped measurements from existing surface features shown on the survey plan. The approximate reduced level (RL) at each borehole location, as shown on the borehole logs, was interpolated from spot heights and contours from the survey plan. The height datum is Australian Height Datum.

The apparent compaction of the fill and strength of the cohesive soils were assessed from Standard Penetration Test (SPT) 'N' values, augmented by hand penetrometer tests carried out on cohesive samples recovered by the SPT split tube sampler. The strength of the bedrock in the augered portion was assessed from observation of the drilling resistance of the TC drill bit attached to the augers and tactile examination of the rock cuttings. It should be noted that strengths assessed in this way are approximate and variances of at least one strength order should not be unexpected.

Where the bedrock was cored, the recovered core was returned to Soil Test Services (STS), a NATA accredited laboratory, for photographing and Point Load Strength Index (Is_{50}) testing. Using established correlations the Unconfined Compressive Strength (UCS) of the bedrock was then calculated from the Is_{50} results. These Point Load Strength test results are summarised in the attached Table A and on the borehole logs.

Groundwater observations were recorded in both boreholes during and on completion of auger drilling. No longer term groundwater observations or monitoring were made.

Our geotechnical engineer, Mr Arthur Billingham, was present on a full-time basis during the fieldwork, to direct the electromagnetic scanning, set out the borehole locations, nominate testing and sampling and prepare the borehole logs. The borehole logs, which include field test results and groundwater observations, are attached, together with a set of explanatory notes which describe the investigation techniques, and their limitations and define the logging terms and symbols used.

During the fieldwork, samples were also obtained for environmental testing and assessment purposes. Reference should be made to the report by EIS (Reference E29845K2) for specific details.

3 RESULTS OF INVESTIGATION

3.1 Site Description

This main works area consists of the existing open air carpark located centrally in the eastern half of the Nepean Hospital site. The car park is an asphaltic concrete (AC) paved surface that appeared in good condition upon a cursory visual inspection. The area slopes down to the north east at gradients ranging from about 1° to 2° from a local high point near the junction between North Block and East Block (in the vicinity of BH15). The car park is accessed off Somerset Street to the east.

The car park area is surrounded on all sides by hospital buildings which are generally on-grade with the adjacent paved areas. The exception is along the northern edge of the area where some excavation appears to have been undertaken for the construction of the Drugs and Alcohol Services building and Gateway Clinic. A concrete block retaining wall runs along the length of the northern edge of the car park, with surface levels in the car park generally between 1.8m and 2.0m above the ground floor levels of the buildings below.

East of the area (and in the area of the current boreholes) is ”Somerset Childcare Centre”, a single-storey brick building, with surface levels between the car park and building being similar. A number of stormwater drains traverse the current investigation area.

3.2 Subsurface Conditions

The 1:000,000 Geological Series Sheet 9030 ‘Penrith’ indicates that the site is underlain by Bringelly Shale of the Wianamatta Group consisting of shale, carbonaceous claystone, claystone, laminite, fine- to medium-grained lithic sandstone, rare coal and tuff. This profile does not take into account in-situ weathering or any earthworks that have taken place on the site.

The boreholes encountered a profile of fill overlying residual silty clay which transitioned to weathered shale in BH201and weathered shale and sandstone in BH202. The bedrock is quite variable in strength throughout the profile. For a detailed description of the subsurface profile reference should be made to the attached borehole logs.

Pavements

Asphaltic concrete pavements were encountered in both boreholes. The asphalt pavements were 40mm thick and were underlain by either a sandy gravel or gravelly sand road base to a depth of 0.3m and 0.5m in BH201 and BH202 respectively.

Fill

Fill was encountered in BH201 below the pavement layers and extended to a depths 1.5m below existing surface levels. The fill in BH201 comprised a sand with inclusions of silt, clay and igneous gravel. No fill was encountered below the pavement payers in BH202.

Residual Silty Clay

Residual silty clay was encountered in each borehole. The silty clay was assessed as being of medium or high plasticity and generally of very stiff to hard strength. Traces of fine-grained ironstone gravel were observed within the silty clays.

Weathered Bedrock

Weathered bedrock was first encountered at depths of 4.0m in BH201 and 2.5m in BH202. In BH201, the bedrock on first rock contact comprised weathered shale of extremely low strength. The weathered shale typically increased in strength with depth to low and medium strength. In BH202, the rock on first contact comprised sandstone of extremely low strength, although just below this upper layer was a layer of sandstone that appeared to have been altered, possibly by geological metamorphic processes. As this layer of rock was only auger drilled, the exact nature of the alteration could not be fully determined. Below this, the profile comprised layers of shale and sandstone ranging typically from very low to medium strength, with a few layers of high strength sandstone at depths of 10.0m and 17.0m. The rock in BH202, contained a significantly greater number of defects than encountered in BH201 and there was no noticeable increase in strength or rock quality with depth.

The following table provides our rock classification assessment for BH201 and BH202. Rock classifications for BH10 to BH16 are included within Section 5.5.3 of our previous geotechnical report dated 24 February 2017, and reference should be made to that table for further information.

Summary Table of Depths for each Rock Class at each Borehole Location

Borehole Number	Depths (Reduced Levels) Class V Rock	Depths (Reduced Levels) Class IV Rock	Depths (Reduced Levels) Class III Rock	Depths (Reduced Levels) Class II or better Rock
BH201	4.0m to 8.4m (RL46.1 to RL41.7) Shale	8.4m to 10.3m (RL44.7 to RL39.8) Shale	10.3m to 16.4m (RL39.8 to RL33.7) Shale	16.4m to 17.7m (RL33.7 to RL32.4) Shale
BH202	2.5m to 5.5m (RL48.0 to RL45.0) Shale+ Sandstone	5.5m to 10.0m (RL45.0 to RL40.5) Shale + Sandstone 11.9m to 14.5m (RL38.6 to RL36.0) Shale 17.0m to 21.9m (RL33.5 to RL28.6) Shale + Sandstone	14.5m to 17.0m (RL36.0 to RL33.5) Shale + Sandstone	10.0m to 11.9m (RL40.5 to RL38.6) Sandstone

1. Rock Classifications based on Pells et al 1998 'Foundations on Shale and Sandstone in the Sydney Region'
2. Refer to borehole logs for more specific information.

Groundwater

All boreholes were dry on completion of auger drilling. We note that during the coring process, water is introduced into the borehole and therefore water levels immediately after completion of coring have not been recorded as they would be artificially high.

4 GENERAL COMMENTS

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE A
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	29845L2
Project:	Nepean Hospital Redevelopment	**Report:**	A
Location:	Nepean Hospital, Derby Street, Kingswood, NSW	**Report Date:**	7/12/2017
		Page 1 of 3	

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
201	6.25 - 6.28	0.2	4
	6.85 - 6.89	0.2	4
	7.19 - 7.22	0.2	4
	7.63 - 7.66	0.2	4
	8.49 - 8.52	0.4	8
	8.89 - 8.92	0.3	6
	9.34 - 9.37	0.06	1
	9.80 - 9.82	0.1	2
	10.29 - 10.33	0.3	6
	10.69 - 10.72	0.3	6
	11.12 - 11.15	0.2	4
	11.59 - 11.63	0.7	14
	12.06 - 12.10	0.4	8
	12.55 - 12.58	0.4	8
	13.08 - 13.10	0.5	10
	13.67 - 13.70	0.3	6
	14.05 - 14.08	0.3	6
	14.70 - 14.73	0.6	12
	15.10 - 15.13	0.3	6
	15.55 - 15.59	0.4	8
	16.02 - 16.05	0.3	6
	16.45 - 16.49	0.5	10
	17.00 - 17.03	0.6	12
	17.63 - 17.68	0.8	16

NOTES: See Page 3 of 3

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TABLE A
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	29845L2
Project:	Nepean Hospital Redevelopment	**Report:**	A
Location:	Nepean Hospital, Derby Street, Kingswood, NSW	**Report Date:**	7/12/2017
		Page 2 of 3	

BOREHOLE NUMBER	DEPTH m	$I_{S(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
202	6.77 - 6.81	0.2	4
	7.26 - 7.29	0.2	4
	7.92 - 7.95	0.1	2
	8.13 - 8.16	0.2	4
	8.89 - 8.92	0.3	6
	9.11 - 9.15	0.3	6
	9.46 - 9.49	0.3	6
	10.15 - 10.18	1.0	20
	10.89 - 10.92	5.4	108
	11.20 - 11.23	2.8	56
	11.90 - 11.93	0.4	8
	12.18 - 12.21	0.4	8
	12.85 - 12.88	0.3	6
	13.51 - 13.54	0.3	6
	13.76 - 13.79	0.4	8
	13.86 - 13.89	0.09	2
	14.93 - 14.96	0.6	12
	15.00 - 15.04	1.0	20
	15.37 - 15.40	0.4	8
	15.84 - 15.87	0.3	6
	16.18 - 16.21	0.5	10
	16.84 - 16.87	0.3	6
	17.00 - 17.03	1.1	22
	17.54 - 17.58	1.0	20

NOTES: See Page 3 of 3

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SOIL TEST SERVICES

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TABLE A
POINT LOAD STRENGTH INDEX TEST REPORT

Client:	JK Geotechnics	**Ref No:**	29845L2
Project:	Nepean Hospital Redevelopment	**Report:**	A
Location:	Nepean Hospital, Derby Street, Kingswood, NSW	**Report Date:**	7/12/2017
		Page 3 of 3	

BOREHOLE NUMBER	DEPTH	$I_{S\,(50)}$	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH
	m	MPa	(MPa)
202	18.06 - 18.09	0.1	2
	18.95 - 18.99	0.4	8
	20.10 - 20.13	0.1	2
	20.43 - 20.47	0.3	6
	21.64 - 21.68	0.2	4

NOTES:

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RMS T223.
4. For reporting purposes, the $I_{S(50)}$ has been rounded to the nearest 0.1MPa, or to one significant figure if less than 0.1MPa
5. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :
   U.C.S. = 20 $I_{S\,(50)}$

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Borehole No. 201
1 / 3

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Method:** SPIRAL AUGER **R.L. Surface:** ~50.1 m
Date: 29/11/17 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING						50			-	ASPHALTIC CONCRETE: 40mm.t	M			APPEARS WELL COMPACTED
										FILL: Sandy gravel, fine to medium gained, grey, igneous gravel, fine to coarse grained sand, brown.				
					N = 31 8,13,18					FILL: Sand, fine to coarse grained, brown, with silt, and fine grained igneous gravel, trace of silty clay nodules.				
						49	1							
					N = 12 4,6,6				CH	SILTY CLAY: high plasticity, light grey, trace of fine grained ironstone gravel.	MC>PL	St / VSt	100 280 380	MOISTURE ALONG FILL/RESIDUAL SOIL INTERFACE
						48	2							RESIDUAL
					N = 23 8,11,12					as above, but trace of fine to coarse grained ironstone gravel.		H	350 400 450 510	
						47	3							
										as above, but with ironstone gravel.	MC~PL			
						46	4		-	SHALE: grey, with iron indurated red brown bands.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
					N > 15 8,15/ 130mm REFUSAL					SHALE: brown grey, with fine grained sandstone, banded brown and grey.				
						45	5				DW	VL - L		VERY LOW TO LOW RESISTANCE
						44	6			REFER TO CORED BOREHOLE LOG				

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Borehole No. 201

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Core Size:** NMLC **R.L. Surface:** ~50.1 m
Date: 29/11/17 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10 DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
		45			START CORING AT 5.78m				
			6		SHALE: grey brown, bedded sub horizontally.	XW - DW	EL - VL		
		44			SHALE: grey, bedded sub horizontally.	DW	L		(6.45m) CS, 0°, 15 mm.t (6.51m) J, 90°, P, R (6.61m) J, 40°, P, S (6.67m) J, 90°, P, S
		43	7						(7.52m) J, 90°, P, S
		42	8		as above, but grey and dark grey.	XW - DW	EL - VL		
						DW			(8.48m) J, 50°, P, S
0% RETURN		41	9				L - M		(9.16m) CS, 0°, 80 mm.t (9.57m) J, 90°, P, S
					SHALE: carbonaceous, dark grey.				(9.90m) XWS, 0°, 10 mm.t
		40	10		SHALE: grey and dark grey, bedded sub horizontally.		VL		(10.06m) XWS, 0°, 120 mm.t
						SW	L - M		(10.77m) J, 90°, P, S
		39	11						(11.83m) J, 90°, P, R (11.90m) CS, 0°, 5 mm.t

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Borehole No. 201
3 / 3

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Core Size:** NMLC **R.L. Surface:** ~50.1 m
Date: 29/11/17 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS DEFECT SPACING (mm) 500 300 100 50 30 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
0% RETURN		38			SHALE: grey and dark grey, bedded sub horizontally. *(continued)*	SW	L - M			(12.27m) XWS, 0°, 20 mm.t (12.38m) J, 90°, P, S
		37	13							
		36	14							(14.26m) XWS, 0°, 1 mm.t (14.49m) CS, 0°, 8 mm.t (14.60m) J, 90°, P, R
		35	15							
		34	16				M			(15.64m) Be, 0°, P, R, CLAY LINED
		33	17							(16.79m) J, 90°, P, S (17.36m) J, 80°, P, S
		32	18		END OF BOREHOLE AT 17.67 m					


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JOB No 29845L2 BH201 START CORING AT 5.7m
5
6
7
8
9
10
11
12
13
14
15
16
17
EOBH AT 17.67m

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 202
1 / 4

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Method:** SPIRAL AUGER **R.L. Surface:** ~50.5 m
Date: 30/11/17 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING									-	ASPHALTIC CONCRETE: 40mm.t FILL: Gravelly sand, fine to coarse grained, light brown, fine grained igneous gravel, brown.	D			
					N = 6 3,2,4	50	1		CH	SILTY CLAY: high plasticity, light grey.	MC>PL	VSt	200 200 320	RESIDUAL
					N = 27 6,12,15	49	2		CL	as above, but medium plasticity, with fine to coarse grained ironstone gravel.	MC~PL	H	510 >600 >600	
						48	3		-	SANDSTONE: fine to medium grained, light brown, with clay seams.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
									-	SANDSTONE: fine grained, grey, possibly altered by metamorphic process.	DW	H		HIGH RESISTANCE
						47	4		-	SANDSTONE: fine to medium grained, light brown, with grey shale bands.	XW - DW	EL - VL		VERY LOW RESISTANCE
						46	5		-	SHALE: grey and light grey.	XW	EL		
						45	6		-	SANDSTONE: fine grained, brown grey.	DW	L - M		LOW TO MODERATE RESISTANCE
						44				REFER TO CORED BOREHOLE LOG				

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Borehole No. 202
2 / 4

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Core Size:** NMLC **R.L. Surface:** ~50.5 m
Date: 30/11/17 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT SPACING (mm) (500, 300, 100, 50, 30, 10)	DEFECT DETAILS DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
					START CORING AT 6.23m					
20-40% RETURN		44	7		INTERBEDDED SANDSTONE: fine grained, grey brown, SHALE: grey and dark grey, with iron indurated bands, bedded sub horizontally.	DW	L			(6.34m) XWS, 0°, 3 mm.t (6.39m) J, 90°, P, S, IS (6.44m) XWS, 0°, 25 mm.t (6.64m) J, 90°, P, S, WITHOUT FRAGMENTED ZONE (6.98m) XWS, 0°, 130 mm.t (7.06m) XWS, 0°, 4 mm.t (7.13m) XWS, 0°, 4 mm.t (7.17m) XWS, 0°, 20 mm.t
		43	8		SHALE: grey and dark grey, bedded sub horizontally.		VL			(7.57m) J, 90°, P, S, IS (7.62m) J, 70°, P, S (7.68m) XWS, 0°, 5 mm.t (7.81m) Cr, 0°, 140 mm.t (8.06m) J, 60°, P, S, IS (8.22m) Be, 0°, P, S, IS (8.44m) J, 90°, P, R (8.45m) XWS, 0°, 46 mm.t, P, R (8.60m) J, 70 - 90°, P, R (8.77m) XWS, 0°, 85 mm.t
		42	9			SW	L - M			
0% RETURN		41	10		SANDSTONE: fine grained, grey, bedded sub horizontally.	FR	H			(9.64m) CS, 0°, 2 mm.t (9.69m) XWS, 0°, 10 mm.t (9.74m) XWS, 0°, 25 mm.t (9.85m) CS, 0°, 2 mm.t (9.91m) J, 90°, P, S (10.11m) XWS, 0°, 3 mm.t (10.28m) J, 90°, P, S, IS
		40	11							(11.09m) J, 80°, P, R, IS
		39	12							(11.80m) J, 60°, P, R, IS
		38			SHALE: dark grey and grey, bedded sub horizontally.	SW	L - M			(12.28m) CS, 0°, 30 mm.t (12.36m) CS, 0°, 25 mm.t (12.94m) XWS, 0°, 10 mm.t

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Borehole No. 202
3 / 4

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Core Size:** NMLC **R.L. Surface:** ~50.5 m
Date: 30/11/17 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT SPACING (mm) 500, 300, 100, 50, 30, 10	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
0% RETURN		37	13		SHALE: dark grey and grey, bedded sub horizontally. *(continued)*	DW	VL			(13.02m) XWS, 0°, 40 mm.t (13.12m) XWS, 0°, 30 mm.t (13.19m) XWS, 0°, 5 mm.t (13.25m) XWS, 0°, 30 mm.t (13.36m) XWS, 0°, 20 mm.t (13.42m) XWS, 0°, 20 mm.t
							M			
			14			DW	VL - L			(13.88m) CS, 0°, 1 mm.t (14.12m) CS, 0°, 8 mm.t (14.20m) CS, 0°, 5 mm.t (14.30m) CS, 0°, 120 mm.t
		36				SW	M			(14.83m) XWS, 0°, 6 mm.t
			15							(15.13m) XWS, 0°, 3 mm.t (15.29m) J, 90°, P, S
		35					L - M			
			16							(15.95m) CS, 0°, 35 mm.t (16.03m) CS, 0°, 1 mm.t (16.13m) J, 90°, P, S
		34			INTERBEDDED SHALE: dark grey, SANDSTONE: fine grained, grey.					
			17		SANDSTONE: fine grained, grey, bedded sub horizontally.	FR	H			(17.12m) CS, 0°, 7 mm.t (17.17m) CS, 0°, 2 mm.t (17.25m) CS, 0°, 10 mm.t
		33								(17.47m) CS, 0°, 4 mm.t (17.63m) CS, 0°, 8 mm.t (17.71m) XWS, 0°, 85 mm.t
			18		SHALE: dark grey, with grey fine grained sandstone bands.	DW	VL - L			(17.92m) XWS, 0°, 45 mm.t
		32								(18.64m) J, 20°, P, S (18.76m) J, 30°, P, S (18.81m) J, 90°, P, S (18.91m) XWS, 0°, 5 mm.t
			19		SHALE: dark grey and grey.					(19.03m) CS, 0°, 3 mm.t (19.18m) XWS, 0°, 120 mm.t (19.30m) CS, 0°, 5 mm.t
		31								(19.45m) XWS, 0°, 70 mm.t (19.66m) XWS, 0°, 6 mm.t (19.76m) J, 70°, P, R, WITHOUT FRAGMENTED ZONE (19.89m) XWS, 0°, 8 mm.t

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
202
4 / 4

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L2 **Core Size:** NMLC **R.L. Surface:** ~50.5 m
Date: 30/11/17 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL -0.03, VL -0.1, L -0.3, M -1, H -3, VH -10, EH	DEFECT DETAILS DEFECT SPACING (mm) 500, 300, 100, 50, 30, 10	DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
0% RETURN		30	21		SHALE: dark grey and grey. *(continued)*	SW	L			(19.95m) J, 90°, P, R (20.58m) J, 90°, P, S (20.73m) XWS, 0°, 35 mm.t (20.95m) FRAGMENTED ZONE, 0°, 110 mm.t (21.08m) CS, 0°, 8 mm.t (21.32m) CS, 0°, 4 mm.t (21.44m) FRAGMENTED ZONE, 0°, 10 mm.t (21.73m) CS, 0°, 20 mm.t (21.78m) CS, 0°, 45 mm.t (21.85m) CS, 0°, 20 mm.t
		29								
		28	22		END OF BOREHOLE AT 21.86 m					
		27	23							
		26	24							
		25	25							
		24	26							

JK_LIB_CURRENT - V8.00.GLB Log J & K CORED BOREHOLE - MASTER 29845L2 KINGSWOOD.GPJ <<DrawingFile>> 11/12/2017 16:40 Produced by gINT Professional, Developed by Datgel


JK Geotechnics
JOB No. 29845L2 BH202 START CORING AT 6.23m
6
7
8
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11
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14


JK Geotechnics
15
16
17
18
19
20
21
EBH 21.86m

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 7.1.5.1557
AERIAL IMAGE ©: 2015 GOOGLE INC.

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

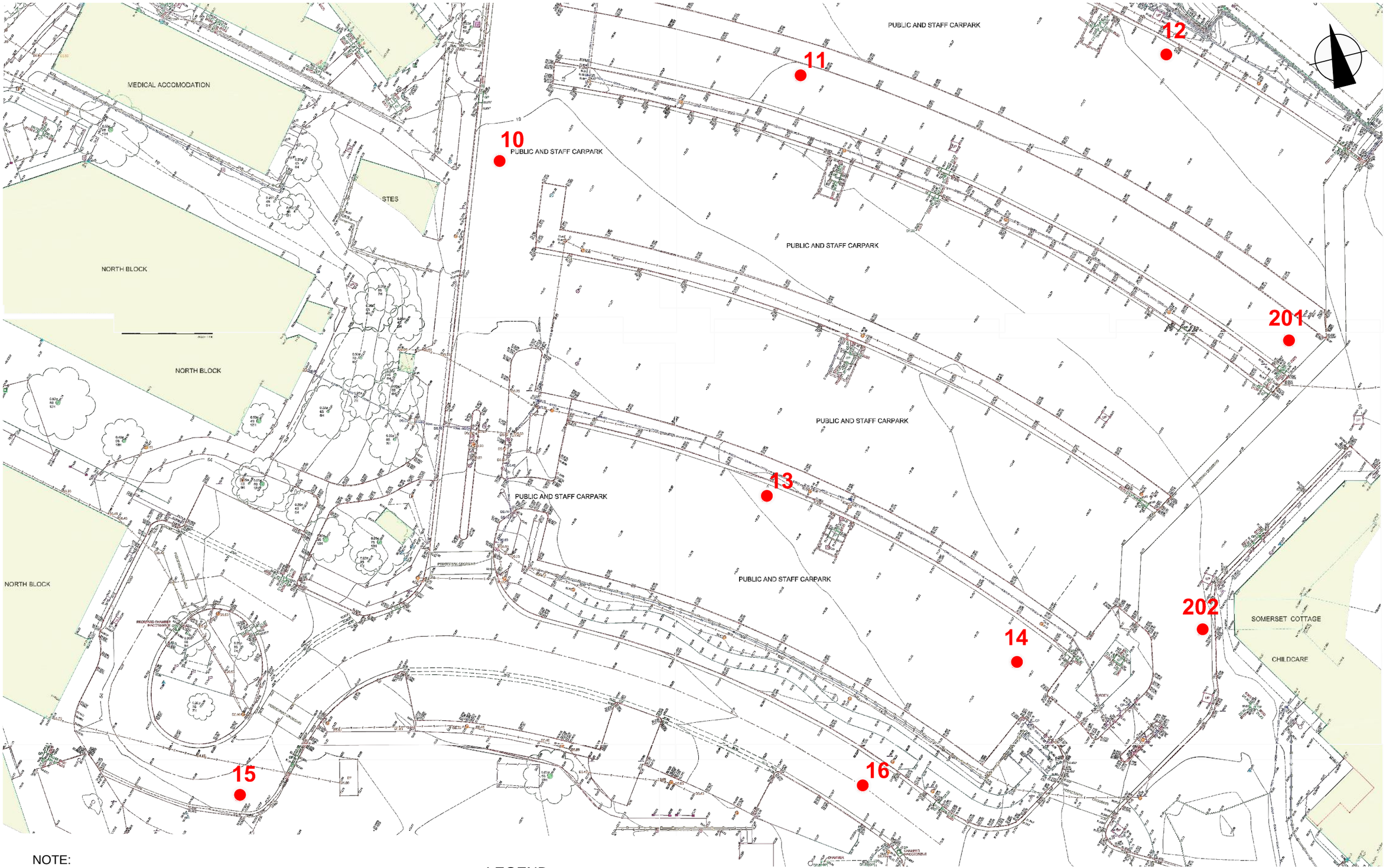
Location: NEPEAN HOSPITAL, DERBY STREET KINGSWOOD, NSW

Report No: 29845L2

Figure No: 1

JK **Geotechnics**

PLOT DATE: 7/12/2017 10:58:59 AM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\29000'S\29845L NEPEAN HOSPITAL\CAD\29845L2.DWG



NOTE:

1. BHs 10 TO 16 WERE DRILLED AS PART OF OUR JANUARY 2017 INVESTIGATIONS, REF: 29845L1rpt MWCDB.
2. BH201 AND BH202 WERE DRILLED AS PART OF OUR CURRENT INVESTIGATION.

LEGEND

● BOREHOLE

0 4 8 12 16 20

SCALE 1:400 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **BOREHOLE LOCATION PLAN**

Location: NEPEAN HOSPITAL, DERBY STREET KINGSWOOD, NSW

Report No: 29845L2

Figure No: 2

JK **Geotechnics**

PLOT DATE: 8/12/2017 4:33:11 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\29000'S\29845L NEPEAN HOSPITAL\CAD\29845L2.DWG

REPORT EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained 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.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water 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 "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength 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 F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using a Cone Penetrometer Test (CPT). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm or 44mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

  The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The 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.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

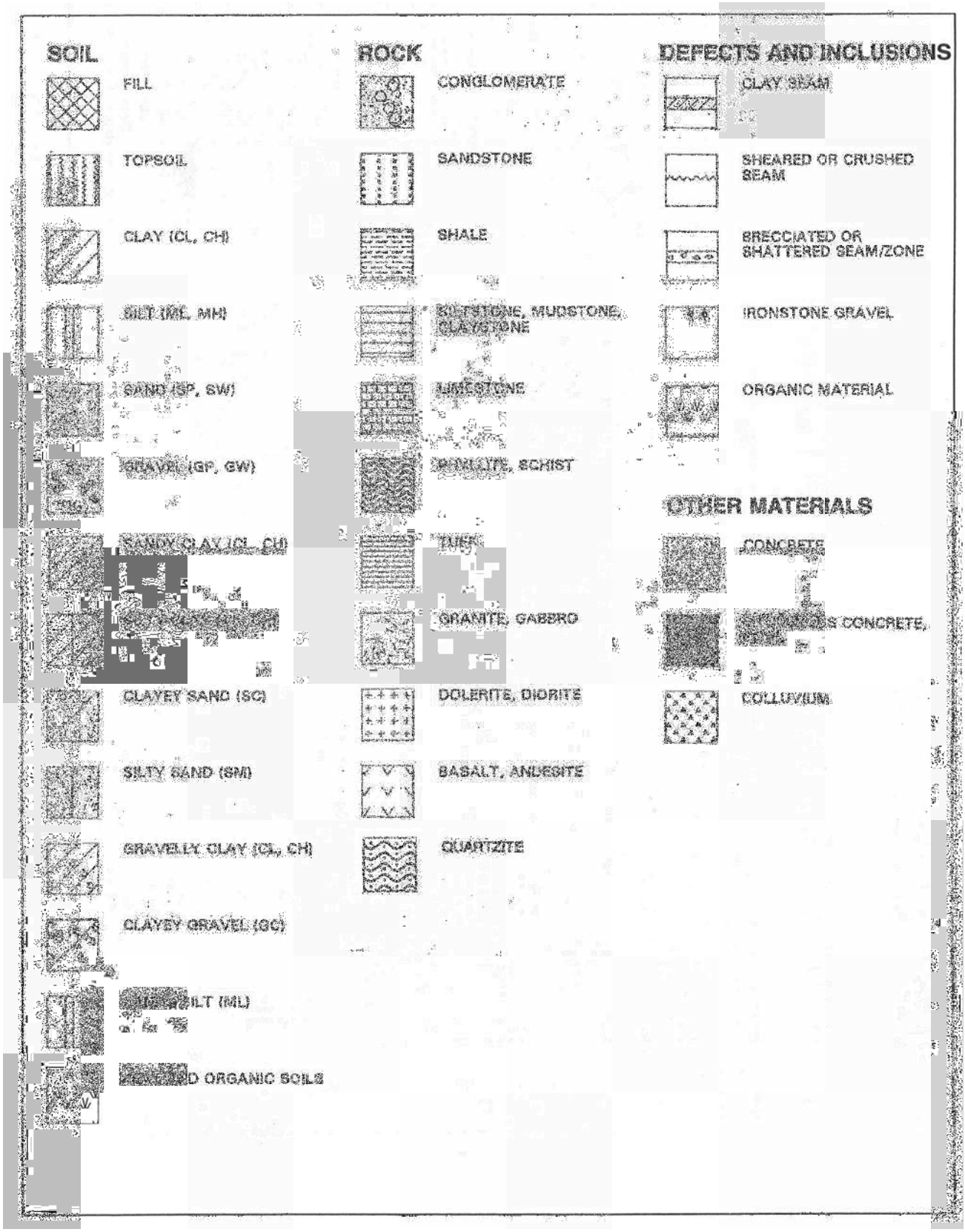
Requirements could range from:

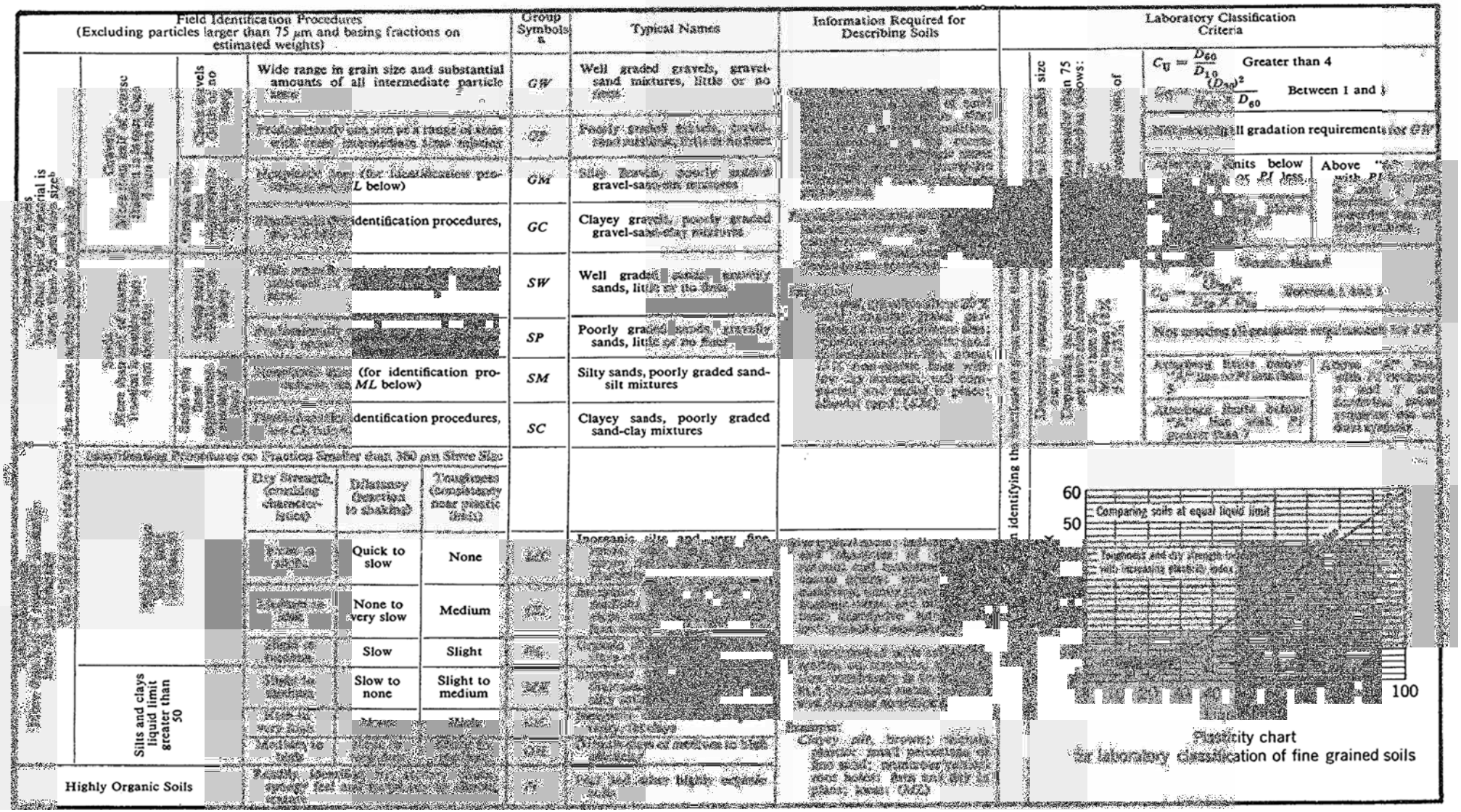
i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS





Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines).
2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	▼	Standing water level. Time delay following completion of drilling may be shown.
	C	Extent of borehole collapse shortly after drilling.
	▶	Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY – Runs freely through fingers.
	M	MOIST – Does not run freely but no free water visible on soil surface.
	W	WET – Free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – Unconfined compressive strength less than 25kPa
	S	SOFT – Unconfined compressive strength 25-50kPa
	F	FIRM – Unconfined compressive strength 50-100kPa
	St	STIFF – Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF – Unconfined compressive strength 200-400kPa
	H	HARD – Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** / **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose <15 0-4
	L	Loose 15-35 4-10
	MD	Medium Dense 35-65 10-30
	D	Dense 65-85 30-50
	VD	Very Dense >85 >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

LOG SYMBOLS continued

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
----------	----------	0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
----------	----------	0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
----------	----------	0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
----------	----------	1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
----------	----------	3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
----------	----------	10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

APPENDIX A

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 10
1 / 3

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L **Method:** SPIRAL AUGER **R.L. Surface:** ~51.1 m
Date: 10/1/17 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING						51			-	ASPHALTIC CONCRETE: 40mm.t FILL: Gravelly sand, fine to coarse grained, brown, fine to medium grained, grey igneous gravel.	M			
					N = 10 4,5,5				CH	as above, but orange brown.	MC>PL	VSt	380 310 250	
						50	1			SILTY CLAY: high plasticity, grey mottled red brown.				
					N = 11 4,4,7					SILTY CLAY: high plasticity, light grey, trace of medium grained ironstone gravel.		H	220 320 410	
						49	2				MC~PL			
					N = 28 7,13,15	48	3		-	SHALE: grey and dark grey, with clay seams.	XW	EL	540 520	REMOULDS TO A MATERIAL WITH CLAY PROPERTIES
										SANDSTONE: fine grained, light brown, with shale seams and clay seams.	XW - DW	EL - VL		VERY LOW 'TC' BIT RESISTANCE
						47	4							
						46	5				DW	VL - L		LOW RESISTANCE
										SANDSTONE: fine grained, light grey.	SW	H		HIGH RESISTANCE
						45	6			REFER TO CORED BOREHOLE LOG				

JK_LIB_CURRENT - V8.00.GLB Log J & K AUGERHOLE - MASTER 29845L KINGSWOOD.GPJ <<DrawingFile>> 23/02/2017 11:48 Produced by gINT Professional, Developed by Datgel

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 10
2 / 3

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L | **Core Size:** NMLC | **R.L. Surface:** ~51.1 m
Date: 10/1/17 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK305 | **Bearing:** N/A | **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: DEFECT SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
		46			START CORING AT 5.94m					
		45	6		SANDSTONE: fine grained, light grey, with iron indurated bands.	SW	M - H			
		44	7		as above, but trace of dark grey laminae.		M			
					SHALE: dark grey and grey, with fine grained, grey sandstone bands.		L - M			(7.28m) J, 90°, P, R (7.53m) XWS, 0°, 4 mm.t (7.67m) XWS, 0°, 10 mm.t
		43	8				L			(7.95m) XWS, 0°, 7 mm.t (8.03m) XWS, 0°, 5 mm.t
100% RETURN							M			(8.61m) J, 90°, Un, S (8.74m) J, 90°, P, S (8.86m) J, 90°, P, R (8.98m) J, 90°, P, S (9.04m) FRAGMENTED ZONE, 0°, 3 mm.t
		42	9				L			(9.43m) XWS, 0°, 1 mm.t (9.61m) XWS, 0°, 2 mm.t (9.66m) XWS, 0°, 40 mm.t (9.75m) Be, 0°, 20 mm.t
		41	10				M			(10.06m) FRAGMENTED ZONE, 0°, 15 mm.t (10.11m) XWS, 0°, 1 mm.t (10.29m) XWS, 0°, 10 mm.t (10.50m) J, 90°, P, R, XW INFILL (10.76m) CS, 0°, 3 mm.t
			11		CORE LOSS 0.13m					
		40			SHALE: grey.	XW	EL			
						DW	VL			(11.58m) XWS, 0°, 100 mm.t
						XW	EL			

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 10
3 / 3

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L | **Core Size:** NMLC | **R.L. Surface:** ~51.1 m
Date: 10/1/17 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK305 | **Bearing:** N/A | **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT SPACING (mm) (500, 300, 100, 50, 30, 10)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
100% RETURN		39			SHALE: grey. *(continued)*	XW	EL			
						DW	L			(12.57m) XWS, 0°, 140 mm.t
			13							(12.88m) J, 30°, P, R
		38								(13.02m) J, 30°, P, R (13.11m) J, 30°, P, R (13.18m) XWS, 0°, 35 mm.t (13.29m) XWS, 0°, 2 mm.t (13.40m) J, 20°, P, R (13.48m) XWS, 0°, 3 mm.t
					SHALE: grey and dark grey.		L - M			(13.76m) FRAGMENTED ZONE, 0°, 80 mm.t (13.82m) CS, 0°, 1 mm.t (13.84m) CS, 0°, 2 mm.t
		37	14							(14.21m) CS, 0°, 80 mm.t (14.43m) CS, 0°, 140 mm.t (14.58m) J, 90°, P, S, XW INFILL
					SHALE: grey and dark grey, with fine grained, grey sandstone bands.	SW	M			(14.93m) Be, 0°, P, S (15.09m) J, 90°, P, R
		36	15				VL			(15.33m) XWS, 0°, 20 mm.t
							L - M			
		35	16							(16.22m) J, 45°, P, R
					END OF BOREHOLE AT 16.26 m					
		34	17							
		33	18							


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JOB No. 29845L BH10 START CORING AT 5.94m
5
6
7
8
9
10
11
12
13
14
15
16
CORE LOSS 0.8m
EOH AT 16.26m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 11
1 / 3

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L **Method:** SPIRAL AUGER **R.L. Surface:** ~50.5 m
Date: 23/12/16 **Datum:** AHD
Plant Type: JK305 **Logged/Checked By:** A.B./L.S.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING									-	ASPHALTIC CONCRETE: 40mm.t FILL: Sandy gravel, fine to medium grained igneous, grey, fine to medium grained sand.	M			ROADBASE
					N = 8 5,4,4	50	1		CL	SILTY CLAY: medium plasticity, light grey.	MC>PL	St	160 120 180	
												VSt		
					N = 11 3,5,6	49	2			as above, but with fine to medium grained ironstone gravel.			230 230 210	
						48						H		
					N = 16 9,6,10	47	3						430 560 560	
							4		-	SANDSTONE: fine grained, light brown, with shale and iron indurated bands.	DW	VL		VERY LOW 'TC' BIT RESISTANCE
					N=SPT 8/ 30mm REFUSAL	46	5					VL - L		LOW RESISTANCE WITH MODERATE BANDS.
						45				SANDSTONE: fine grained, grey.	SW	H		HIGH RESISTANCE
							6			REFER TO CORED BOREHOLE LOG				
						44								

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 11

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L | **Core Size:** NMLC | **R.L. Surface:** ~50.5 m
Date: 23/12/16 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK305 | **Bearing:** N/A | **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DETAILS: DEFECT SPACING (mm) (500, 300, 100, 50, 30, 10)	DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General
		45			START CORING AT 5.76m					
			6		SANDSTONE: fine grained, grey.	SW	VH			(5.84m) HEALED J, 90°, P
		44			SANDSTONE: fine grained, grey and light brown.		H			
			7				M - H			
		43			SANDSTONE: fine grained, grey and brown, with grey and dark grey shale bands.	DW	VL			(7.52m) XWS, 0°, 50 mm.t (7.70m) XWS, 0°, 7 mm.t (7.88m) FRAGMENTED ZONE, 0°, 35 mm.t (7.90m) CS, 0°, 4 mm.t (8.01m) XWS, 0°, 1 mm.t
			8				M			
		42			CORE LOSS 0.20m					
100% RETURN					SHALE: dark grey with fine grained, grey sandstone bands.	SW	M - H			(8.64m) XWS, 0°, 70 mm.t (8.71m) XWS, 0°, 3 mm.t
			9							(9.00m) J, 90°, P, S, IS (9.12m) FRAGMENTED ZONE, 0°, 30 mm.t
		41								(9.31m) J, 90°, P, S, IS (9.61m) J, 70°, P, S
			10							
		40								(10.46m) Be, 0°, P, S
			11							(10.79m) J, 90°, P, S (11.03m) J, 90°, P, S (11.25m) XWS, 0°, 40 mm.t
		39			SHALE: grey and dark grey.		VL M			

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 11
3 / 3

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L | **Core Size:** NMLC | **R.L. Surface:** ~50.5 m
Date: 23/12/16 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK305 | **Bearing:** N/A | **Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT SPACING (mm) (500, 300, 100, 50, 30, 10)	DEFECT DETAILS: DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific / General
100% RETURN		38	13		SHALE: grey and dark grey. *(continued)*	XW	EL			
						FR	M			(13.20m) J, 10°, P, R
		37								(13.64m) XWS, 0°, 1 mm.t
			14							(14.00m) Be, 0°, P, S
		36								
			15		END OF BOREHOLE AT 14.76 m					
		35								
			16							
		34								
			17							
		33								
			18							
		32								