



ABN 64 002 841 063

Job No: 14561/2 Our Ref: 14561/2-AA 18 November 2019

Australian Foundation for Disability C/- J Wyndham Prince Pty Ltd PO Box 4366 PENRITH WESTFIELD NSW 2750 Email: <u>mwhite@jwprince.com.au</u>

Attention: Mr M White

Dear Sir

re: Proposed Multi Storey Mixed Development Lot 1 in DP7711927, 61-79 Henry Street, Penrith Geotechnical Investigation Report

This report presents the results of a geotechnical investigation carried out at the above site for the proposed mixed use development. Preliminary Contamination Assessment (PCA) of the site is not included and reported separately. The investigation was approved by Mr M Bellantonio of Australian Foundation for Disability in a signed confirmation of engagement dated 8 October 2019 and was carried out in accordance with the scope of work detailed in the Geotechnique Pty Ltd proposal (Our Ref: Al.sf/Q8898) dated 22 August 2019.

Proposed Development

Based on the preliminary concept drawings received, it is understood that the proposed development at the above site involves demolition of existing commercial building structures and construction of a number of multi-storey buildings (both commercial and residential use) including a hotel building at the south-west corner. The proposed buildings are up to twenty storeys high with three levels of basement car park. The basement excavation is anticipated to be about 9.0m deep below the existing ground surface.

A geotechnical investigation was required to assess the sub-surface conditions across the site in order to provide geotechnical recommendations on design of basement excavation, retaining structures, floor slabs and footings.

Regional Geology

The Geological Map of Penrith (Geological Series Sheet 9030, Scale 1:100,000, Edition 1, 1991), published by the Department of Minerals and Energy indicates the residual soils within the site to be underlain by Triassic Age Shale of the Wianamatta Group, comprising shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff. Quaternary Age soils of the Cranebrook Formation, comprising of gravel, sand, silt and clay, can be expected along the western boundary line of the site.



The Soil Landscape Map of Penrith (soil Landscape Series Sheet 9030, Scale 1:100,000, 1989), prepared by the Soil Conservation Service of NSW, indicates that the site is located within the Luddenham Landscape area and typically consists of poorly drained, relatively impermeable residual natural soils.

The Salinity Potential in Western Sydney (2002) map indicates that the site has Moderate Salinity Potential.

Field Work

Field work for this investigation was carried out between 30 October and 1 November 2019 and included the following:

- Carrying out a walk over survey to assess general site conditions and identify preferred locations for boreholes.
- Reviewing services plans obtained from "Dial Before You Dig" to determine locations of underground services across the site.
- Scanning the proposed borehole locations for underground services to ensure drilling would not damage existing services. We engaged a specialist services locator for this purpose.
- Drilling five boreholes (BH1 to BH5) within the accessible part of the site using a track mounted drilling rig fully equipped for geotechnical investigation. Boreholes were initially drilled to V / TC-bit refusal in bedrock and then continued (by rock coring) to depths beyond the proposed excavation levels for basements. Borehole locations are shown on the attached Drawing No 14561/2-AA1 and the engineering borehole logs and core photographs, are also attached.
- Conducting Standard Penetration Test (SPT) in the boreholes at regular depth interval to assess strength characteristics of sub-surface soils.
- Recovering representative soil samples and core samples for visual assessment and laboratory testing.
- Measuring depths to groundwater level or seepage in the boreholes, where encountered.
- Install two standpipes in the machine drilled borehole for future monitoring of the groundwater level.

Field work was supervised by a Geotechnical Engineer from this company who was responsible for nominating the borehole locations, supervision of drilling and field test, collection of soil and rock samples for laboratory testing and preparation of engineering logs.

Site Description

The site consisted of a large single storey commercial building to the north and two double storey commercial buildings to the east and west. The vacant portion of the site is occupied by a large car park in the middle and concrete driveways along the boundary lines. The site is of semi-rectangular shape and bounded by Great Western Highway to the north, Lawson Street to the west, Henry Street to the south and commercial property to the east. Topography of the site is generally flat with a mild slope towards west.

Sub-surface Conditions

Sub-surface conditions encountered at the site are detailed in the attached borehole logs, and summarised in the Table below.

Borehole No	Top RL (AHD m)	Termination Depth (m)	Pavement Thickness (mm)	Fill (m)	Natural Soil (m)	Bedrock (m)
BH1	31.436	14.0	200*	0.2 – 1.2	1.2 – 7.6	7.6 - >14.0
BH2	31.989	10.5	200*	0.2 – 0.7	0.7 – 5.2	5.2 - >10.5
BH3	35.091	10.0	150**	0.15 – 1.6	NE	1.6 - >10.0
BH4	31.574	10.0	200**	NE	0.2 – 0.9	0.9 - >10.0
BH5	33.086	10.5	500**	0.5 – 3.7	3.7 – 5.7	5.7 - >10.5

Table 1: Subsurface Conditions

NE: Not Encountered *Asphalt Concrete Pavement (car park) **Cement Concrete Pavement (drive way)

The materials encountered in the boreholes can be generally described as below:

Pavement Layers	Cement Concrete
	Asphalt Concrete
	Road-base Gravel
Fill	Sand, fine grained, yellow/grey
	Silty Clay, low to medium plasticity, brown, traces of gravel
	Silty Clay, medium plasticity, brown mottled grey, with mixed gravel and ironstone
	Silty Clay, medium to high plasticity, grey/brown
Natural	Silty CLAY, low to medium plasticity, red/brown, traces of ironstone gravel
	Silty Sandy CLAY, medium plasticity, pale brown mottled orange
	CLAY, medium to high plasticity, brown grey
	Sandy CLAY, medium to high plasticity, grey/orange, with ironstone gravel
Bedrock	SHALE, grey, extremely to distinctly weathered, low to medium strength
	SHALE, grey, slightly weathered to fresh, medium to high strength

Geotechnical Model

Based on the information presented in Table 1, the sub-surface profile within the proposed development is anticipated to comprise a sequence of fill and natural clayey soils underlain by weathered shale bedrock. Sandy fill encountered at borehole location BH3 is likely to be trench backfilling material from nearby stormwater pipe. The pavement profile in the car park area consisted of asphalt concrete layer (40mm) underlain by road-base gravel (160mm) over clayey subgrade. Thickness of concrete driveways along the boundary lines likely to vary between 150 to 200mm. Depth to bedrock across the site varies between 0.9m and 7.6m below the existing ground surface.

Groundwater Conditions

Groundwater/seepage was encountered at borehole location BH1 at a depth 5.0m from the existing ground surface. Other boreholes were found to be in dry condition within the auger depth. Note that water used for coring precluded measurement of groundwater level at completion of drilling. It should also be noted that fluctuations in the level of groundwater/seepage might occur due to variations in rainfall and/or other factors not evident during drilling. To monitor long term water level at site, two monitoring wells were installed during the field investigation at borehole locations BH2 and BH4.

3

Laboratory Testing

Rock cores obtained from the boreholes were photographed and tested at regular depth intervals for the determination of the Point Load Strength Index (I_{s50}). The point load strength indices for the rock cores and the assessed rock strengths, in accordance with Australian Standard AS1726-1993 (Reference 1), are summarised in the following Table 2.

Borehole No	Depth (m)	Diametral I _{s(50)} (MPa)	Axial I _{s(50)} (MPa)	Diametral Assessed Strength*	Axial Assessed Strength*
	9.56	0.60	1.69	Medium	High
	10.71	0.40	1.50	Medium	High
BH1	11.90	0.67	1.30	Medium	High
	12.73	0.50	1.32	Medium	High
	13.48	0.46	1.96	Medium	High
	7.73	4.16	4.61	Very High	Very High
вцо	8.75	0.35	0.78	Medium	Medium
	9.38	0.73	1.89	Medium	High
	10.36	0.27	1.32	Low	High
	7.77	0.48	0.44	Medium	Medium
BH3	8.63	0.68	0.69	Medium	Medium
	9.66	0.60	1.78	Medium	High
	6.92	1.28	2.10	High	High
	7.52	0.55	0.62	Medium	Medium
	8.73	0.45	1.23	Medium	High
	9.70	0.36	0.65	Medium	Medium

Table 2: Point Load Strength Index

* Estimated strength, I_{s(50)}: <0.03: Extremely Low, 0.03-0.1: Very Low , 0.1-0.3: Low, 0.3-1.0: Medium, 1.0-3.0: High, 3.0-10.0 Very High # Estimated Unconfined Compressive Strength (UCS) ≈ 12 x Axial Point Load index

It should be noted that Point Load Strength tests could only be carried out on intact (stronger) portions of rock cores. Therefore, strength assessments presented in Table 2 indicate the upper limits of rock strengths.

Bedrock Classification for Foundation Design

Based on subsurface conditions (Table 1), rock strengths (Table 2) and rock discontinuities (shown in the borehole logs); bedrock from the proposed development site is classified for foundation design in accordance with Pells et al (Reference 2) in Table 3 below.

		Top Depth to	Bedrock (m)
Borehole No	Top RL (mAHD)	Class V or IV	Class III or better
BH1	31.436	7.6	8.5
BH2	31.989	5.2	7.5
BH3	35.091	1.6	7.4
BH4	31.574	0.9	7.4
BH5	33.086	5.7	8.1

Table 3: Bedrock classification

4



DISCUSSION AND RECOMMENDATIONS Excavation Condition

Proposed development is understood to involve 9m deep basement excavation. Therefore, materials to be excavated are expected to comprise clayey fill, natural clay and weathered shale bedrock. It is considered that excavation of overburden soils and weathered shale bedrock (Class V or IV) could be achieved using conventional earthmoving equipment, such as excavators (20 tonnes or more). However, excavation into Class III or better shale would be considerably more difficult and require larger equipment (such as Caterpillar D9 or equivalent with a rock hammer or rock saw). Selection of rock cutting equipment is based on site access, desired smoothness of the excavated rock surface and acceptable ground vibration during rock excavation.

Groundwater/seepage was encountered at borehole location BH1 (middle of the site) at a depth 5.0m below the existing ground surface. Other boreholes were found to be in dry condition within TC-bit refusal depths. We do not anticipate significant groundwater inflow during proposed excavation. Minor groundwater/seepage inflow if any could be managed by a conventional sump and pump method. It should be noted that fluctuations in the level of groundwater/seepage might occur due to variations in rainfall and/or other factors and trafficability problems could arise locally during wet weather or if water is allowed to pond at the site. We suggest a specialist dewatering contractor be contacted for advice if significant groundwater inflow is encountered during basement excavation. To monitor long term water level at site, two monitoring wells were installed during the field investigation.

Batter Slopes and Retaining Structures

Proposed development will involve approximately 9m deep excavation for basement. Some minor fill placement might also be required during site preparation work. Cut and fill slopes during and after development works should be battered for stability or retained by engineered retaining structures. Recommended batter slopes for the stability of cut and fill slopes are presented in Table 4.

Material	Temp (Vertical :	oorary Horizontal)	Perm (Vertical : I	anent Horizontal)
	Protected	Exposed	Protected	Exposed
Controlled Fill/ Natural Clay	1.0 : 1.0	1.0 : 1.5	1.0 : 2.0	1.0 : 2.5
Shale - Class V to IV	1.0 : 0.75	1.0 : 1.0	1.0 : 1.0	1.0 : 1.5
Shale - Class III or better	Sub-vertical	Sub-vertical	Sub-vertical	Sub-vertical

Table 4: Recommended batter slopes

Vertical excavations in Class III shale will have a low risk of instability. However, some local rock bolting and shotcreting might be required depending on the relative orientation of rock discontinuities (bedding partings, fractures and joint systems) and excavation faces. The borehole logs and core photographs show some rock discontinuities. Therefore, it is important that an experienced geotechnical engineer should inspect if excavation progresses in excess of 1.5m and identify any signs of instability and recommended suitable stabilisation methods. It is also recommended that battered slopes and excavation faces are provided with adequate surface and sub-surface drainage.



Batter slopes steeper than those recommended in Table 4 need to be retained by engineered retaining structures. Appropriate retaining structures for the proposed development would comprise soldier pier walls installed before excavation is commenced. The centre to centre spacing of piers can range from 2 to 3 times pier diameter.

Earth pressure distribution on such cantilevered retaining walls may be assumed to be triangular in shape and estimated as follows:

 $p_h = \gamma kH$

Where,

p _h	=	Horizontal active earth pressure (kN/m ²)
γ	=	Bulk density of materials to be retained (kN/m ³)
k	=	Coefficient of earth pressure $(k_a \text{ or } k_0)$
ka	=	Active earth pressure coefficient
k ₀	=	At rest earth pressure coefficient
Н	=	Retained height (m)

For anchored retaining walls, earth pressure distribution can be assumed trapezoidal with estimated peak value as 5H (8H for at rest condition) kPa, where H is the retained height (m). The pressure distribution should be nil at the surface, increasing to 5H (8H for at rest condition) at depth of 0.25H and remaining constant to 0.75H, then decreasing to nil at the base of the excavation.

For the design of flexible retaining structures where some lateral movement is acceptable an active earth pressure coefficient (k_a) is recommended. If it is critical to limit the horizontal deformation of a retaining structure use of an earth pressure coefficient at rest (k_0) should be considered. Recommended earth pressure coefficients for the design of retaining structures are presented in the following Table 5.

Retained Material	Unit Weight (kN/m ³)	Active Earth Pressure Coefficient, K _a	At Rest Earth Pressure Coefficient, K ₀	Ultimate Passive Earth Pressure (kPa)
Controlled Fill/ Natural Clay	18	0.40	0.60	Ignore
Shale - Class V to IV	20	0.20	0.30	350*
Shale - Class III or better	22	Not Applicable	Not Applicable	1000*

Table 5: Recommended eart	h pressure coefficients
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* Apply appropriate factor of safety

The above coefficients are based on the assumption that ground level behind the retaining structure is horizontal and the retained material is effectively drained. Additional earth pressures resulting from surcharge load (buildings, infrastructures, etc) on retained materials and groundwater pressure, if any should also be allowed for in design of retaining structures. The design of any retaining structure should also be checked for bearing capacity, overturning, sliding and overall stability of the slope.

6



Rock anchors might be required for the support of retaining structures. We recommend that rock anchors are taken into Class IV or better bedrock and can be designed for a bond strength (between grout and bedrock) taken as 10% of end bearing capacity values recommended in "Footings" section of the report.

Floor Slabs and Footings

Assuming that the proposed structure will have three levels of basements, material at the base of basement excavation is anticipated to be to be Class III shale. Floor slabs for proposed buildings may be constructed as ground bearing slabs or suspended slabs supported by footings designed in accordance with recommendations provided in this report. For the design of ground bearing slabs, we recommend a Modulus of Subgrade Reaction Value of 30kPa/mm for Class V or IV shale and 50kPa/mm for Class III or better shale.

Loading conditions from the proposed structure are not known at this stage. We consider that appropriate foundations would comprise either shallow footings (pad and strip) or deep foundations (bored piers). Deep footings might be preferable if footings are required to support significant lateral and/or uplift pressures. The recommended allowable bearing pressures for design of shallow and deep foundations are presented in the following Table 6.

Founding Material	Allowable Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Natural Clay	150	Ignore
Shale – Class V	600	50
Shale - Class IV	1200	100
Shale - Class III	3000	250

Table 6: Recommended allowable bearing pressures

The recommended allowable shaft adhesions against uplift pressures are half the shaft adhesions for compressive loads presented in Table 6.

As depths to bedrock with the recommended allowable bearing pressures could vary across the site, the founding depths of footings to be constructed will also vary. The depth ranges presented in Table 3 are measured from existing ground surface at borehole locations and are indicative only. Therefore, an experienced Geotechnical Engineer on the basis of assessment made during footing excavation or pier hole drilling should confirm founding levels during construction. The engineer should ensure that the design strength of bedrock is achieved.

For footings founded in bedrock total settlements under the recommended allowable bearing pressures are estimated to be about 1% of pier diameter or minimum footing dimension. Differential settlements are estimated to be about half the estimated total settlements. Although groundwater/seepage was not encountered during drilling, it might be prudent to provide sub-floor drainage for long-term conditions.

7



General

Assessments and recommendations presented in this report are based on site observation and information from five boreholes only. Although we believe that the sub-surface profile presented in this report is indicative of the general profile across the site, it is possible that the sub-surface profile could differ from that encountered in the boreholes. Likewise, comments on groundwater/seepage are based on observation during field work. We recommend that this company is contacted for further advice if actual site conditions encountered during basement excavation differ from those presented in this report.

If you have any questions, please do not hesitate to contact the undersigned.

Yours faithfully GEOTECHNIQUE PTY LTD

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DR MD ARIFUL ISLAM (MIEAust CPEng NER) Senior Geotechnical Engineer

Attached Drawing No 14561/2-AA1 Borehole Locations Borehole Logs (BH1 to BH5), Core Photographs, and Explanatory Notes

References

- 1. Australian Standard, Geotechnical Site Investigation, AS1726-1993.
- 2. Pells, P J N, Mostyn, E and Walker, B F, Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, Dec 1998.





engineering log - borehole

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engineering log - borehole

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engineering log - borehole

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form no. 002 version 04 -			6		DS	n=13 4,5,8	4.5		grey/red with yellow staining, trad ironstone gravel	on pressivity,				- - - - - -



engineering log - borehole

	Cli Pro Lo	ent : oject catic	:: on:	J Pi 61	Wync opos I-79 ł	lham I ed Mu Henry	Prino Ilti S Stre	ce Pty torey l et, Pe	Ltd Mixed Development nrith	Job N Bore Date Logge	No.: 1 hole N : 31/ [:] ed/Che	4561/ o. : 10/201 cked b	2 BH2 9 y : RR	
d	rill	moc	lel ar	nd m	ount	ing :	С	hristie	Hydropower Rig	slope :	de	eg.	R.L. sı	I rface :
	ho	le di	amet	er :	75	r	nm		bearing :	deg.	dat	um :		AHD
method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESC soil type, plasticity or partic colour, secondary and mine	RIPTION cle characteristic, or components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
					n= Refusal 20/50	5.5 — 5.5 — 6.5 — 7 — 7.5 — 7 — 8 — 8.5 — 9 — 9.5 — 9.5 — 9 — 9.5 —			SHALE, grey, extremely to c low to medium strength, with Started coring BH2 at 7.1m	istinctly weathered, a clay bands				Bedrock

	Clien Proje Locat	t: ct: tion:	J P 6	Wyndham Prince Pty Ltd Proposed Multi Storey Mixed Develo 1-79 Henry Street. Penrith	pment	:		E	Job No. : Borehole N Date : 31/1	14561/2 o.: BH2 0/2019
				,,				L	_ogged/Che	cked by : RR
	drill n	nodel	and	mounting : Christie Hydrop	ower	Rig		slope	: deg	R.L. surface : ≅31.989
	core	size:		NMLC		1	be	aring	: deg	. datum :
		Ŀ	5	CORE DESCRIPTION	_		poi	nt load		DEFECT DETAILS
barrel lift	water loss/level	depth of R in meters	graphic lo	rock type, grain characteristics, colour, structure, minor components.	weathering	strength	ir str Iç EL VL	idex ength (50) ∟ ^M н ^{VH}	defect spacing (mm) ន្តិ ខ្ញុំ ខ្លួ ខ្លួ ខ្ញុ ខ្ញុ	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific General
		7		Started coring BH2 at 7.1m	D\4/					
		_		SHALE, grey	SW	Н				
		_		Coreloss (50mm) SHALE, grey	DW-	н				
		7.5 —			SW					_ Bp=0 ⁻ , Ir, Ro, Cg _ Jo=15°, Un, Sm, Cn _ lo=5°, Ir, Bo, Cn
		_								-
		_						×		
		_								-
		8 —								-
		_								-
		-								- Cs=50mm Un Ro Ca
		8.5 —								
		_								-
		_								
		9								Bp=0°, Ir, Ro, Cg
		_								
		_								
		_						×		
		9.5 —								
		_								
		_								Jo=0°, PI, Ro, Sn Jo=0° PI, Ro, Sn
		_								Jo=0°, PI, Ro, Sn Ds=10mm, PI, Sm, Cg
		10 ——								– Ds=20mm, PI, Sm, Cg Bn=30° PI Sm Cn
		_								
		_								-
L		-10.5						Î		
		-		Terminated BH2 at 10.5m						
										-
		_								
		11 —								- I
09/10		_								
03 -		_								
ersior		_								
003 v		11.5								
n no.		_								
forn										-







engineering log - borehole

	Cli Pro Lo	ent : oject catic	:: on:	J ۷ Pr 61	Wync opos -79	lham I ed Mu Henry	Prino Ilti S Stre	ce Pty torey et, Pe	Ltd Mixed Development nrith	Job I Bore Date Logg	No.: 1 hole N : 31/ [;] ed/Che	4561/ o.: I 10/201 cked b	2 3H3 9 y : RR	
d	rill	moc	lel ar	nd m	ount	ing :	С	hristie	Hydropower Rig	slope :	de	eg.	R.L. sı	Irface :
	ho	le di	amet	er :	125	r	nm		bearing :	deg.	dat	um :		AHD
method	groundwater	env samples	PID reading (ppm)	geo samples	field test	, depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIP soil type, plasticity or particle o colour, secondary and minor c	TION :haracteristic, omponents.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						U _			Concrete cement (150mm)					Driveway Pavement
		GP			n=9	 0.5			FILL: Sand, fine grained, yellow,	/grey	M=OMC			Bedding sand next to stormwater pipe
		GP		DS	4,4,5	_								_
						1								
						1.5 —								
		G		DS	n=16 7,6,10	2.5 			SHALE, grey, very low to low st extremely weathered, with clay SHALE, grey, low strength, extra distinctly weathered	emely to				Bedrock
						4								



engineering log - borehole

	Cli Pro Lo	ent : oject catio	:: on:	J V Pr 61	Wync opos -79	lham F ed Mu Henry	Prino Ilti S Stre	ce Pty torey I et, Pe	Ltd Mixed Development nrith	Job I Bore Date Logg	No.: 1 hole N : 31/ [:] ed/Che	4561/ o.: I 10/201 cked b	2 3H3 9 y: RR	
C	Irill	mod	lel ar	nd m	ount	ing :	С	hristie	Hydropower Rig	slope :	de	eg.	R.L. su	I rface :
	ho	le di	amet	er :	125	r	nm		bearing :	deg.	dat	um :		AHD
method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCI soil type, plasticity or partic colour, secondary and mine	RIPTION le characteristic, or components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						5.5 			SHALE, grey, low to medium extremely to distinctly weath SHALE, grey, medium to hig distinctly weathered	estrength, ered				
									Started coring BH3 at 7.2					



Clie	ent :	J	Wyndham Prince Pty Ltd			J	ob No.: 1	4561/2
Pro	oject :	F	Proposed Multi Storey Mixed Dev	/elopment		E	Borehole No	b.: BH3
	cation :	6	51-79 Henry Street, Penrith				Date: 01/1	1/2019 Ired by L. BB
	mode	اممط	mounting Christia Usa	Iropower		L	.oggea/cnec	
	n moae	and		a opower i	xig	siope	. aeg.	κ.∟. suriace : ≅35.091
cor	e size:		NMLC	1		bearing :	deg.	datum :
	<u>ب</u>	5	CORE DESCRIPTION			point load		DEFECT DETAILS
≝	of R ters	iclo	rock type, grain characteristics.	erinç	£	index	defect spacing	DESCRIPTION
arrel ater	epth epth	raph	colour, structure, minor component	eath s:	trenç	IS(50)	(mm)	planarity, roughness, coating.
_ ຊີ.		<u></u>	Started coring BH3 at 7.2m	3	ن		20 20 20 20 20 20 20 20 20 20 20 20 20 2	Specific General
	-							-
	-		SHALE, grey	DW- MW	м-н			Cs=30mm, Ir, Ro, Sn
	-							Jo=80°, Un, Ro, Sn Bn=0° Pl. Sm. Cn
	7.5 —							$D_{s=10}$ mm Pl Ro Ca
	-							- Jo=0°, PI, Ro, Cg
	-					×		-
	8-							_ Jo=90°, Un, Ro, Cn ─
	-							-
	-							- Jo=90° - Jo=0° PL Ro Ca
	-							-
	8.5							
	-					×		-
	-							-
	-	_						Jo=0°, PI, Ro, Cg
	9-							
	-							- Jo=90°, Un, Sm, Sn
	-							- Jo=0°, PI, Sm, Cn Jo=0°, PI, Sm, Cn - Rn=0°, PI, Sm, Cn
	9.5 —							
	-					×		Bp=10°
	-							-
	-							-
	10		Terminated coring BH3 at 10.0m					-
	-	-						
	-	-						-
	10.5							-
	-	_						-
	-							
	-	_						-
	11 —	-						
	-							
	-	_						
	-	-						
	11.5							
	-	-						

form no. 003 version 03 - 09/10







engineering log - borehole

Location: 61-79 Henry Street, Penrith Date Logo	jed/Che	/11/20 [·] ecked k	19 by: RR	
drill model and mounting : Christie Hydropower Rig slope :	d	eg.	R.L. sı	u rface :
hole diameter : 75 mm bearing : deg.	dat	tum :		AHD
method ground water method env method samples nondwater env samples nondwater ground water ground water nondwater ground water ground water	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
Image: Secondary and minor components. Image: Secondary and minor components. G G G G Concrete Cement (200mm) G G G G G G DS Free secondary and minor components. Concrete Cement (200mm) G G DS Free secondary and minor components. Concrete Cement (200mm) G DS Free secondary and minor components. Cl-Cl DS Free secondary and minor components. SHALE, grey, low to medium plasticity, red motified brown 1 Free secondary and minor components. SHALE, grey, very low strength, residual soil to extremely weathered, with clay bands 1 Free secondary and minor components. SHALE, grey, low to medium strength, extremely to distinctly weathered 3 Free secondary and minor components. SHALE, grey, low to medium strength, extremely to distinctly weathered	M <pl< th=""><th>VSt</th><th></th><th>Driveway Pavement</th></pl<>	VSt		Driveway Pavement



engineering log - borehole

drill model and mounting: Christie Hydropower Rig slope : deg. R.L. surface :=31. hole diameter : 75 mm bearing : deg. datum : AHD is an intermediation of the second		Cli Pro Lo	ent : oject catio	:: on:	J ' Pr 61	Wyno opos I-79 I	dham F ed Mu Henry	Prino Ilti S Stre	ce Pty storey l eet, Pe	Ltd Mixed Development nrith	Job Bore Date Logg	No.: hole N : 01/ ed/Che	14561/ lo.: 11/201 cked b	2 BH4 I9 y: RR	
hole diameter: 75 mm bearing: deg. datum: AHD value <	d	rill	mod	lel ar	nd m	ount	ing :	С	hristie	Hydropower Rig	slope :	de	eg.	R.L. sı	ırface : ≅31.574
Solutional solutional		ho	le di	amet	er :	75	n	nm		bearing :	deg.	dat	um :		AHD
by b	method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESC soil type, plasticity or partic colour, secondary and mine	RIPTION cle characteristic, or components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
Started coring BH4 at 5.3m 5.6 6 6 7 7.8 8		DRY					5 								-
		DRY								Started coring BH4 at 5.3m					



Clie	nt :	J	Wyndham Prince Pty Ltd				J	ob No.: 1	4561/2
Pro	ject :	Ρ	roposed Multi Storey Mixed Develop	oment			В	Sorehole No	b.: BH4
Loc	ation :	6	1-79 Henry Street, Penrith				D)ate: 01/1	1/2019
							L	ogged/Chec	ked by : RR
drill	model	and	mounting : Christie Hydrop	ower	Rig	slo	pe	: deg.	. R.L. surface : ≅31.574
core	e size:	,	NMLC			bearin	ıg :	deg.	. aatum :
	<u>ب</u>		CORE DESCRIPTION			point loa	ad		DEFECT DETAILS
ti ti ti ti	of R ers	l o l	rock type grain characteristics	erinç	÷	index	L.	defect spacing	DESCRIPTION
arrel ater	met	aph	colour, structure, minor components.	eath	reng	I _S (50)		(mm)	type, inclination, thickness, planarity, roughness, coating.
a ŝe	2 7 .드	2	Started coring BH4 at 5 3m	Š	st		I VH	50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Specific General
		-							-
			SHALE, grey/brown	EW- DW	M-H				Jo=90°, PI, Sm, Cn
	5.5								_
	-								Jo=0°, St, Ro, Cn
									-
	6								_ Jo=0°, PI, Ro, Cn
									Cs=30mm, PI, Ro, Cn
			SHALE grey with clay bands	EW/-	L-M				Jo=10°, PI, Sm, Cn
			STALE, grey, with day bands	DW					Ds=10mm, PI, Sm, Cn
	6.5								
									-
									-
							×		
	7								Jo=70°, Un, Ro, Cn
			SHALE, grey	DW- MW	M-H				-
									-
	7.5								Jo=0°, PI, Sm, Cn
						×			-
									Jo=0°, PI, Sm, Cg
	8								_
									Jo=0°, PI, Sm, Cg
									- Jo=0°, PI, Sm, Cg
									-
	8.5								_ Jo=0°, PI, Sm, Cg
									- Jo=0°, PI, Sm, Cg
)	K		- Jo=0° PI Sm Ca
									-
	9								-
	-								
	-								Cs=10mm, Pl, Ro, Cn
	9.5								─ Jo=0°, PI, Sm, Cg
						×			
	_								Jo=0°, Pl, Ro, Cn

form no. 003 version 03 - 09/10



	Clien	t :	J	Wyndham Prince	e Pty Ltd						J	ob	No	.:	14	4561/2		
	Proje	ct :	Ρ	roposed Multi St	orey Mixed Develo	pment					В	ore	eho	le	No	b.: BH4		
	Locat	tion :	6	1-79 Henry Stree	et, Penrith						D	ate	:	01	/11	1/2019		
										<u> </u>	L	ogg	jed	Ch	ec	ked by: RR		
	arill r	nodel	and	mounting :	Christie Hydrop	ower l	≺ig	-	S	00	pe			de	eg.	R.L. surface :	≅31.	.574
	core	size:	,		NMLC			b	bea	rin	ig :			de	eg.	datum :		
		Ļ		CORE DE	SCRIPTION	_		p	oint	loa	ad					DEFECT DETAILS		
≝	vel	of R ers	c loc	rock type are	in charactoristics	erinç	Ъ.		inc	lex		s	defe	ect ina		DESCRIPT	ION	
arrel	ater ss/le	epth met	aphi	colour, structure	, minor components.	eath	reng	2	ls(50)			(mr	n) ັ		type, inclination, th planarity, roughness	ickness, , coatin	, g.
ĝ	N N	<u>, 9</u>	g			Š	st	EL		м : :	I VH	200	200	100	<u>9</u>	Specific	Ge	neral
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		_														-	ſ	
		10.5		T												-		
				rerminated BH4 at 1	10.5M											-	ſ	
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form no. 003 version 03 - 09/10







engineering log - borehole

	Cli Pro Lo	ent : oject catic	: on:	J Pr 61	Wync opos I-79 ł	dham F ed Mu Henry	Prino Ilti S Stre	ce Pty torey et, Pe	Ltd Mixed Development nrith	Job I Bore Date Logg	No.: 1 hole N : 01/ ⁻ ed/Chee	4561/ o.: I 11/201 cked b	2 BH5 9 y: RR	
d	rill	moc	lel ar	nd m	ount	ing :	С	hrisite	Hydropower Rig sl	ope :	de	g.	R.L. sı	I rface :
L	ho	le di	amet	er :	75	r	nm		bearing : c	deg.	dat	um :		AHD
method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle charact colour, secondary and minor compor	teristic, nents.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0 — — — —	-		Concrete Cement (500mm)					Driveway Pavement
		GP		DS	n=11 5,5,6	0.5			FILL: Silty Clay, low to medium plastic brown, traces of gravel	ity,	M=OMC			Well compacted
		GP GP DS				1								
		GP		DS	n=13 5,6,7	1.5 — — — —			FILL: Silty Clay, medium to high plastic brown	city, grey/				
		GP				2 —								
		GP G			n=16 6,7,9			СІ-СН	Silty CLAY, medium to high plasticity, brown	grey/	M <pl< th=""><th>St</th><th></th><th>Natural</th></pl<>	St		Natural
						_								-



engineering log - borehole

	Cli Pro Lo	ent : oject catio	:: on:	J Wyndham Prince Pty Ltd Proposed Multi Storey Mixed Development 61-79 Henry Street, Penrith							Job No.: 14561/2 Borehole No.: BH5 Date: 01/11/2019 Logged/Checked by: RR					
drill model and mounting :						ing :	С	hrisite	Hydropower Rig	slope :	de	eg.	R.L. sı	I rface :		
	ho	le di	amet	er :	75	r	nm		bearing :	deg.	dat	um :		AHD		
method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESC soil type, plasticity or particity colour, secondary and min	RIPTION cle characteristic, or components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations		
TC Bit						5 — — 5 — — 5 — — 5.5 — — 6 — — 6 — — 7 — — 7 — — 7 — — 7 — — 8 — — 8 — — 9 — — 9 — — 9 .5 — — 9 — — 9 .5 — —			SHALE, grey/orange, very lo extremely weathered, with c SHALE, grey, low to medium weathered SHALE, grey, medium to hig distinctly to slightly weathered	w strength, lay bands				Bedrock		



engineering log - borehole

Client : Project : Location :			J Wyndham Prince Pty Ltd Proposed Multi Storey Mixed Development 61-79 Henry Street, Penrith						Job No.: 14561/2 Borehole No.: BH5 Date: 01/11/2019 Logged/Checked by: RR					
drill model and mounting :						ing :	С	hrisite	Hydropower Rig	slope :	de	eg.	R.L. sı	Irface :
hole diameter: 75			n	nm		bearing :	deg.	dat	um :		AHD			
method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESC soil type, plasticity or parti colour, secondary and min	RIPTION cle characteristic, or components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
	DRY								Terminated BH5 at 10.5m					
	RY								Terminated BH5 at 10.5m					
						14.5 —								



Li an Calumn		Preservations (Non-cored Borenole Log)
Log Column	Symbol/value	Description
Drilling Method	V-bit	Hardened steel 'V' shaped bit attached to auger
_	TC-bit	Tungsten Carbide bit attached to auger
	RR	Tricone (Rock Roller) bit
	DB	Drag bit
	BB	Blade bit
Groundwater	Dry	Groundwater not encountered to the drilled or auger refusal depth
		Groundwater level at depths shown on log
Environment Sample	CP	Groundwater seepage at depths shown on log
	GF	Glass bottle sample over denths shown on log
	P	Plastic bag sample over depths shown on log
PID Reading	100	PID reading in ppm
Geotechnical Sample	DS	Disturbed Small bag sample over depths shown on log
		Undisturbed 50mm tube sample over depths shown on log
Field Test	N=10	Standard Penetration Test (SPT) 'N' value Individual numbers indicate blows per
	3.5.5	150mm penetration.
	0,0,0	
	N=R	'R' represents refusal to penetration in hard/very dense soils or in cobbles or
	10,15/100	boulders.
		The first number represents10 blows for 150mm penetration whereas the second
		number represents 15 blows for 100mm penetration where SPT met refusal
		Dumentia Cana Departmentian (DCD) or Death Sand Departmentar (DCD). Feeh
	DCP/PSP 5	Dynamic Cone Penetration (DCP) or Perth Sand Penetrometer (PSP). Each
	6	10mm ponetration in bard/vorv dones soils or in grouple or boulders
	R/10	Torring penetration in hard/very dense sons of in gravers of boulders.
	1010	
Classification	GP	Poorly Graded GRAVEL
	GVV	
	GM	
	GC	
	SW	
	SC	Clavey SAND
	MI	SILT/Sandy SILT/clavey SILT low plasticity
	MI	SILT/ Sandy SILT/clavey SILT, medium plasticity
	МН	SILT/ Sandy SILT/clayey SILT, high plasticity
	CL	CLAY/Silty CLAY/Sandy CLAY/Gravelly CLAY, low plasticity
	CI	CLAY/ Silty CLAY/Sandy CLAY/Gravelly CLAY, medium plasticity
	СН	CLAY/ Silty CLAY/Sandy CLAY/Gravelly CLAY, high plasticity
Moisture Condition		
Cohesive soils	M <pl< td=""><td>Moisture content less than Plastic Limit</td></pl<>	Moisture content less than Plastic Limit
	M=PL	Moisture content equal to Plastic Limit
	M>PL	Moisture content to be greater than Plastic Limit
Cohesionless soils		Dry _ Runs freely through hand
	M	Moist - Tends to cohere
	w	Wet - Tends to cohere
Consistency		Term Undrained shear strength, C _u (kPa) Hand Penetrometer (Qu)
Conesive soils		Very Soft ≤12 <25
		SOTT >12 ≤25 25 −50
	F	FIIIII >25 ≤50 50 − 100
	St	Stiff >50 ≤100 100 - 200
		Hard >200 -400
Density Index		Term Density Index, In (%) SPT 'N' (blows/300mm)
Cohesionless soils	VL	Very Loose ≤15 ≤5
	L	Loose >15 ≤35 >5 ≤10
	M	Medium Dense >35 ≤65 >10 ≤30
	D	Dense >65 ≤85 >30 ≤50
	VD	Very Dense >85 >50
Hand Penetrometer	100	Unconfined compressive strength (q_u) in kPa determined using pocket
	200	penetrometer, at depths shown on log
Remarks	Desidual	Geological origin of soils
	Allunium	Residual soils above bedrock
	Collusio	River deposited Alluvial soils
		Gravity deposited Colluvial solls
	Marine	Marine Soile
	wallic	

Log Symbols & Abbreviations (Non-cored Borehole Log)

GEOTECH TESTING PTY LTD

						ומססוווכמווס							
Major C	Divisions	Particle size (mm)	Group Symbol	Typical Names	Field Identifi	cations Sand and	I Gravels				Laboratory classificat	ion	
	BOULDERS	200							% (2) < 0.075mm	Plasticity of Fine Fraction	$C_{\rm u} = D_{60}/D_{10}$	$C_{c} = (D_{30})^{2} / (D_{10} D_{60})$	Notes
	COBBLES	63						,suc					
		Coarse 20	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grai of all intermediate coarse grains, no	iin size and substa sizes, not enough dry strength	ntial amounts fines to bind	jor Divisid	0-5	•	*	between 1 and 3	 Identify lines by the method given for fine orisined soils
	GRAVELS (more than half of coarse fraction is		GP	Poorly graded gravels, gravel- sand mixtures, little or no fines, uniform gravels	Predominantly one some intermediate fines to bind coars	e size or range of s e sizes missing, no se grains, no dry st	sizes with ot enough trength	eM' ni na	0-5		Fails to com	oly with above	
COARSE GRAINED SOILS (more than half of	larger than 2.36mm)	Medium 6	В	Sifty gravels, gravel-sand-silt mixtures	'Dirty' materials wi zero to medium dr	ith excess of non-p ry strength	olastic fines,	viteria giv	12-50	Below 'A' line or <i>l</i> ₀<4			 Borderline classifications occur when the percentage of
material less 63mm is larger than 0.075mm)		Fine 2.36	ပဗ	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials wi medium to high dr	ith excess of plasti ry strength	ic fines,	o ant ot br	12-50	Above 'A' line or <i>l_p>7</i>			fines (fraction smaller than 0.075mm size) is
		Coarse 0.6	MS	Well-graded sands, gravelly sands, little or no fines	Wide range in grai of all intermediate coarse grains, no	in size and substa sizes, not enough dry strength	ntial amounts fines to bind	s accordir	р		9<	between 1 and 3	greater man 5% and less than 12%. Borderline classifications
	SANDS (more than half of	Medium 0.2	Ъ	Poorty graded sands and gravelly sands; little or no fines, uniform sands	Predominantly one some intermediate fines to bind coars	e size or range of s e sizes missing, no se grains, no dry st	sizes with of enough trength	noitasti to	0-5 0		Fails to com	oly with above	require the use of dual symbols e.g. SP-SM, GW- GC
	coarse fraction is smaller than 2.36mm)		SM	Silty sands, sand-silt mixtures	'Dirty' materials wi zero to medium dr	ith excess of non-p ry strength	olastic fines,	ification o	12-50	Below 'A' line or <i>l_p<</i> 4			2
		Fine 0.075	S	Clayey sand, sand-clay mixtures	'Dirty' materials wi medium to high dr	ith excess of plasti ry strength	ic fines,	m for class	12-50	Above 'A' line of <i>l_p>7</i>			
			ML	Inorganic silts and very fine sands, rock flour. siltv or clavev fine	Dry Strength	Dilatancy	Toughness	1m6ð					
				sands or clayey silts with slight plasticity	None to low	Quick to slow	None	<u></u> buiss		Below 'A' line			
	SILTS & CLAYS (liqui	d limit < 50%)	CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, slity clays, lean clays	Medium to high	None to very slow	Medium	aterial pa	աաց	Above 'A' line	40		
FINE GRAINED			or	Organic sitts and organic sitty clays of low plasticity	Low to medium	Slow	Low	m to noite	70.0 prize	Below 'A' line	bercent	5	
SOILS (more than half of material less than 63mm is smaller than			ΗW	Inorganic silts, micaceous or diatomaceous fine sandy or silty soits, elastic silts	Low to medium	Slow to none	Low to medium	the grad	sed %09 (Below 'A' line	<mark>ارسان الم</mark>	5	
0.075mm)	SILTS & CLAYS (liqui	d limit > 50%)	Ю	Inorganic clays of medium to high plasticity, fat clays	High to very high	None	High	əsU	More than	Above 'A' line	sticity In		НО
			НО	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium			Below 'A' line		╧╺╧	HM
	HIGHLY ORGANIC S	olls	٤	Peat and highly organic soils	Identified by colou generally by fibrou	ır, odour, spongy fi us texture	eeland		Effervesces	with H ₂ O ₂	0 10 20	30 40 50 .iquid Limit (W _L), percer	60 70 80

AS1726 – Unified Soil Classification System



Core Size NQ NMLC NQ 47 52 63 Water Loss Complete water loss Weathering FR First Rock shows no sign of decomposition or staining Water Loss Frequencies Weathering FR First Rock shows no sign of decomposition or staining SW Slightly Weathered Rock shows no sign of decomposition or staining DW Distinctly Weathered Rock shows no sign of decomposition or staining DW Distinctly Weathered Rock shows no sign of decomposition or staining EW Extremely Weathered Rock is weathered to such an extent that it has 'sol' properties, i.e. it either disintegrate or can be remoulded, in water RS Residual Soli Soli developed on extremely weathered for care to forger wident; there is a large change in wolume but sol has not been significantly transported Strength EL Term Point Load Strength Index (Lo., MPa) Very Low x0.03 x0.1 Very Low x0.03 x0.1 Very Low x0.03 x0.1 Very Usity spaced c.20 x0 Very Usity spaced c.20 x0 Very Wigh spaced c.20 x0 Very Wigh spaced c.20 x0 Very Wigh spaced c.200 <tr< th=""><th>Log Column</th><th>Symbol</th><th>Description</th><th></th></tr<>	Log Column	Symbol	Description	
Water Loss Parial water loss Weathering Parial water loss Parial water loss Parial water loss Weathering PR FR Fresh Rock is slightly discoloured but shows little or no change of strength from fresh rock may be highly discoloured but shows little or no change of strength from fresh rock may be highly discoloured analy by inorstaining rocks trangth usually by inorstaining proteites, i.e. i there disintegrate or rate that there is a large change in water that thas soil in water EW Extremely Weathered Rock is weathered to such an exten that thas soil decreased by deposition of weathering products in pores structure and substance failor are no longer wident; there is a large change in wolume but soil has not been significantly transported Strength E Extremely Low >0.03 <0.1	Core Size	NO	Nominal Core Size (mm)	
Water Loss Complete water loss Weathering FR Preial water loss Weathering FR Fresh Rock is slightly discoloured but shows little or no change of strength from fresh rock DW Distinctly Weathered Rock strength usually change bottle or no change of strength from fresh rock DW Distinctly Weathered Rock strength usually change bottle or no change of strength from fresh rock DW Distinctly Weathered Rock strength usually change bottle or no change of strength from fresh rock DW Distinctly Weathered Rock strength usually change bottle or no thange of strength may be highly discoloured, usually by may found that it has 'soil' properties, i.e. it either distingting or can be removided, in water RS Residual Soil Soil developed on extremely weathered rock, the mass structure and subtance fabric are no longer evident; there is a large change in volume but soil has not been significantly transported Strength EL Earremely Low > 0.0 a so.1 Low VL Low > 0.1 so.3 at 1 High High VH El Earremely right Soil developed on extremely weathered rock, then ass structure and subtance fabric are no longer evident; there is a large change in rock low, MPa) Very Vicw > 0.03 at 1 High High > 0.1 so.3 at 1 High VH El Earremely right see spaced 20 to 50 Cond Veray spaced			47 52	
Water Loss Parial water loss Parial water loss Parial water loss Weathering FR Fresh Rock shows no sign of decomposition or staning SW Slightly Weathered Rock is slightly discoloured but shows little or no change of strength from fresh rock may be highly discoloured used by weathering. The rock may be highly discoloured used by leaching. Increased by leaching. Increas			63	
Notes close Description notes Partial water loss Partial water loss Weathering FR Fresh Rock shows no sign of decomposition or staining SW Slightly Weathered Rock is slightly discoloured but shows little or no change of strength meshading by weathering. The rock may be highly discoloured but shows little or no change of strength more than its or solar products in pores DW Distinctly Weathered Rock strength usually changed by weathering. The rock may be highly discoloured but shows little or no change of strength meshading by in or straining. products in pores EW Extremely Weathered Rock is sentered to such an extent that it has sol? Strength Extremely Low Rock is weathered to such an extent that it has sol? Strength EL Extremely Low >0.03 VL Low >0.03 Sol developed on extremely weathered rock, the mass structure and substance lation are no longer evident; an water in water and solar are no longer evident; an water and solar are strength in water in water and solar are strength in the sol in products and be no strength in the sol in product sol in an extent sol in an extent sol in an orbit of the mass structure and substance levident; and the mapped in the sol in an extent sol in an exten sol in a extent sol in an exten sol in a extent sol	Water Loss		Complete water loss	
Veathering Partial water loss Partial water loss Weathering FR Fresh Rock shows no sign of decomposition or staining SW Slightly Weathered Rock is slightly discoloured but shows little or no change of strength from fresh nock usually by ironstaining. DW Distinctly Weathered Rock is sightly discoloured but shows little or no change of strength from fresh nock usually by ironstaining. EW Extremely Weathered Rock is weathered to such an extent that it has soil properties, i.e. telther disintegrate or can be remoulded, in water RS Residual Soil Soil developed on extremely weathered to such an ot sol the mass structure and substance fabric are no longer evident, there is a large change in thume but soil has not been Strength EL Erremely Low Soil developed on extremely mean. VL Very Low 0.03 Soil VH Very Low 0.03 Soil Low Soil developed on extremely keelly be compared to such and been Soil developed on extremely keelly be compared beveloped and to be compa				
Weathening FR Fresh Rock is allow a no sign of decomposition of stanning SW Slightly Weathered Rock is slightly discoloured but shows little or no change of strength time fresh rock DW Distinctly Weathered Rock is slightly discoloured but shows little or no change of strength time fresh rock EW Extremely Weathered Rock is slightly discoloured but shows little or no change of strength rough discoloured but shows little or no change of strength rough discoloured by leaching. The rock may be highly discoloured, usually by ionstaining. Porosity may be increased by leaching or may be decreased by leaching. or may be decreased by leaching. or may be decreased by leaching. The rock structure and substance faince are no longer evident: there is a large change in olonger evident. there is a large change in olonger evident. there is a large change in olonger evident. there is a large change in olonger evident. Strength EL Extremely Low \$0.03 VL Low >0.03 1 Defect Spacing Extermely used parting Jo 20 to 60 Closely spaced <td< td=""><td></td><td></td><td>Partial water loss</td><td></td></td<>			Partial water loss	
SW Slightly Weathered of strength from fresh rock may be highly discoloured, usually by inorstaining. Porosity may be increased by deposition of weathering. The rock may be highly discoloured, usually by inorstaining. Porosity may be increased by deposition of weathering products in pores decreased by deposition of weathering products in pores EW Extremely Weathered Rock is weathered to such an extending on may be decreased by deposition of weathering products in pores RS Residual Soil Soil developed on extremely weathered rock the mass structure and substance fabric are no longer evident; there is a large change in volume but soil has not been significantly transporte Strength Term Point Lead Strength Index (Las, MPa) EL VL Very low > 0.03 VL Low > 0.1 VH Very low > 0.03 VH Very vigh spaced 200 to 600 Very vigh spaced 200 to 600 Very videly spaced <td>Weathering</td> <td>FR</td> <td>Fresh</td> <td>Rock shows no sign of decomposition or staining</td>	Weathering	FR	Fresh	Rock shows no sign of decomposition or staining
DW Distinctly Weathered may be highly discoloured, usually by inorstaining, provisity may be increased by leaching, or may be decreased by leaching, or may be decreased by deposition of weathering products in pores in water EW Extremely Weathered RS Rock is weathered to such an extent that it has 'soil properties, i.e. it either disintegrate or can be remoulded, in water RS Residual Soil Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer exdent; there is a large change in xolume but soil has not been significantly transported to the strength Index (Los, MPa) Strength EL Term (Yery Low) Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer exdent; there is a large change in xolume but soil has not been significantly transported to the strength Index (Los, MPa) Strength EL Term (Yery Low) Soil developed on extremely weathered rock; the mass structure and substance but soil has not been significantly transported to the strength Index (Los, MPa) Defect Spacing EL Term (Yery Low) Soil a soil (Yery Low) Soil (Yery Low) Defect Spacing EL Description (Yery dosely spaced Very dosely spaced Very dosely spaced Very widely spaced Spacing (mm) Defect Description Bp (Fp D) Bp (Yor Widely spaced Very widely spaced Very widely spaced Very widely spaced Soil to 200 Defect Description Bp (Fp D) Shit zone Shit zo		SW	Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength from fresh rock
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RS Residual Soil Soil developed on extremely weathered rock: the mass structure and substance fabric are no longer evident; significantly transported Strength Image: Imag		EW	Extremely Weathered	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrate or can be remoulded, in water
Strength Term Point Load Strength Index (Less, MPa) Extremely Low >0.03 ≤0.1 VL Low >0.1 s0.3 L Low >0.1 s0.3 M High >1 s3 VH Very Low >0.03 ≤1 VH Very High >3 ≤1 Defect Spacing EH Extremely High >10 Defect Spacing Description Spacing (mm) Defect Spacing Description Spacing (mm) Defect Description Spacing (mm) Extremely dosely spaced 200 to 60 Very widely spaced 200 to 600 Widely spaced 200 to 600 Very widely spaced 500 to 2000 Very widely spaced >600 to 2000 Very widely spaced 200 to 6000 200 to 6000 Very widely spaced >600 to 2000 Defect Description Sh Sheared zone Stono Shon Sheared zone Cs Crushed seam Decomposed seam Inflied seam Sin Sheared zone Ds Inflied seam Inflied seam Sin Sheared zone Sin Macro-surface geometry St Stepped Sin Sincoth Sin <t< td=""><td></td><td>RS</td><td>Residual Soil</td><td>Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but soil has not been significantly transported</td></t<>		RS	Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but soil has not been significantly transported
EL Extremely Low 50.03 VL Very Low >0.1 50.3 L Low >0.1 50.3 L Low >0.3 s1 L Low >0.3 s1 H High >1 s3 VH Very High >3 s1 Defect Spacing Extremely Lingh >10 S3 Defect Spacing Extremely dosely spaced <20	Strength		Term P	oint Load Strength Index (I _{s50} , MPa)
VL Very Low >0.03 S0.1 L Low >0.1 50.3 M Medium >0.3 S1 H High >1 S3 VH Very High >3 S10 Defect Spacing Extremely High >10 Spacing (mm) Extremely closely spaced C0 Closely spaced 20 to 60 C0 Very Usely spaced 60 to 200 C0 Very Usely spaced 200 to 600 C0 Very Usely spaced 200 to 600 C0 Very Widely spaced 200 to 600 C0 Defect Description Fp Foliation parting F0 Foliation parting Join Sheared zone Crushed seam Sector Sector Sector Macro-surface geometry St Stepped Stepped Sinooth Sinooth Sinooth Sinooth Sinooth Sinooth Sinooth Sinoth		EL	Extremely Low	≤0.03
L M HighLow Medium>0.3 \$1\$1. \$1High High>1\$3. \$1.Defect SpacingExtremely High>10Defect SpacingDescription Extremely dosely spaced<20 \$2.0Defect SpacingDescription Extremely dosely spaced<20 \$2.0Defect Description TypeBp FP Foliation parting JoBedding parting FP Foliation parting Joint<200 to 600 \$2000 to 6000Defect Description TypeBp FP Foliation parting JointBedding parting Sha Shared zone Cs Crushed seam IsShared zone Cs Curved Undulating Ir Ir Ir Iregular PlanarShared zone Since Since Since Since SinceStapped Since Since Since Since Since Since Since Since Since Since SinceStapped Since Since Since Since Since SinceStapped Since Since Since Since SinceStapped Since Since Since Since SinceStapped Since Since Since SinceStapped Since Since Since SinceStapped Since Since Since SinceStapped Since Since Since SinceStapped Since Since Since Since SinceStapped Since Since Since Since SinceStapped Since Since Since SinceStapped Since Since Since Since Since SinceStapped Since Since Since Since SinceStapped Since Since Since Since Since Since SinceStapped Since Since Since Since Since SinceStapped Since Since		VL	Very Low	>0.03 ≤0.1
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High >1 53 VH EH Extremely High >3 \$10 Defect Spacing Extremely dosely spaced \$20 Extremely dosely spaced 20 to 60 60 to 200 Very closely spaced 200 to 600 600 to 200 Weilum spaced 200 to 600 600 to 200 Widely spaced 2000 to 600 600 to 200 Defect Description Fp Folation parting Fp Folation parting > Jo Joint Sh Sheared zone Sh Sheared zone Crushed seam Ds Decomposed seam Infilled seam Macro-surface geometry St Stepped Cu Un Unduating Ir Irregular PI Planar Micro-surface geometry Sm Si Slickensided Coating or infilling cn Coating or infilling cn		M	Medium	>0.3 ≤1
VH Very right > 3 S is u Defect Spacing EH Extremely right >10 Spacing (mm) Defect Spacing Description Spacing (mm) 20 Extremely disely spaced 20 to 60 60 to 200 Very videly spaced 200 to 600 600 to 2000 Widely spaced 200 to 600 600 to 2000 Defect Description Fp Foliation parting >6000 Fype Bp Bedding parting >6000 Fype Foliation parting >6000 >6000 Sh Sheared zone Crushed seam 5 Des Decomposed seam Infilled seam 5 Macro-surface geometry St Stepped Curved Un Undulating Ir Irregular P Planar Sinooth Si Si Slickensided Si Slickensided Coating			High	>1 ≤3
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Widely spaced 600 to 2000 Very widely spaced Defect Description Type Bp Bp Bedding parting Fp Foliation parting Jo Foliation parting Joint Sh Sheared zone Crushed seam Ds Decomposed seam Is Infilled seam Macro-surface geometry St Ro Stopped Cuved Un Micro-surface geometry Ro Sm Smooth Si Si Sickensided Micro-surface geometry Ro Si Sickensided Si Sickensided Coating or infilling cn			Medium spaced	200 to 600
Defect Description Type Bp Fp Fp Sh Bedding parting Foliation parting Joint Sh Bedding parting Foliation parting Joint Sh Bedding parting Foliation parting Joint Joint Joint Sh Bedding parting Foliation parting Joint Joint Joint Joint Sh Sheared zone Crushed seam Decomposed seam Infilled seam Macro-surface geometry St Cu Un Un Un Un Un Un Un Un Un Un Un Si Stepped Cu Curved Un Un Undulating Ir Pl Stepped Cu Curved Un Undulating Ir Planar Micro-surface geometry Ro Si Rough Sickensided Coating or infilling cn Sn Sickensided			Widely spaced	600 to 2000
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Coating or infilling cn clean Vn veneer cg coating				
Coating or infilling sn stained vn veneer cg coating		cn	clean	
cg coating	Coating or infilling	sn	stained	
cy coauny			coating	
		~y	county	

Log Symbols & Abbreviations (Cored Borehole Log)



Grain Size mm				Bedded focks (mostly sedimentary)							
More than 20	20	Gr De	ain Size scription			At leas	at 50% of	grains are of car	bonate	At least 50% of grains are of fine-grained volcanic rock	
	6	RUD	PACEOUS	CONGLOMERATE Rounded boulders, cob cemented in a finer mat Breccia Irregular rock fragments	bles and gravel trix s in a finer matrix		DLOMITE ed)	Calcirudite		Fragments of volcanic ejecta in a finer matrix Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	SALINE ROCKS Halite Anhydrite
	0.6	ARENACEOUS	Coarse Medium Fine	SANDSTONE Angular or rounded gra cemented by clay, calci Quartz grains and silice Arkose Many feldspar grains Greywacke Many rock chips	ins, common ly te or iron minera l s cous cement		LIMESTONE and DC (undifferentiat	Calcarenite		Cemented volcanic ash	Gypsum
	0.002 Less than 0.002	- ARGILLACEOUS		MUDSTONE SHALE Fissile	SILTSTONE Mostly silt CLAYSTONE Mostly clay	Calcareous Mudstone		Calcisiltite Calcilutite	CHALK	Fine-grained TUFF	_
Amorphous or crypto-crystalline				Fint: occurs as hands of nodules in the chalk Chert: occurs as nodules and beds in limestone and calcareous sandstone							COAL LIGNITE
				Granular cemented – e:	Granular cemented – except amorphous rocks						
				SILICEOUS		CALCA	REOUS			SILICEOUS	CARBONACEOUS
				SEDIMENTARY ROCK Granular cemented rock specimens and is best s	S ks vary greatly in stru seen in outcrop. Onl	ength, sor ly sedimer	ne sands ntary roci	tones are strongers, and some met	er than m amorphic	any Igneous rocks. Bedding c rocks derived from them, co	may not show in hand ntain fossils
				Calcareous rocks conta	ain calcite (calcium c	arbonate)	which ef	ervesces with di	ute hydro	ch l oric acid	

AS1726 – Identification of Sedimentary Rocks for Engineering Purposes

AS1726 - Identification of Metamorphic and Igneous Rocks for Engineering Purposes

Obviously fo	liated rocks (mostly metamorphic)		Rocks with	massive structure	and crystalline texture	(mostly igneous)		Grain size (mm)
Grain size description			Grain size description	Pe	egmatite		Pyrosenite	More than 20
	GNEISS	MARBLE			1	-	Peridorite	20
	Well developed but often widely	QUARTZITE		GRANITE	Diorite	GABBRO	rendonie	
	spaced foliation sometimes with schistose bands							6
COARSE		Granulite	COARSE	These rocks are phorphyritic and for example, as	e sometimes are then described, porphyritic granite			
	Migmatite	HORNEELS						
	and gneisses	HORAN EEG					Pyrosenite Peridorite Peridorite	2
	SCHIST Well developed undulose foljation; generally much mica	Amphibolite		Micorgranite	Microdiorite			0.6
			MEDINA	These rocks are	sometimes	D.L.S.		
MEDIUM		Serpentine	MEDIUM	as porphyrics	are then described	Dolerite		0.2
								0.06
- This	PHYLLITE Slightly undulose foliation; sometimes 'spotted'		- IN -	RHYOLITE	ANDESITE	PAGNIT		0.002
	SLATE Well developed plane cleavage (foliation)		FINE	These rocks are phorphyritic and as porphyries	sometimes are then described	BASALI		Less than 0.002
	Mylonite Found in fault zones, mainly in igneous and metamorphic areas			Obsidian	Volcanic glass			Amorphous or cryptocrystallin e
CRYSTALLINE				Pale<				
SILICEOUS		Mainly SILICEOUS		AC I D Much quartz	INTERMEDIATE Some quartz	BASIC Little or no quartz	ULTRA BASIC	
METAMORPH Most metamor impart fissility. foliated metam Any rock bake and is general Most fresh me	IIC ROCKS phic rocks are distinguished by foliatic Foliation in gneisses is best observe sorphics are difficult to recognize exce d by contact metamorphism is descrit ly somewhat stronger than the parent tamorphic rocks are strong although p	on which may d in outcrop. Non- pt by association. Jed as 'hornfels' rock verhaps fissile	IGNEOUS RC Composed of Mode of occu	DCKS closely interlocking rrence : 1 Batholith	g mineral grains. Stron ; 2 Laccoliths; 3 Sills; 4	g when fresh; not p Dykes; 5 Lava Flo	orous ws; 6 Veins	