Attachment C13

Proponent Geotechnical Report

Appendix K – Geotechnical investigation

Goodman Limited

BURROWS INDUSTRIAL ESTATE GEOTECHNICAL INVESTIGATION

PSM2808-005R REV1 MAY 2019



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PSM
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1 INTRODUCTION

This report presents the results of the geotechnical investigation undertaken by Pells Sullivan Meynink (PSM) for the proposed Burrows Industrial Estate Warehouse Development at 1 - 3 Burrows Road, Alexandria.

The work was undertaken in accordance with our proposal letter PSM2808-001L dated 20 July 2015 and PSM2808-006L dated 18 March 2019.

This report has been revised to include the results of the site investigation on the following dates:

- 1. 13 August 2015
- 2. Between 23 April and 24 April 2019

The aim of the geotechnical investigations was to assess the subsurface conditions and to provide geotechnical design advice and recommendations for the current proposed redevelopment.

2 PROPOSED REDEVELOPMENT

We were provided with the following documents:

- 117708001-00 Survey Drawings
- 18119 SK23-27 Architectural Drawings

Based on your email and drawings, we understand the following:

- The site area is 35,895m²
- The current proposed redevelopment will comprise demolition of some of the existing buildings and pavements and construction of a three-storey warehouse with a basement level expected to have a clearance height of 4.2 m.
- The proposed basement FFL is at RL 1.0 m.

3 GEOTECHNICAL INVESTIGATION

3.1 Fieldwork – 13 August 2015

Fieldwork was undertaken on 13 August 2015 and comprised:

- 6 x Cone Penetrometer Tests (CPT 1 to CPT 6)
- 3 x Bulk samples (CBR1 to CBR 3)



The CPTs were carried out using a 15.5 tonne truck mounted testing rig. The CPTs were undertaken to a refusal depth between 12 and 14 m. CPT results and interpreted profiles are presented in Appendix A.

Prior to testing, on-site service location "scans" were undertaken by a service locator in the presence of a PSM geotechnical engineer to ensure the test locations were free from buried utilities. Coring through pavement was undertaken to allow the CPT cone to test the underlying material and also to recover bulk samples for testing.

The testing and sampling locations are shown in Figure 1. Testing and sampling locations were located with a GPS with the accuracy of +5 m.

3.2 Geotechnical Laboratory Testing (August 2015)

Three (3) bulk samples (CBR 1, CBR 2 & CBR 3) recovered during the fieldwork using hand-auger were sent to a NATA registered geotechnical testing laboratory for California bearing ratio (CBR) testing. The test result sheets are attached in Appendix B and the results are tabulated in Table 1 below.

CBR SAMPLE ID	SAMPLE DEPTH (m)	MATERIAL DESCRIPTION	FIELD MOISTURE CONTENT (%)	STANDARD MAXIMUM DRY DENSITY (t/m ³)	OPTIMUM MOISTURE CONTENT (%)	4 DAY – SOAKED CBR (%)
CBR 1	0.2 - ~0.5	Clayey SAND	25.5	1.63	20.1	15
CBR 2	0.2 - ~0.5	Clayey SAND	30.8	1.26	31.0	10
CBR 3	0.2 - ~0.5	Clayey SAND	17.3	1.69	17.5	50

TABLE 1 CBR TESTING RESULT SUMMARY

3.3 Fieldwork – 23 to 24 April 2019

Fieldwork was undertaken on 23 to 24 April 2019 and comprised:

• 3 x Cored boreholes (BH01 to BH03)

The boreholes were drilled using a track mounted rig. All boreholes employed rotary auger drilling in soil, with NMLC coring used to recover bedrock. The boreholes were drilled to a depth of 15 m and piezometer were installed in each of the boreholes. Point load index testing has been undertaken on the recovered rock cores at approximately 1 m intervals. Boreholes logs are presented in Appendix C and point load index testing results are presented in Appendix D.

The testing and sampling locations are shown in Figure 1.



3.3.1 Standpipe piezometers

Three standpipe piezometers were installed at the borehole locations. Appendix E presents the construction records of the piezometers. A water level logger was installed in each piezometer to record water level eg. every hour (automatic data collection). This allows us to assess the effect of rainfall on the groundwater, etc.

4 SITE CONDITIONS

4.1 Geological Setting

The 1:100,000 Sydney Geological map indicates that the site is underlain by Quaternary alluvium being peat, sandy peat and mud.

4.2 Surface Conditions

The site is currently occupied by single storey warehouses and up to two storey offices. The north west of the site is paved with asphalt overlying a concrete slab and the north east of the site is covered with a concrete slab. The pavement is up to 300 mm thick.

4.3 Subsurface Conditions

The subsurface conditions encountered by the CPTs are summarised in Table 2 and Table 3.

TABLE 2SUMMARY OF SUBSURFACE UNITS ENCOUNTERED AT CPT LOCATIONS

UNIT NAME	APPROXIMATE DEPTH TO THE TOP OF UNIT (m)	DESCRIPTION
PAVEMENT	0.0	Pavement comprises asphalt and concrete slab or concrete slab.
FILL	0.2 to 0.3	Gravelly SAND to Clayey SAND. Density index ranges from medium dense to very dense.
UPPER SAND	1.0 to 3.0	Silty SAND. Density index ranges from loose to dense.
UPPER CLAY	2.8 to 5.2	CLAY to Silty CLAY. Soft to firm clay.



UNIT NAME	APPROXIMATE DEPTH TO THE TOP OF UNIT (m)	DESCRIPTION					
LOWER SAND	4.0 to 8.7	SAND to Silty Sand. Density index ranges from dense to very dense. Grey, fine to medium grained.					
LOWER CLAY	7.9 to 10.7	CLAY to Silty Clay. Consistency stiff to very stiff. Pale grey mottled brown and red to mottled dark grey and brown. High Plasticity.					
BEDROCK A	10.4 to 13.5	SHALE: Dark grey with some brown stains to black, inferred to be very low strength. Extremely weathered to moderately weathered. Inferred from CPT refusal.					
BEDROCK B		SHALE: Dark grey to black, inferred to be low to medium strength. Slightly weathered to Fresh.					



TABLE 3ASSESSED LEVELS OF GEOTECHNICAL UNITS AT CPT AND BH LOCATIONS

		APPR	OXIMA	TE RED	UCED I (m AH	LEVEL O D)	F TOP C	F UNIT	
	CPT 1	CPT 2	CPT 3	CPT 4	CPT 5	CPT6	BH01	BH02	BH03
CONCRETE PAVEMENT (COLLAR RL)	2.8	2.3	3.75	2.9	3.5	3.45	2.05	2.3	3.5
FILL	2.6	2.1	3.55	2.7	3.2	3.25	1.75	2.1	3.25
UPPER SAND	1.2	1.3	2.25	-0.1	0.5	1.45	-2.35	-1.7	-1
UPPER CLAY	-0.2	-0.5	-0.25	-1.6	-1.2	-1.75	NE	NE	NE
LOWER SAND	-3	-3.9	-2.25	-4.7	-4	-5.25	NE	NE	NE
LOWER CLAY	-5.1	-8.4	-5.85	-6.1	-6.7	-5.95	-5.95	-6.5	-5.5
BEDROCK A	-9.2	-10.1	-9.05	-11	-9.8	-10.65	-8.35	-10.9	-8
BEDROCK B	NE	NE	NE	NE	NE	NE	-9.75	NE	-9.3
END OF HOLE	-9.2	-10.1	-9.05	-11	-9.8	-10.65	-12.97	-12.88	-11.5

Note: NE - Not Encountered

The collar levels were estimated from the survey plan provided to PSM.

4.4 Groundwater

Groundwater was encountered during drilling / augering between 0.6 and 1.8 m below the surface; (i.e. between RL 1.4 m and 1.7). We note that these levels were higher than those recorded in the water loggers below.

A PSM geotechnical engineer visited the site on 8 May 2019 to download the water level data from the loggers. The monitoring data from the piezometer is presented in Figure 4 to Figure 6. The data is consistent with dip measurement undertaken manually using a measuring tape.

PSM will be undertaking ongoing groundwater monitoring.



5 DISCUSSION AND RECOMMENDATIONS

5.1 General

The design advice provided in the following sections has been prepared on the following basis:

- No major earthworks will be undertaken on the site. The current subgrade levels will be maintained for the redevelopment.
- The subgrade and any minor earthworks to bring the subgrade to the current levels will be undertaken in accordance with Section 5.2 below.
- Further testing including plate load testing and additional CBR testing will be undertaken following demolition to confirm the advice provided in the following Sections.

If any of those bases are not applicable, PSM should be requested to confirm that the design advice below is still applicable.

5.2 Subgrade Treatment and Minor Earthworks

We recommend that, after the existing structures are demolished, debris and building / pavement rubble are removed, and the site is graded:

- The exposed subgrade surface be proof rolled with a minimum 12 tonne smooth drum non vibratory roller. A PSM engineer should witness the proof rolling and advise the number of passes for each section.
- Any "soft" spots identified, should be excavated and replaced with approved material, with maximum compacted layer thickness of 200 mm.
- Replacement material to be compacted to a density ratio of between 98% and 102% (Standard) and moisture variation of between 2% dry and 2% wet, unless otherwise directed by PSM.
- Each "soft" spot is to have the minimum of 1 density test completed by a GITA.

Should minor filling (filling up to 300 mm deep) be required to bring the exposed subgrade to the existing level, following the above subgrade treatment we recommend:

- Fill to be placed and compacted to a density ratio of between 98% and 102% (Standard) and moisture variation of between 2% dry and 2% wet.
- Fill to be placed in Lots that are defined as a single layer of Engineered Fill consisting of uniform material which has undergone similar treatment.
- The minimum density testing frequency to be taken as follows:
 - For Lots less than 30 m³ 1 test per Lot
 - For Lots between 30 m³ to 150 m³ 2 tests per Lot



- For Lots greater than 150 m^3 shall not be less than the greater of:
 - 1 test per 500 m³ of material placed
 - 3 tests per lot.
- If any one test undertaken within a Lot fails, the whole of the Lot shall be reworked and retested, i.e. "a none to fail basis".

We recommend plate load testing be undertaken at the final surface to confirm the design advice prior to the slab construction.

Following the testing, PSM will issue final design advice, the intention being to confirm the design advice in this report.

We recommend that our inspection regime and testing be presented to the structural engineer and builder. On this basis, Goodman can be confident that, at completion, the works have been constructed in accordance with the designs and geotechnical recommendations.

Should major earthworks be required e.g. to raise the site level, then a Bulk Earthwork Specification will be required. PSM can prepare this Specification if required.

5.3 Site Classification

While the proposed development is out of scope of AS2870 (2011) *Residential slabs and footings*, we assess that, for the subgrade, the characteristic surface movement, y_s , would be less than 20 mm and thus would classify the site as Class S.

5.4 Permanent and temporary batters

The batter slope angles shown in Table 3 are recommended for the design of batters up to 3 m height and above the groundwater table; subject to the following recommendations:

- 1. The batters shall be protected from erosion.
- 2. Permanent batters shall be drained.
- 3. Temporary batters shall not be left unsupported for more than 1 month without further advice, and inspection by a geotechnical engineer should be undertaken following significant rain events.
- 4. Where loads are imposed or structures/services are located within one batter height of the crest of the batter, further advice should be sought.



TABLE 3 BATTER SLOPE ANGLES

UNIT	TEMPORARY	PERMANENT
SOIL UNITS, eg. ENGINEERED FILL, NATURAL SOIL	2.0H : 1V	2.5H : 1V

Steeper batters may be possible subject to further advice, probably including inspection during construction.

5.5 Excavation support

Permanent cuts in the ENGINEERED FILL, NATURAL SOIL and BEDROCK units steeper than the recommended permanent batter slopes in Table 3 will need to be supported by some form of retaining structure.

The excavation of the proposed basement level(s) thoroughfare will need to be supported by some form of retaining structure and should be based on the following:

- Effective soil strength parameters in Table 4,
- Water pressure (depending on the type of structure)
- Surcharge loads

Note that design of retention systems may be based on either K_a or K_o earth pressures. Design using active earth pressures provides the minimum lateral earth pressure that must be supported to avoid failure and requires a wall that can rotate or translate to allow the pressures to reduce to these values (vertical and lateral movements up to 2% of height may occur, typical movements will be much less).

Where the design is based on K_o pressures, construction should be carefully controlled to avoid unwanted effects. It should be noted that designing for K_o pressures does not, of itself, ensure that movement does not occur. Movements are controlled by the construction method, especially sequence.

Both surface and sub-surface drainage needs to be designed and constructed properly to prevent pore water pressures from building up behind the retaining walls or appropriate water pressures must be included in the design.

5.6 Slab on ground

The design of slabs can be based on a subgrade with a Young's modulus (E) shown in Table 4 and subsurface profile discussed in Section 4.3. A short term Young's modulus of 15 MPa can be adopted for slab founded on FILL or UPPER SAND unit.

We note that slabs will be affected by settlement of the deeper soil layers.



The structural designer or builder may wish to employ a surface layer of road base / crushed sandstone / concrete for trafficability or structural purposes. This is not required to achieve the properties provided in this design advice.

For the basement slab, the designer needs to also consider the water pressure (depending on the type of structure).

5.7 Footings

5.7.1 Shallow Footings

Pad footings can be founded on or within the FILL or UPPER SAND unit. They can be proportioned on the basis of an allowable bearing pressure (ABP) presented in Table 4. These pads are to have a minimum horizontal dimension of 1 m and an embedment depth of at least 500 mm. Shallow footings should not be founded closer than their minimum plan dimension to the UPPER CLAY unit.

Please note that an allowable bearing pressure (ABP) is not a soil property. It depends on many factors such as the size of the footings, the embedment depth, the load direction and eccentricity, the stiffness of the footing, the adopted factor of safety (FOS), as well as the soil properties. As footings get bigger or deeper the capacity increases very quickly, as the load gets eccentric or inclined the capacity reduces very quickly.

Higher ABPs may be available but these depend on the size, depth, loads, etc. and would be subject to specific advice.

Settlement of footings should be assessed based on a foundation material with a long term Young's modulus shown in Table 4.

5.7.2 Pile footings

Piles should be designed in accordance with the requirements in AS 2159 (2009), Piling – Design and Installation.

Selection of the pile system depends on many considerations and should be undertaken by the designer in conjunction with the Principal and contractor / builder.

We envisage that piles to be founded within the BEDROCK unit. If piles need to be founded within SAND units, further advice should be sought, but we do not expect this to be practical.

With regards to the pile design we recommend that:

- A geotechnical strength reduction factor, $\Phi g = 0.60$ (AS2159 CL. 4.3.2) be adopted for a high redundancy system for an assessed average risk rating (ARR) of 3.0. This should be reviewed to suit the specific design and construction methods proposed by the structural designers.
- It may be possible to increase the pile reduction factors, if the details of the proposed pile installation procedures indicate a high level of quality control with regards to concrete placement, base cleanliness etc.



Where the pile is sized using the allowable bearing capacity in Table 4 (i.e. assuming all the serviceability load is carried by the base), the settlement would be expected to be less than 1% of the pile diameter.

Any structural settlement due to shortening (or extension) of the footing element itself should be considered.

Where the founding or loading conditions between footings vary consideration should be given to the effects of differential settlements.

5.7.3 Differential Settlements

Where adjacent foundation and slab details differ (e.g. between the remaining existing structure and new extension), differential settlement will need to be assessed.

5.8 Groundwater and Dewatering

At this stage we have preliminary information regarding the groundwater level from the installed standpipe piezometers. The groundwater monitoring undertaken between 24 April and 8 May 2018 indicates depth to groundwater between RL -1.5 m and RL 0.66 m. We note that the neighbouring site activity (WestConnex site) may also have affected the groundwater level within the site.

It is anticipated that the proposed basement excavation will potentially intersect the groundwater table; thus dewatering (temporary and or permanent) may be required.

For a conservative permanent design, the structural designer can consider a design groundwater level at surface.

We note that the design groundwater level is a trade-off between the design/construction cost and ongoing operation cost, eg. pumping.

For an appropriate outcome, it is our option that the preliminary design groundwater level can be taken to RL 1.7 m, eg. 1 metre above the measured level. Such design will require proper pressure relief system to be designed and constructed. We will review this advice regarding the design groundwater level based on our ongoing groundwater monitoring.

We observed hydrocarbon within BH03 during drilling. Environmental assessment may be required to remove groundwater and material in this area.



	BULK UNIT	SOIL EFFECTIVE STRENGTH PARAMET	SOIL EFFECTIVE ENGTH PARAMETERS	ULTIMATE BEARING PRESSURE UNDER	ALLOWABLE BEARING PRESSURE UNDER	ULTIMATE SHAFT	ELASTIC PA	ELASTIC PARAMETERS
INFERRED UNIT	WEIGHT (KN/m ³)	c′ (kPa)	ϕ' (deg)	CENTRIC VERTICAL LOADING (KPa)	CENTRIC VERTICAL LOADING (KPa)	ADHESION (KPa)	YOUNG MODULUS (MPa)	POISSON' S RATIO
FILL	18	0	25	250*	100*	N/A	10	0.3
UPPER SAND	18	0	25	250*	100*	N/A	10	0.3
UPPER CLAY	18	0	20	No footings antici	No footings anticipated in this unit	N/A	4	0.3
LOWER SAND	18	0	35	No footings antici	No footings anticipated in this unit	N/A	30	0.3
LOWER CLAY	18	0	32	No footings antici	No footings anticipated in this unit	N/A	20	0.3
BEDROCK A	22	N/A	N/A	3000	1000**	100	100	0.3
BEDROCK B	22	N/A	N/A	6000	2500**	350	500	0.25
Note: * Minimu	Note: * Minimum footing dimensions: 1 m x 1 m in plan with	ions: 1 m × 1 m ir	in plan with an em	an embedment depth at least = 0.5 m	0.5 m			

TABLE 4 ENGINEERING PARAMETERS OF INFERRED GEOTECHNICAL UNITS ** ABP in BEDROCK to cause settlement of <1% of minimum footing dimension.

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5.9 Pavements

Due to limited access to the subgrade underlying the concrete pavement, only three (3) CBR tests were undertaken. The CBR test results show a wide range of values.

For the purposes of preliminary structural pavement thickness design, a design CBR of 10% can be adopted for existing subgrade. Higher CBR values might be possible if testing is undertaken at specific areas. We recommend that specific CBR testing be undertaken at subgrade level when pavement layouts are finalised and after the demolition work is completed.

5.10 Earthquake Classification

Given that the sub-surface conditions comprise material with an assessed consistency of soft, eg. UPPER CLAY unit and that it is less than 20 m thick, we have classified the site sub-soil to be Class De in accordance with AS 1170.4-2007 Section 4.2

For and on behalf of PELLS SULLIVAN MEYNINK

JOSSELIN RIBOT GEOTECHNICAL ENGINEER

AGUSTRIA SALIM PRINCIPAL







Photo 1 - General Site Conditions - Site Entrance



Photo 2 - General Site Conditions - View to the South from entrance



Photo 3 - General Site Conditions - North part of the site looking South

		Goodmar	n Limited
		1 - 3 Burrows R	load, St Peters
		Geotechnical	Investigation
		SITE INVESTIGATION	23 and 24 April 2019
P S M		SELECTED SITE I	PHOTOS [1 OF 2]
	Pells Sullivan Meynink	PSM2808-005R	FIGURE 2



Photo 4 - General Site Conditions - View to the North from the South



Photo 5 - Drilling rig and exclusion zone









APPENDIX A

CPT RESULTS AND INTERPRETED PROFILES









CONE PENETRATION TEST - INFERRED SOIL TYPE



W:\2801-2900\PSM2808\Eng\CPT\NEW\[CPT2.xlsm]Subject test



CONE PENETRATION TEST - INFERRED SOIL TYPE



W:\2801-2900\PSM2808\Eng\CPT\NEW\[CPT3.xlsm]SOIL TYPE













APPENDIX B

CBR TEST REPORT



115 Wicks Road Macquarie Park, NSW 2113 PO Box 976 North Ryde, Bc 1670 Telephone: 02 9888 5000 Facsimile: 02 9888 5001



FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client: Pells Sullivan Meynink Pty Ltd PSM Project No.: PSM2808-004L		Ref No: L3788E Report: 1 Report Date: 25/08/2015 Page 1 of 1							
SAMPLE NUMBER	1	2	3						
Surcharge (kg)	4.5	4.5	4.5						
Maximum Dry Density (t/m³)	1.63 STD	1.26 STD	1.69 STD						
Optimum Moisture Content (%)	20.1	31.0	17.5						
Moulded Dry Density (t/m ³)	1.55	1.28	1.68						
Sample Density Ratio (%)	95	101	99						
Sample Moisture Ratio (%)	118	95	91						
Moisture Contents									
Insitu (%)	25.5	30.8	17.3						
Moulded (%)	23.7	29.4	16.0						
After soaking and									
After Test, Top 30mm(%)	24.1	29.9	18.6						
Remaining Depth (%)	22.9	33.5	18.6						
Material Retained on 19mm Sieve (%)	5*	7*	15*						
Swell (%)	0.0	0.0	0.0						
C.B.R. value:									
@5.0mm penetration	15	10	50						

NOTES:

· Refer to appropriate notes for soil descriptions

• Test Methods : AS1289 6.1.1, 5.1.1 & 2.1.1.

• Date of receipt of sample: 14/08/2015.

• * Denotes not used in test sample.



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Authorised Signature / Date (D. Treweek)

25/8/15

All services provided by STS are subject to our standard terms and conditions. A copy is available on request

APPENDIX C

BOREHOLES LOGS



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Client: Project Hole Lo Hole P	ocat	ion:	Goodma Burrows 1-3 Burr 331557	s Ro rows	ad s Rd \$	St Pet		N		Commen Complete Logged E Checked	ed: By:					
Drill Mo Hole D			0		ck Mo mm	ounted	1			RL Surfac Datum:	ce:	2.0 Ał)5 m ID		Op	perator: Rockwell
Drilling Information				Soil Description								Observations				
Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structur plasticity, additional	re,	Moisture Condition	Consistency / Relative Density	F Pene (I 8 8	land trom JCS kPa)	eter	Structure, Zoning, Origin, Additional Observations
	z	Observed at 1.76 m in standpipe			-1.0 0.1				Asphalt: 50 mm thick. Concrete: 250 mm thick. Sandy Clayey GRAVEL: to 20 mm, sub-rounded to sub-angular, dark gr black; clay non-plastic; sand fine to n grained. Silty CLAY: medium plasticity, black; shale fragments, metal, rubber and p observed.	nedium	w	L to F				0.30: Inferred FILL.
	etho			Per	-5- -	4		W	Silty SAND with clay: fine to medium grey; clay low plasticity.	Tests	M		re Co		ion	4.40: Inferred alluvial soil. Consistency/Relative Dens
AD/T - / AD/V - / WB -W	Auge Auge ashb anda ush tu	r drillir r drillir ore rd per ıbe	ng TC bit ng V bit netration test ing		No res	sistance igh to usal		> Inflo ⊲ Par		mple ble tration Test Sample		D M	- D - M / - W	ry oist		VS - Very soft S - Soft F - Firm St - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense D - Dense VD - Very dense

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Client: Projec Hole L Hole P	t Na .ocat	ion:	Goodm Burrow 1-3 Bur 331557	s Roa rrows	ad Rd \$	St Pete		N		Com Loge	nmence npleted: ged By: cked B					
Drill M	odel	and	Mounting:	Trac	ck Mo	ounted		IN		-90° RL \$	Surface	-	2.05 n	ו		
Hole D			ng Informati		mm				Bearing:	Datu il Description	um:		AHD	(Operato	or: Rockwell Observations
Co Co Co Co Co Co Co Co Co Co				Graphic Log	Classification Symbol	Material D SOIL NAME: C plasticity,	Description olour, structure,	Moisture	Moisture Condition Consistency / Consistency				Structure, Zoning, Origin, Additional Observations			
	N	Observed at 1.76 m in standpipe			-5.0 -4.0	6 7 7 7		SW-SM	Silty SAND with clay: fir grey; clay low plasticity:	ne to medium grain (continued)	ν V		e to /D			
					-9.0 -2-	8 - - 9 - - - - -		СН	CLAY: high plasticity, g CLAY: high plasticity, p red. Structure becomes visi	ale grey-brown and		л	/St	Ondivis		onsistancu/Delativo Dooo
AD/T - AD/V -	ashb anda ush tu	r drilli r drilli ore rd pei ibe	ng TC bit ng V bit netration test ing		throu	<i>ion</i> sistance ugh to usal		⊳ Inflo ⊲ Par	tater S ow U - Ur tial Loss D - Di SPT - St ES - Er TW - Th LB - La	amples and Tests disturbed Sample sturbed Sample andard Penetratior ivironmental Samp in Walled Irge Disturbed Sam	s n Test le nple	Moi	isture C D - [M - [W - \	Dry Moist	n C	onsistency/Relative Dens VS - Very soft S - Soft F - Firm St - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense D - Dense

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BH01

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Pr Ho	ient: ojec ole L	oca	ion:	Goodm Burrow 1-3 Bur	s Ro rows	ad s Rd \$	St Pet				Comp Logge	ed By:		23/0 JsR	04/20 04/20 8		
	ill M		-	331557 Mounting:			245383 Dunted		N	Inclination:		ked By:	2.0	AS 05 m			
			eter:	-		mm				Bearing:	Datum	n:	Ał			Opera	ator: Rockwell
		1	Drilli	ng Informati	on					S	oil Description					0	Observations
	Samples Tests A Construction A Const			Graphic Log	Classification Symbol	SOIL NAME:	Description Colour, structure, /, additional	Moisture Condition	Moisture Condition Consistency / Relative Density (Cansistency / Consistency / Consistency / Consistency / Condition Consistency / Consistency / Constancy / Constancy / Consistency / Constancy / Constan				Structure, Zoning, Origir Additional Observations				
			n standpipe				_		СН	CLAY: high plasticity, red. (continued)	pale grey-brown and	М	н				
		z	Observed at 1.76 m in standpipe			0	-			SHALE: grey-brown, very low to low streng	extremely weathered, th						
P			Ő			-6-	11-			Continued on cored b	orehole sheet						05: V-bit refusal.
					-	-11.0 -10.0	- 12— - - - 13— -										
					-	-12.0	- - 14 - -										
AD AD WE SP PT)/T -)/V - B -W PT-St - Pt	asht anda ish t	er drilli er drilli ore ard pe	ng TC bit ng V bit netration test <i>v</i> ing		throu	ion sistance Igh to usal	-	⊳ Inflo ⊲ Par	ow U - L tial Loss D - I mplete Loss ES - E TW - T	Samples and Tests Jndisturbed Sample Disturbed Sample Standard Penetration T Environmental Sample Thin Walled .arge Disturbed Sampl	est	Moistu D M W	- Dr - Dr - Ma / - W	n ditio y Dist et	n	Consistency/Relative Den VS - Very soft F - Soft St - Sift VSt - Very stiff VSt - Very loose VL - Very loose L - Loose MD - Medium dense D - Dense VD - Very dense

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En	gi	gineering Log - Cored Borehole									Project N	lo.:				
	lien roie		ame:			an Gro 8 Road					Commer Complete)4/2019)4/2019		
Н	lole	Loca	ation:	1-:	3 Bur	rows F	Rd St I				Logged E	By:	JsR		,	
			tion:					383.0 m N			Checked	-	AS 15 m			
			el and M be and L		-	NMLC								Ор	erate	or: Rockwell
		Dril	ling Info	ormat	ion			Ro	ck Subs	tance					Roc	k Mass Defects
Method	Water	RQD (%)	SAMPLES & FIELD TESTS	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Des ROCK TYPE: Colour, g (texture, fabric, mineral co alteration, cementation, inclusions and minc	ain size, sl mposition, etc as app	hardness, licable),	Weathering ≳ ≩ ≩ § ⊮	Strength Is(50) ● - Axial O - Diametra	. 5	Defect Spacing (mm) ତ ଛି ଛି ହିଁ		efect Descriptions / Commen Description, alpha/beta, infillin or coating, shape, roughness thickness, other
	m in standpipe	86	11.15m 1 is(50) d=0.01 a=0.01 MPa 11.95m 2 is(50) d=0.03 MPa		-10.0			Continued from non-cored bo SHALE: dark grey and browr SHALE: dark grey, thinly lam bedding.	, develope	d bedding.						S, 0°, CL, PR, S, 10 mm S, 0°, CL, PR, S, 25 mm S, 0°, CL, PR, S, 5 mm S, 0°, CL, PR, S, 10 mm JT, 20°, FE SN, PR, RF S, 0°, CL, PR, S, 15 mm
NMLC	Observed at 1.76 n		13.05m 3 ls(50) d=0.2 a=0.3 MPa 13.95m 4 ls(50) d=0.1		-12.0 -11.0	13 - - - - 14										JT, 45°, KL, PR, RF JT, 30°, KL, PR, RF
		66	a=0.4 MPa 14. 95(50) 6 a=0.4 MPa													
Method AD/T - Auger drilling TC bit AD/V - Auger drilling V bit WB - Washbore HQ3- Wireline core (63.5 mm) PQ3- Wireline core (85.0 mm) SPT - Standard penetration test PT - Push tube			<	> Inflov ☐ Partia Comp Comp Conc Core r		XW - Extrer HW - Highly MW - Mode SW - Slight FR - Fresh Streng VL - Very I L - Low M - Mediu	g th Low	FT - Fau SS - She BP - She BP - Bec SM - See IS - Infil JT - Joir CO - CO CZ - Cru VN - Vei	ear Surface ear Zone Iding parting Im Ied Seam It It It Shed Zone N		G - Grave S - Sand Z - Silt CA - Calci CL - Clay	n er ng fragme el	SL - Slickensided POL - Polished S - Smooth RF - Rough vertex - Very Rough Shappe PR - Planar CU - Curved UN - Undulating UN - Stepped			
	Evelor	natory N	lotes for detai	ils of abb	reviation		No co	e recovery	H - High VH - Very I EH - Extrer	High mely High	FZ - Fra	cture Zone Iding Shear		FE - Iron QZ - Quari X - Carbo		IR - Irregular
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С	lient	:		Go	odma	an Gro	aup			Commen	ced: 2	3/04/2019	
			ame:			Road				Complete		3/04/2019	
			ition:					Peters		Logged E		sR	
Н	ole I	Posi	tion:	33	1557	.0 m E	624	5383.0 m N		Checked	-	S	
			and M			Track			90°	RL Surfa			
Ba	arre	Тур	e and L	.engti	n:	NMLC	; 3 m	Bearing:		Datum:	AHD	Оре	rator: Rockwell
		Drill	ing Info	ormat	ion			Rock Substar	nce			F	Rock Mass Defects
			s & STS	WPT (Lugeons)			b	Material Description			Strength Is(50)		Defect Descriptions / Comme
		(%)	SAMPLES & FIELD TESTS	(Luge			Graphic Log	ROCK TYPE: Colour, grain size, struc (texture, fabric, mineral composition, har	rdness,	Weathering	 Axial Diametral 	Defect Spacing	Description, alpha/beta, infilli
	Water	RQD (%)	SAN	VPT	RL (m)	Depth (m)	Grapt	alteration, cementation, etc as applica inclusions and minor components	s i	> > < > ~	0.1 0.3 1 10	(mm) 0	or coating, shape, roughnes thickness, other
-	>	ш		>	(11)	(11)				옷 옷 둔 & 뜻	╡ _┙ ѯェ⋚ਜ਼	200 1000 1000	
								Hole Terminated at 15.02 m Target depth. Standpipe installed		iiii		i i i i i	
						-							
						_							
					-								
					-14.0	16-							
						-							
										iiii			
						-							
					-15.0	17—							
					7								
						-							
						-							
					0.0	18-							
					-16.								
						-							
										iiii			
						-							
					-17.0	10							
					-17	19-							
						-							
						-							
			ethod					ater Weatheri			t Type	Infilling/Coa	
	AD/V	- Aug	er drilling T er drilling \	C bit / bit			> Inflo		eathered	FT - Faul SS - She SZ - She	ar Surface	CN - Clean SN - Stain VN - Veneer	SL - Slickensided POL - Polished S - Smooth
	HQ3	- Wire	shbore eline core (plete Loss FR - Fresh		BP - Bed SM - Sea	ding parting m	CO - Coating RF - Rock fra	RF - Rough agments VR - Very Rough
	SPT	- Star	eline core (ndard pene			Grap	ohic L	og/Core Loss Strength		JT - Join		G - Gravel S - Sand	Shape PR - Planar
	PT ·	- Pus	h tube			, IIII j	Core	recovered (hatching L - Low M - Medium		CO - Con CZ - Crus VN - Vein	shed Zone	Z - Silt CA - Calcite CL - Clay	CU - Curved UN - Undulating ST - Stepped
						\mathbf{H}	nuica	H - High		viv - Veir		GL - Clay	IR - Irregular



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Client: Project N Hole Loc Hole Pos	ation:	Goodmar Burrows 1-3 Burro 331729.0	Road ws Rd	St Pet		N		Commence Completed Logged By Checked B	1: /:)4/201)4/201	
Drill Mod	el and N	Mounting: T	rack Mo				Inclination: -90°	RL Surface	-		30 m		
Hole Dia		1 g Information	00 mm		Bearing: Datum: AHD (Soil Description					0	perator: Rockwell Observations		
Penetration		Samples	Recovery (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structu plasticity, additional		Condition	Consistency / Relative Density	Penet U (k	and rometer CS Pa)	
2 2 1 1 1 1 1 1 1 1 1 1 1 1							Concrete: 200 mm thick. Sandy GRAVEL: to 30 mm, sub-an grey to black; sand coarse grained; metal, rubber, ceramics, copper an observed.	gular, dark some			10	300 400 500 500 500 500 500 500 500 500 5	0.20: Inferred FILL.
	dpipe		0.3	1									1.00: Numerous bricks observed
	Observed at 3.84 m in standpipe		-0.7	3-					W L	to F			
			-1.7	4		SW-SM	Silty SAND with clay: fine to mediur grey; clay low plasticity.			D to VD			4.00: Inferred alluvial soil. 4.20: Some shells observed
Meth AD/T - Au AD/T - Au AD/V - Au WB -Was SPT - Stan PT - Push AS - Auge	ger drilling ger drilling bore dard pen- tube	g TC bit g V bit etration test	throu	<i>ion</i> sistance ugh to usal	•	> Inflo ⊲ Par	ater Samples and w U - Undisturbed S tial Loss D - Disturbed Sam SPT - Standard Pene mplete Loss ES - Environmental TW - Thin Walled LB - Large Disturbe	ample ple tration Test Sample	Mo	D M	re Cor - Dr - Ma - Wa	ndition y Dist et	Consistency/Relative Dens VS - Very soft S - Soft F - Firm St - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose

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Client: Project Hole Lo Hole Po	ocati	on:	Goodma Burrows 1-3 Burr 331729.	s Roa rows l	id Rd S			N				C Lo	ommen omplete ogged E hecked	ed: By:					
Drill Mo Hole Di			0	Track 100 r		unted			Inclin Bear	ation: ing:	-90°		L Surfa	ce:	2.3 A⊦	30 m HD Operator: F			tor: Rockwell
	D	rillin	g Informatio	on			Soil Description								Observations				
Penetration	Support	Water	Samples Tests Remarks		RL (m)	Depth (m)	Graphic Log	Classification Symbol	SOI	L NAME:	al Description Colour, st ty, addition	ructure.		Moisture Condition	Consistency / Relative Density	Pene L (ł	land tromei JCS (Pa)		Structure, Zoning, Origin, Additional Observations
		Observed at 3.84 m in standpipe			-5.7 -4.7 -3.7			SW-SM	Silty SAND grey; clay lo	w plastic	ity. (contin	ued)		×	D to VD				
	thoo		1 TC b#	Pene	etration			CH	CLAY: high		Samples	and Te	ble		St to VSt	re Co	nditio	n	Consistency/Relative Dens
AD/T - A AD/V - A WB -Wa SPT - Sta PT - Pus AS - Aug	uger ashbo indar sh tu	drilling ore d pene be	g V bit etration test		lo res throug refu			⊲ Par	ow tial Loss nplete Loss	D - SPT- ES - TW -	Disturbed Standard Environme Thin Walle Large Dist	Sample Penetrat ental Sate	tion Test mple		M W	- Di - M - W	oist et		VS - Very soft S - Soft F - Firm St - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense D - Dense VD - Very dense Ce - Cemented

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		ng Log - I					Project No.:		
Client:	10		nan Group	0			Commenced:	23/04/2019	
Project N Hole Loo			/s Road rrows Rd	St Pete	ere		Completed: Logged By:	23/04/2019 JsR	
Hole Po			9.0 m E 6				Checked By:	AS	
Drill Mod	del ar	d Mounting:	Track M	ounted		Inclination: -90°	RL Surface: 2	2.30 m	
Hole Dia		-	100 mm			Bearing:			rator: Rockwell
	Dri	lling Informat	tion			Soil Descri	ption		Observations
Penetration	Support Water	Samples Tests Remarks	Recovery (m)	Depth (m)	Graphic Log Classification Symbol	Material Description SOIL NAME: Colour, struc plasticity, additional	Moisture 'aunt' Condition Condition	Hand Penetrometer UCS (kPa)	Structure, Zoning, Origin Additional Observations
	N Observed at 3.84 m in standpipe		-9.7		СН	CLAY: high plasticity, pale grey-bi (continued) Becomes dark grey		o t	2.20: Becomes harder to drill
			-10.7	13-		Continued on cored borehole she	et		
			-11.7	- 14					
AD/T - Au AD/V - Au WB -Was	iĝer di shbore idard p h tube	penetration test	thro	tion esistance ugh to fusal	$rac{}{\sim}$	Vater Samples au flow U - Undisturbed artial Loss SPT - Standard Pe pomplete Loss ES - Environment TW - Thin Walled LB - Large Disturb	Sample Imple netration Test al Sample	ture Condition D - Dry M - Moist W - Wet	Consistency/Relative Dens VS - Very soft F - Siff VSt - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense D - Dense
									VD - Very dense

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Engineering Log - Cored Borehole

Borehole ID

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P H H	lole lole	ect Na Loca Posi		Bu 1-3 33	rrows 3 Bur 1729	.0 m E	d Rd St E 6245	Peters 470.0 m N		Commer Complete Logged I Checked	ed: 2 By: J I By: A	23/04/2019 23/04/2019 IsR/NTH AS			
			el and M be and I			Track		nted Inclination: -90° Bearing:		RL Surfa Datum:	ice: 2.30 AHD		rator: Rockwell		
		Drill	ling Info	ormati	ion			Rock Substance				Rock Mass Defects			
Method	Water	RQD (%)	SAMPLES & FIELD TESTS	WPT (Lugeons)	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable), inclusions and minor components		Veathering	O - Diametral	Defect Spacing (mm)	Defect Descriptions / Comm Description, alpha/beta, infil or coating, shape, roughne thickness, other		
					-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1										
NMLC	Observed at 3.84 m in standpipe	100	14.35m 1 is(50) d=0 a=0 MPa		-11.7			Continued from non-cored borehole sheet SHALE: dark grey and brown, extremely weathere very low to low strength. SHALE: dark grey, thinly laminated, well develope bedding.					- 13.20: V-bit refusal.		
	AD/ WB HQ3 PQ3 SPT PT	T - Aug - Wa: - Wird - Wird - Star - Pus	ethod ger drilling ' shbore eline core eline core ndard pene sh tube	/ bit (63.5 mn (85.0 mn etration t	n) est	Graj	 > Inflov □ Partia ■ Component ■ Component ■ Core n ■ Core n ■ Indica ■ No co 	al Loss MW - Moderately Weathe Subscription of the second	ered	FT - Fai SS - Shi BP - Bei SM - Sei IS - Infi JT - Joi CO - Coi CZ - Cru VN - Vei FZ - Fra BSH - Bei	ear Surface ear Zone dding parting am lled Seam nt nt ntact ushed Zone	Infilling/Coa CN - Clean SN - Stain VN - Veneer CO - Coating RF - Rock fr G - Gravel S - Sand Z - Sitt CA - Calcite CL - Clay FE - Iron QZ - Quartz X - Carbon	SL - Slickensided POL - Polished S - Smooth agments VR - Very Rough VR - Very Rough CU - Curved UN - Undulating ST - Stepped IR - Irregular		

Project No.:

PSM2808

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Client:		Good	man Gr	oup			Comm	enced:	23/04/2019	
Project Na	ame:		ws Roa				Comple		23/04/2019	
Hole Loca			urrows				Logged		JsR	
Hole Posi					5470.0 m N		Checke	-	AS	
Drill Mode		-		(Moui		Inclination: -90°	RL Sur			natan Daalawall
Barrel Typ		-		C 3 m	1	Bearing:	Datum			rator: Rockwell
Dril	ling Infor	mation	1			Rock Substance	Substance			Rock Mass Defects
	& TS	ous)		5		I Description		Strength Is(50)		Defect Descriptions / Comme
, (%	SAMPLES & FIELD TESTS	WPT (Lugeons)		Graphic Log	(texture, fabric, miner	our, grain size, structure ral composition, hardness	Weatheri	ng •- Axial O - Diametral	Defect Spacing	Description, alpha/beta, infilli
Water RQD (%)	SAMI	La R		raphi	alteration, cementa inclusions and	ation, etc as applicable), minor components		0.1 1 0.3 3 10	(mm)	or coating, shape, roughnes thickness, other
		≥ (n	n) (m)	0			NX H M NS	≝ ຊ ¬ ≥ ∓ ≩ ∰	<pre><20 60 600 1000</pre>	,
100	2 ^{5.05m} d=0.1 a=0.1									
	MPa]	Hole Terminated at 15.1 Target depth. Standpipe					
				1						
				-						
		-	_							
		-6	<u>2</u> 16-	1						
				-						
				1						
				-						
			17-							
		+								
				1						
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				1						
		- u - u - v	2 18-	-						
				1						
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		-4	<u>-</u> 19-	1						
			.	-						
				4						
				1						
				-						
	othed				l	Moothawing		fact Trime		ting Doughange
AD/T - Aug	e <i>thod</i> Jer drilling TC		Ľ	Wa Niflov <	ater w	Weathering XW - Extremely Weather HW - Highly Weathered	ed FT -	fect Type Fault Shear Surface	CN - Clean SN - Stain	ting Roughness SL - Slickensided POL - Polished
WB - Wa			<	Parti	al Loss	MW - Moderately Weath SW - Slightly Weathered	ered SZ - BP -	Shear Zone Bedding parting	VN - Veneer CO - Coating	S - Smooth RF - Rough
PQ3- Wir	eline core (63 eline core (85	5.0 mm)			plete Loss	FR - Fresh Strength	SM - IS -	Seam Infilled Seam	RF - Rock fra G - Gravel	agments VR - Very Rough Shape
PT - Pus	ndard penetr h tube	auon test	Gra	_ Core	og/Core Loss recovered (hatching	VL - Very'Low L - Low	CZ -	Contact Crushed Zone	S - Sand Z - Silt CA - Calcite	PR - Planar CU - Curved UN - Undulating
			1:::::	l indica	ites material)	M - Medium H - High	VN - 1		CL - Clay	ST - Stepped



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F	Client Projec Hole L Hole F	t Na .oca	tion:	Goodma Burrows 1-3 Burr 331679.	Ro Rows	ad s Rd \$	St Pet		N		Commer Complete Logged E Checked	ed: 3y:				
							ounted			Inclination: -90°	RL Surfa		3.	50 m		
ŀ	Hole [Dian	eter:		100	mm				Bearing:	Datum:		Ał	ID	C	perator: Rockwell
			Drilli	ng Informatio	on					Soil Descri	otion					Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, struc plasticity, additional	cture,	Moisture Condition	Consistency / Relative Density	Penet L (k	land tromete JCS (Pa) ୍ଡ୍ର ଦ୍ୱି ତ୍ଥି	Additional Observations
DT		z								Concrete: 250 mm thick.						
						2.5	- - 1 -			Sandy GRAVEL: to 30 mm, sub- black; sand fine to medium graine metal, ceramics observed.	ngular, d; some	М	L to F			0.25: Inferred FILL.
AD/V		z	Observed at 2.87 m in standpipe			1.5	- 2 - - -			Silty SAND: fine to medium graine	d, grey.					
						-0.5 0.5	3 - - - 4			Some clay with medium plasticity	at 3.0m	W	L to F			
							-		SW-SM	Silty SAND with clay: fine to media grey; clay low plasticity.	um grained,		D to VD			4.40: Inferred alluvial soil.
V S F	AD/T - AD/V - VB - V	lash tand ush	er drilli er drilli oore ard pe ube	ing TC bit ing V bit netration test ving		throu	ion sistanc ugh to usal		> Inflo ⊲ Par	ater Samples a ater Samples a bw U - Undisturbed tial Loss D - Disturbed Sa SPT - Standard Pe nplete Loss ES - Environment TW - Thin Walled LB - Large Disturb	nd Tests Sample mple netration Test al Sample ped Sample	M	D M	re Co. - Dr - M - W	ndition y oist et	Consistency/Relative Dens VS - Very soft S - Soft F - Firm St - Stift VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense D - Dense VD - Very dense

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Client:Goodman GroupCommenced:24/04/2019Project Name:Burrows RoadCompleted:24/04/2019Hole Location:1-3 Burrows Rd St PetersLogged By:JsRHole Position:331679.9 m E 6245385.0 m NChecked By:AS)4/201					
Drill Mo Hole Di			Mounting:		ck Mo) mm	ounted	l	Inclination: -90° RL Surface: 3.50 m Bearing: Datum: AHD Oper					perator: Rockwell		
			ng Informat		,				Soil Des			7.1			Observations
Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Descrip SOIL NAME: Colour, plasticity, additio	structure,	Moisture Condition	Consistency / Relative Density	Penet U (k	and rometer CS Pa) ଛ ୡ ଛ	r Structure, Zoning, Origin, Additional Observations
					-2.5			SW-SM	Silty SAND with clay: fine to n grey; clay low plasticity. <i>(cont</i>	edium grained, nued)	w	D to VD	11	₩ ₩ 200	
	z	Observed at 2.87 m in standpipe			-3.5	- 7 - - -		CH SM-SC	CLAY: high plasticity, pale gro Silty SAND: fine to medium g		 M	 St			
		0			-4.	8					w	D to VD			
					-5.5	9		СН	CLAY: high plasticity, pale gro	y-brown.	 M	VSt to H			
AD/T - A AD/V - A WB -Wa	Auĝe ashb anda sh tu	r drilli r drilli ore rd pei ibe	netration test	Pe	throu	<i>ion</i> sistance ugh to usal	-	⊳ Inflo ⊲ Par	ow U - Undistur tial Loss D - Disturbe SPT - Standar mplete Loss ES - Environr TW - Thin Wa	s and Tests bed Sample I Sample Penetration Test lental Sample led sturbed Sample		D M	re Coi - Dr - Ma - Wa	ndition y bist et	Consistency/Relative Dens VS - Very soft S - Soft F - Firm St - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense

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Ρ	Client: Projec	t Na		Goodm Burrow	s Roa	d					Comme Comple	eted:			/04/2 /04/2		
	lole L lole F			1-3 Bur 331679					N		Logged Checke	-		JsF AS			
							ounted			Inclination: -90°	RL Sur		3	50 m			
	lole D				100 r		anto a			Bearing:	Datum:			HD		Op	perator: Rockwell
			Drilli	ng Informati	on					Soil Desc	ription						Observations
	Penetration	Support	Water	Samples Tests Remarks		RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Descriptio SOIL NAME: Colour, str plasticity, additiona	ucture,	Moisture Condition	Consistency / Relative Density	F Pene (8 00	Hand trom JCS kPa)	eter	Structure, Zoning, Origin, Additional Observations
		z	Observed at 2.87 m in standpipe			5 -7.5			СН	CLAY: high plasticity, pale grey- (continued) Becomes pale grey-brown and r		м	VSt to H				11.50: V-bit refusal. 11.90: Cleaning by washing borehole
						-10.5 -9.5				Continued on cored borehole sh	eet						
A S P	.D/T - .D/V - VB -W	Auge asht anda ush t	er drilli er drilli ore urd pe ube	ng TC bit ng V bit netration test <i>v</i> ing		lo res throu	on sistance gh to usal		⊳ Infle ⊲ Par		and Tests d Sample Sample enetration Tental Sample d trbed Sample	Λ st	Moistu D M W	// - W	ry loist	ion	Consistency/Relative Dens VS - Very soft S - Soft F - Firm St - Stiff VSt - Very stiff H - Hard VL - Very loose L - Loose MD - Medium dense D - Dense VD - Very dense

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ing	ine	ering	Log	J - C	ore	d Bo	orehole	Project N	lo.: I	PSM2808	
Clie Pro		lame:			an Gro 8 Road			Commen Complete		24/04/2019 24/04/2019	
Hol	e Loc	ation:					Peters	Logged E	Зу: .	JsR	
-	e Pos	el and M			.9 m E		385.0 m N Inclination: -90°	Checked RL Surfa		AS m	
		pe and L		-	NMLC			Datum:	AHD		rator: Rockwell
	Dri	lling Info	ormat	tion			Rock Substance			F	Rock Mass Defects
		ES & ESTS	Jeons)			Log	Material Description	Weathering	Strength Is(50) ● - Axial	Defect	Defect Descriptions / Commer
Water	RQD (%)	SAMPLE FIELD TE	WPT (Lugeons)	RL	Depth	Graphic L	ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable), inclusions and minor components	weathening	\bigcirc - Diametral	Spacing (mm)	Description, alpha/beta, infillir or coating, shape, roughness thickness, other
	L L	<u>о</u> <u></u>	WF	(m)	(m)	Ö	inclusions and minor components	XW MW SW	z z z ž ∰	1000 1000	
				-7.5	- - - 11 - - -						
				-8	- 12 -		Continued from non-cored borehole sheet SHALE: dark grey, thinly laminated, well developed bedding.				− IS, 0°, CL, PR, RF, 80 mm ∼ IS, 0°, CL, PR, RF, 10 mm
in standpipe		12.95m 1 ls(50) d=0.1 a=0.1 MPa		-9.5							- BP, 0°, CN, PR, RF [↑] IS, 0°, CL, PR, RF, 50 mm - BP, 0°, CN, PR, RF
at 2.87 m	97				-						BP, 0°, FE SN, PR, RF CZ, RF, PR, RF, 60 mm
Observed		13.96m 2 Is(50) d=0.3 a=0.3 MPa		-10.5							
		ls(50) d=0.1 14.9400,2 3 MPa					Hole Terminated at 15.00 m. Target depth. Standpipe installed				— JT, 60°, RF, PR, RF
A	D/T - Au	lethod Iger drilling 1	FC bit			₩a > Inflov		FT - Fau	ct Type Ilt ear Surface	CN - Clean SN - Stain	ting Roughness SL - Slickensided POL - Polished
W H	/B - W Q3- W	iger drilling \ ashbore ireline core (63.5 m		<	Partia	The Flighty Weathered	SZ - She	ear Zone Iding parting	VN - Veneer CO - Coating RF - Rock fra	S - Smooth RF - Rough agments VR - Very Rough
P SI	Q3- W PT- St	ireline core (andard pene ish tube	85.0 mi	m)	Grap		pg/Core Loss Strength VL - Very Low		lled Seam nt	G - Gravel S - Sand Z - Silt	PR - Planar CU - Curved
r.						_ indica	ecovered (hatching L - Low es material) M - Medium H - High	CZ - Cru VN - Veir	shed Zone	CA - Calcite CL - Clay FE - Iron	UN - Undulating ST - Stepped IR - Irregular
ee Fxo	lanatorv	Notes for detai	ils of abb	reviation	ل التبيية s and basi		re recovery VH - Very High ptions. EH - Extremely High		ding Shear	QZ - Quartz X - Carbona	





Pells Sullivan Meynink Engineering Consultants

Rock-Soil-Water

EXPLANATION SHEET BOREHOLE LOG

GENERAL

Method

Coring Size

Non-Cored Borehole	
Auger	
Hand Auger	
Diamond Rotary	
Percussion	
Other	

Testing

Symbol	Description
UCS	Uniaxial Compressive Strength
TXL	Triaxial Test
BT	Brazilian Test
DT	Direct Tensile
SD	Slake Durability
Packer	Rock Mass Permeability

Cored Borehole	Nominal Core Diameter (mm)
NMLC	51.9
BQ	36.5
BQ3	33.5
NQ	47.6
NQ3	45.1
HQ	63.5
HQ3	61.1
PQ	85
PQ3	83.1
Diatube	Variable
Other	-

Samples

Symbol	Description
U50	50 mm undisturbed tube sample
D	Disturbed sample
Bs	Bulk sample

Water

Symbol	Description
	Water level
	Water inflow
—	Complete water loss
$\overline{}$	Partial water loss

SOIL DESCRIPTIONS

Unified Soil Classification System (USCS)

Major Divisions		Symbol	Typical Names	
		Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines.
Coarse-	Gravels (more than 50%		GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.
Grained Soils	coarser than 2mm)	Gravels	GM	Silty gravels, gravel-sand-silt mixtures.
More than	,	With Fines	GC	Clayey gravels. gravel-sand-clay mixtures.
50% coarser	Sands	Clean	SW	Well-graded sands and gravelly sands, little or no fines.
than 0.075mm	(more than 50% of coarse	Sands	SP	Poorly graded sands and gravelly sands, little or no fines.
	fraction finer than 2mm)	Sand With Fines	SM	Silty sands, sand-silt mixture.
			SC	Clayey sands, sand-clay mixtures.
	Silts and Clays Liquid limit Fine- 50% or less Grained Soils		ML	Inorganic silts, very fine sands, rock flour silty or clayey fine sands.
_			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and silty clays of low plasticity.
more finer than Silts and Clays			MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.
0.0701111	0.075mm Liquid limit greater than 50%		СН	Inorganic clays of high plasticity, fat clays.
			ОН	Organic clays of medium to high plasticity.
	Highly Organic So	ils	PT	Peat etc.

Moisture Condition

Term	Symbol
Dry	D
Moist	М
Wet	W
Wet at Plastic Limit	WP
Wet at Liquid Limit	WL



Strength

COHESIVE SOILS are described in terms of undrained shear strength, colour and structure with comments on minor constituents or apparent special features. Undrained shear strength is measured by hand penetrometer or determined by laboratory testing or estimated from experience. Classification in terms of undrained shear strength is as follows:

Term	Symbol	Description for Field Estimation	Shear Strength (kPa)	UCS (kPa)
Very Soft	VS	Easily penetrated several centimetres by fist.	<12	<25
Soft	S	Easily penetrated several centimetres by thumb. Can be moulded by light finger pressure.	12-25	25-50
Firm	F	Can be penetrated by thumb with moderate effort. Can be moulded by strong finger pressure.	25-50	50-100
Stiff	ST	Readily indented by thumb.	50-100	100-200
Very Stiff	VST	Readily indented by thumbnail.	100-200	200-400
Hard	Н	Indented with difficulty by thumbnail	>200	>400

NON-COHESIVE SOILS are described in terms of density, colour, with comments on minor constituents or special features. Density (density index) is generally based on standard penetration testing (AS1289 Method 6.3.1), or other forms of penetration testing. Terms used in describing density are set out below:

Term	Symbol	Density Index	SPT N Values
Very Loose	VL	<15%	<5
Loose	L	15-35 %	5-10
Medium Dense	MD	35-65 %	10-30
Dense	D	65-85 %	30-50
Very Dense	VD	>85 %	>50



ROCK DESCRIPTIONS

Weathering

Term	Symbol	Description
Fresh	FR	Rock substance unaffected by weathering.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Moderately Weathered	MW	Rock substance affected by weathering to the extent staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and signs of chemical or physical decomposition of individual minerals are usually evident. Porosity and strength may be increased or decreased when compared to the fresh rock substance, usually as a result of the leaching or deposition of iron. The colour and strength of the original fresh rock substance is no longer recognisable.
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties, i.e. it can be remoulded and can be classified according to the Unified Soil Classification System, but the texture of the original rock is still evident.

Strength

Term	Symbol	Description for Field Estimation	Point Load Index I _s 50 (MPa)
Very Low	VL	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30 mm thick can be broken by finger pressure.	<0.1
Low	L	Easily scored with a knife; indentations 1 mm to 3 mm show with firm blows of a pick point; has a dull sound under hammer. Pieces of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.	0.1 to 0.3
Medium	М	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.	0.3 to 1.0
High	Н	A piece of core 150mm long by 50mm cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.	1 to 3
Very High	VH	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.	3 to 10
Extremely High	EH	Specimen requires many blows with geological pick to break; rock rings under hammer.	>10



Defect Description

Order of description: type, inclination, shape, roughness, infill type, infill thickness, number

0	Description	
Symbol	Description	
CL	Clay Seam	
FL	Fault - fracture along which displacement is recognisable.	
SR	Shear - a fracture along which movement has taken place but no displacement is recognisable. Evidence for movement may be slickensides, polishing and/or clay gouge.	
SH	Sheared Zone - zone of multiple closely spaced fracture planes with roughly parallel planar boundaries usually forming blocks of lenticular or wedge shaped intact material. Fractures are typically smooth, polished or slickensided; and curved.	
BG	Bedding parting - arrangement in layers of mineral grains or crystals parallel to surface of deposition along which a continuous observable parting occurs.	
BSH	Bedding plane shear - a shear formed along a bedding plane	
JN	Joint - a single fracture across which rock has little or no tensile strength and is not obviously related to rock fabric.	
CN	Contact - surface between two lithologies.	
SC	Schistosity - plane formed by the preferred orientation of the constituent minerals in a parallel arrangement in a coarse grained rock which has undergone regional metamorphism (schist).	
CV	Cleavage - plane of mechanical fracture in a rock normally sufficiently closely spaced to form parallel- sided slices.	
FO	Foliation	
CZ	Crushed Zone - zone with roughly parallel, planar boundaries (commonly slickensided) containing disoriented usually angular rock fragments of variable size often in a soil matrix.	
VN	Vein - fracture in which a tabular or sheet-like body of minerals have been intruded.	
DK	Dyke - Igneous intrusion - often weathered and altered to a clay like substance.	
DZ	Decomposed Zone - zone of any shape but commonly with parallel planar boundaries containing moderately to gradational boundaries into fresher rock.	
FZ	Fractured Zone - a zone of closely spaced defects (mainly joints, bedding, cleavage and/or schistosity) comprised of core lengths in the order of 50 mm or less.	

Defect Type

Standard Defect Symbols



Roughness Colour Code (for summary log)

Ro1
 Ro2
Ro3
Ro4
 Ro4

Shape

Roughness

Term	Symbol	Description
Planar	PL	Forms a continuous plane without variation in orientation.
Curved	CU	Has a gradual change in orientation.
Undulating	UN	Has a wavy surface shape.
Stepped	ST	Has one or more well defined steps
Irregular	IR	Many changes of orientation.

Infill Type

Symbol	Description
KL	Clean
CA	Calcite
СВ	Carbonaceous
CHL	Chlorite
FE	Iron oxide
QZ	Quartz
MG	Manganese
SU	Sulphides
SE	Sericite
RF	Rock fragments
G	Gravel
S	Sand
Z	Silt
CL	Clay

Term	Symbol	Description
Slickensided or polished	Ro1	Very smooth, reflects light.
Smooth	Ro2	Roughness not detected with finger.
Defined ridges	Ro3	Sandpaper feel (fine to medium sandpaper).
Small steps	Ro4	Sandpaper feel (medium to coarse sandpaper).
Very rough	Ro5	Very well defined ridges and/or steps.

Infill Thickness

Where infilling is present, the thickness of infill is recorded using the following convention:

STIron oxide staining of less than 1 mmVNVeneer coating of less than 1 mm

If the infilling is greater than 1 mm, the actual thickness of infill is recorded in millimeters.

If infill is not present, a dash (-) is recorded

Number

Number of defects with similar characteristics.



APPENDIX D

POINT LOAD TEST RESULTS



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POINT LOAD STRENGTH INDEX TEST RESULTS

Lub No. PSM1511 1:3 Burrows Rd - St Peters Single Sampling Technique NUAC						Checked:		JsR	By:
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							- St Peters	1-3 Burrows Rd	Project
								PSM1541	Job No.

APPENDIX E

PIEZOMETER INSTALLATION RECORDS



Engineering Consultants Rock - Soil - Water

S

JOB no.: PSM2808

PROJECT: Burrows Road

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH01 DRILLING CONTRACTOR: Rockwell Drilling PIEZOMETER: DRILLING RIG: Hanjin COLLAR EASTING: 331557 DEPTH OF HOLE (m): 15 m COLLAR NORTHING: 6245383 BOREHOLE INCLINATION: Vertical COLLAR RL(m): PIEZO INSTALLATION DATE: 23/04/2019 2.1 DATUM: SUPERVISED BY: MGA 56 JsR

Tick boxes

Complete dimensions if appropriate



Engineering Consultants Rock - Soil - Water

S

JOB no.: PSM2808

PROJECT: Burrows Road

PIEZOMETER CONSTRUCTION RECORD

HOLE NUMBER: BH02 DRILLING CONTRACTOR: Rockwell Drilling PIEZOMETER: DRILLING RIG: Hanjin COLLAR EASTING: 331729 DEPTH OF HOLE (m): 15 m COLLAR NORTHING: 6245470 BOREHOLE INCLINATION: Vertical COLLAR RL(m): 2.3 PIEZO INSTALLATION DATE: 24/04/2019 DATUM: MGA 56 SUPERVISED BY: JsR

Tick boxes

Complete dimensions if appropriate



Engineering Consultants Rock - Soil - Water

S

JOB no.: PSM2808

PROJECT: Burrows Road

PIEZOMETER CONSTRUCTION RECORD



Tick boxes

Complete dimensions if appropriate



COMMENTS: Gatic cover were used for the protection