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Our Ref: PSM3651-004L Rev 1

27 August 2018

JBS&G
Level 1, 50 Margaret Street
SYDNEY NSW 2000

ATTENTION: DANIEL DENARO
By Email: DDenaro@jbsg.com.au

Dear Daniel

RE: 127 AND 129 FLOWERDALE ROAD, LIVERPOOL
GEOTECHNICAL INVESTIGATION

1 INTRODUCTION

This letter presents the results of the geotechnical investigation undertaken by Pells Sullivan Meynink (PSM) for the proposed residential development at 127 and 129 Flowerdale Road, Liverpool

The work was undertaken in accordance with the PSM proposal dated 13 July 2018 (Ref. PSM3651-001L).

Prior to the work, PSM was supplied with the following documents:

- SGCH Geotechnical Engineer Scope of Service
- DKO architectural concept layout, dated 4 October 2017
- Site plan for the proposed development, dated 28 June 2018.

Figure 1 presents the site plan.

PSM understand the following about the proposed development, based on the documents provided:

- The approximate site area is 1,890 m^2.
- The site is currently tenanted.

- The proposed development consists of a five (5) storey building built on grade. No basement is proposed.
- The proposed development is intended for residential use by St George Community Housing.

2 GEOTECHNICAL SITE INVESTIGATION OUTLINE

Two (2) boreholes (BH01 and BH02) were drilled on the 14 August 2018 using a small track mounted drill rig. An auger with a TC bit was used within soil and some weathered rock with NMLC triple tube coring used to recover rock core within bedrock. The fieldwork was undertaken under the fulltime supervision of a PSM geotechnical engineer, who undertook the following tasks:

- Preparing field logs of material encountered in the boreholes
- Taking photographs of the site and recovered rock cores
- Performing point load strength index tests on recovered rock core at approximately 1 m intervals.

The test locations were measured with a handheld GPS unit with a horizontal accuracy of ± 5 m. The test locations are shown on Figure 1.

Following completion of the fieldwork the boreholes were backfilled with the cuttings and lightly tamped.

Engineering logs of the boreholes, including core photographs, are presented in Attachment A. The results of the point load strength index tests are presented in Attachment B.

3 SITE CONDITIONS

3.1 Geological Setting

The 1:100,000 Penrith Geological map (1991) indicates the site is underlain by:

- The Wianamatta Group formation (Bringelly Shale) comprising shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff.

3.2 Surface Conditions

At the time of the fieldwork the site encompassed two (2) residential lots. The site is bounded by roads on the western and northern boundaries and neighbouring residential lots on the eastern and southern boundaries. The elevation was consistent across the site. BH01 was drilled in the backyard of number 127 Flowerdale Rd and BH02 was drilled in the front yard of 129 Flowerdale Rd.

Figure 2 and Figure 3 present selected photos taken during the fieldwork.

3.3 Subsurface Conditions

The subsurface conditions encountered in the boreholes are summarised in Table 1. The encountered subsurface conditions were consistent with the published geological information.

TABLE 1
SUMMARY OF INFERRED SUBSURFACE CONDITIONS ENCOUNTERED IN PSM BOREHOLES

INFERRED UNIT	ENCOUNTERED DEPTH TO TOP OF INFERRED UNIT (m)	DESCRIPTION
FILL	0.0	Sandy GRAVEL; brown, fine to medium grained, angular to sub-angular. Comprises up to 0.3m of TOPSOIL with rootlets.
NATURAL SOIL	0.5	CLAY; red-brown mottled pale grey, high plasticity with an inferred consistency of at least stiff, fine to medium grained gravel.
BEDROCK A	3.1 to 3.5	LAMINITE; 70% shale, grey, thinly laminated and 30% sandstone, pale grey, fine to medium grained; highly to moderately weathered, very low to low strength.
BEDROCK B	6.5 to 7.4	SHALE; dark grey, moderately to slightly weathered, low to medium strength.

Table 2 presents the elevations of the inferred geotechnical units encountered in the PSM boreholes.

TABLE 2
INFERRED DEPTH TO TOP OF INFERRED GEOTECHNICAL UNITS ENCOUNTERED IN PSM BOREHOLES

BOREHOLE ID	INFERRED DEPTH TO TOP OF INFERRED GEOTECHNICAL UNITS (m bgl)				
	FILL	NATURAL SOIL	BEDROCK A	BEDROCK B	EOH
BH01	0.0	0.5	3.1	6.5	8.6
BH02	0.0	0.5	3.5	7.4	10.1

Note: EOH = End of hole

3.4 Groundwater

No groundwater seepage was observed during augering of either borehole. We note that water was introduced during the coring so no groundwater observations were possible.

4 DISCUSSION AND RECOMMENDATIONS

4.1 Site Classification

Based on the field observations and the inferred geotechnical units, we have classified the site in accordance with Australian Standard AS 2870 (2011) *Residential slabs and footings – Construction*. We recommend that structures which are within the scope of AS 2870 (2011) be designed for a site classification of Class "H1".

For earthquake provisions, we have classified the site sub-soil as Class C_e – *Shallow soil site* in accordance with Section 4.2 of AS 1170.4-2007 *Earthquake Actions in Australia*.

4.2 Temporary and Permanent Batters

The batter slope angles shown in Table 3 are recommended for the design of batters; 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 3 months 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.

If the conditions above cannot be met, further advice should be sought.

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

TABLE 3
BATTER SLOPE ANGLES

UNIT	TEMPORARY	PERMANENT
SOIL (i.e. FILL & NATURAL SOIL)	1.5H : 1V	2H : 1V
BEDROCK (i.e. unit A and B)	1.0H : 1V	1.5H : 1V

4.3 Retaining Walls

Permanent cuts in the 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 design of these structures should be based on the following geotechnical properties:

- Effective soil strength parameters in Table 4, and

- A lateral pressure of 10 kPa for vertical cuts in the BEDROCK unit. This is to allow for blocks and rock wedges formed due to adverse defects that may exist within the unit.

Note that design of retention systems may be based on either K_a or K_o earth pressures. Design using active earth pressures (K_a) 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.

The selection of an appropriate retaining wall system and the proportioning of it are matters of design and depend upon many issues other than those known to the geotechnical engineer. The designer should consider the advice provided in this report.

4.4 Foundations

4.4.1 Shallow Footings

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads provided in Table 4. Pad footings should not be founded on the FILL unit which includes topsoil.

We 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 rapidly, as the load gains eccentricity or becomes inclined, the capacity reduces rapidly. Higher ABPs in soil units may be available, but these depend on the size, depth, loads, etc, and would be subject to specific advice.

Settlements in the SOIL unit can be estimated using the elastic parameters provided in Table 4. Typically a footing founded on the SOIL unit and sized for the ABP in Table 4 could be expected to settle between 1% and 2% of the minimum footing dimension. Where founding conditions or footing types vary the designer shall need to consider the effect of differential settlements.

4.4.2 Piles

Bedrock was encountered at depths of between 3.1 m and 3.5 m below ground level.

Piles should be designed in accordance with the requirements in AS 2159 (2009), *Piling – Design and Installation.* The parameters provided in Table 4 may be adopted in the design of piles. We envisage that piles will be founded within the BEDROCK A or B units.

With regards to the pile design we recommend that:

- A geotechnical strength reduction factor, Φ_g = 0.60 (AS 2159 (2009) – Clause 4.3.2) should 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 method indicate a high level of quality control with regards to concrete placement, base cleanliness, etc.

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

TABLE 4
ENGINEERING PARAMETERS OF INFERRED GEOTECHNICAL UNITS

INFERRED UNIT	BULK UNIT WEIGHT (kN/m^3)	SOIL EFFECTIVE STRENGTH PARAMETERS		ULTIMATE BEARING PRESSURE UNDER VERTICAL CENTRIC LOADING (kPa)	ALLOWABLE BEARING PRESSURE (ABP) UNDER VERTICAL CENTRIC LOADING (kPa)	ULTIMATE SHAFT ADHESION (kPa)	ELASTIC PARAMETERS	
		c' (kPa)	ϕ' (deg)				LONG TERM YOUNG MODULUS (MPa)	POISSON'S RATIO
NATURAL SOIL	18	0	30	400	150[1]	NA	10	0.3
BEDROCK A	24	NA	NA	3,000[2]	1,000[3]	150	100	0.3
BEDROCK B	24	NA	NA	6,000[2]	2,000[3]	350	200	0.3

Note: 1. Pad footings (for ABP of 150 kPa) should have a minimum horizontal dimension of 1.0 m and a minimum embedment depth of 0.5 m.
2. Ultimate values occur at large settlement (>5% of minimum footing / pile dimensions).
3. End bearing pressure to cause settlement of <1% of minimum footing / pile dimensions.

4.5 Slab on ground

Slabs on ground shall be founded below the TOPSOIL on either:

- NATURAL SOIL, or
- FILL unit, that is moisture conditioned and compacted to near the standard maximum dry density (SMDD), e.g. between 98% and 102%, and near the optimum moisture content, e.g. 2% dry and 2% wet standard compaction, or
- ENGINEERED FILL where this is required to achieve the required founding level. The ENGINEERED FILL shall be compacted to near the standard maximum dry density (SMDD), e.g. between 98% and 102%, and near the optimum moisture content, e.g. 2% dry and 2% wet standard compaction.

The design of such slabs on ground can be based on a subgrade with a long term Young's Modulus of 10 MPa. The soil subgrade will need to be prepared or compacted using a smooth drum vibratory roller e.g. with a 10 tonne roller.

We note that the environmental effects (e.g. drying or wetting up of the finished surface) affecting the land prior to development should be taken into account by the designers of the development. We note that normal mounding or sagging away from the perimeter of covered areas will still occur and perimeters, and open joints, will still respond to environmental changes. We note the maintenance requirements of AS 2870 (2011) should be taken into account by the structural engineer and architect.

4.6 Pavements

A design subgrade CBR of 2% can be adopted for preliminary pavement design on NATURAL SOIL subgrade or ENGINEERED FILL subgrade. We recommend that specific CBR testing be undertaken at subgrade level when pavement layouts are finalised.

5 GENERAL

If at any time, the conditions are found to vary from those described in this report, further advice should be sought.

Should there be any queries, please do not hesitate to contact the undersigned.

For and on behalf of
PELLS SULLIVAN MEYNINK

ROHAN STOCKER
Senior Geotechnical Engineer

DAVID PICCOLO
Principal

Encl. Figure 1 Locality Plan
Figure 2 Selected site photographs (1 of 2)
Figure 3 Selected site photographs (2 of 2)
Attachment A Engineering borehole logs and core photographs
Attachment B Point load strength index test results

Notes

1. Nearmap imagery dated 17 July 2018

Approximate site boundary

Pells Sullivan Meynink

JBS&G 127 & 129 FLOWERDALE RD LIVERPOOL, NSW SITE LOCALITY PLAN	
PSM3651-004L	Figure 1

O:\PSM3651\Docs Out\PSM3651-004L\[PSM3651-004L - Figure 1 Site Plan.xls]FIGURE 1

BH01 - Drilling Rig Setup

JBS&G

127 & 129 Flowerdale Rd

Liverpool, NSW

SELECTED SITE PHOTOS

Pells Sullivan Meynink

PSM3651-004L	**Figure 2**

BH02 - Test Location Area

JBS&G

127 & 129 Flowerdale Rd

Liverpool, NSW

SELECTED SITE PHOTOS

Pells Sullivan Meynink

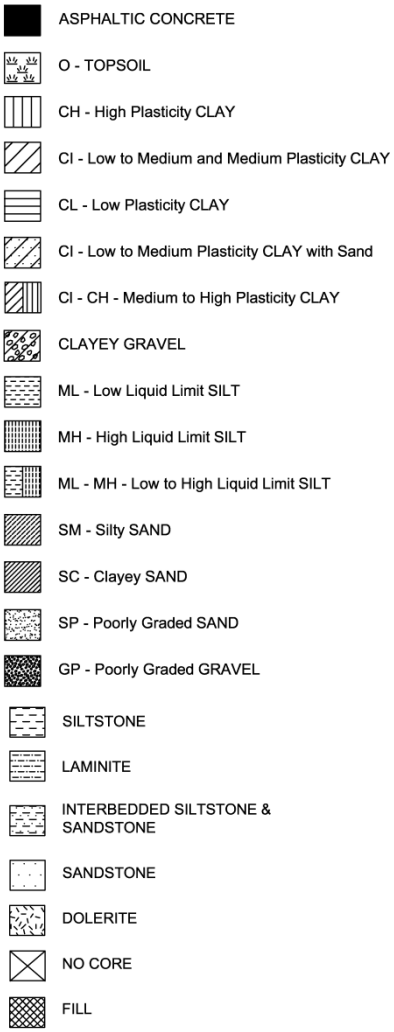
PSM3651-004L	**Figure 3**

ATTACHMENT A

ENGINEERING BOREHOLE LOGS AND CORE PHOTOGRAPHS

EXPLANATION SHEET - SOIL DESCRIPTION

GRAPHIC LEGEND



DEFINITIONS

Soil:

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

Classification symbol & soil name:

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

Support:

C - Casing
T - Timbering

See rock description for method and samples / field test definitions.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 µm to 2.36 mm
	medium	200 µm to 600 µm
	fine	75 µm to 200 µm

MOISTURE CONDITION

CONDITION	FIELD GUIDE
Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere
Wet	As for moist but with free water forming on hands when handles

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH SU (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort
Soft	12 – 25	A finger can be pushed into the soil to about 25mm depth
Firm	25 – 50	The soil can be indented about 5mm with the thumb, but not penetrated
Stiff	50 – 100	The surface of the soil can be indented with the thumb, but not penetrated
Very Stiff	100 – 200	The surface of the soil can be marked, but not indented with thumb pressure
Hard	>200	The surface of the soil can be marked only with the thumbnail
Friable	-	Crumbles or powders when scraped by thumbnail

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	<15
Loose	15 – 35
Medium Dense	35 – 65
Dense	65 – 85
Very Dense	>85

Where no SPT data, the following descriptions are used:

Loose: Can be removed from exposure by hand in a disaggregated form.

Compact (C) Only removed from exposure with an implement, material readily disaggregated by physical means.

Cemented (Ce) Only removed from exposure with an implement, material cannot be disintegrated / remoulded in air/ water.

EXPLANATION SHEET - SOIL DESCRIPTION

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure of sample	**Weakly Cemented**	Easily broken up by hand in air or water
Lenses	Discontinuous layers of lenticular shape	**Moderately Cemented**	Effort is required to break up the soil by hand in air or water
Pockets	Irregular inclusions of different material	**Cemented**	Only removed from exposure by implement, material does not disaggregate
		Compact	Only removed from exposure by implement, material readily disaggregated by physical means

GEOLOGICAL ORIGIN

Weathered in place soils:

Extremely weathered	Structure and fabric of parent rock visible
Residual Soil	Structure and fabric of parent rock not visible

Transported soil:

Aeolian	Deposited by wind
Alluvium	Deposited by streams and rivers
Colluvium	Deposited on slopes (transported downslope by gravity)
Lacustrine	Deposited by lakes
Marine	Deposited in ocean basins, bays, beached and estuaries

Man Made:

Fill	Fill may be significantly more variable between tested locations than naturally occurring soils

COMMON DEFECTS IN SOIL

TERM	DEFINITION
Parting	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (e.g. bedding). May be open or closed.
Joint	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.
Sheared Zone	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.
Sheared Surface	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.
Softened Zone	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.
Tube	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter
Tube Cast	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases, the soil that makes up the tube cast is cemented.
Infilled Seam	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries that cuts through a soil mass. Formed by infilling of open joints.

EXPLANATION SHEET - SOIL DESCRIPTION

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 60 mm AND BASING FRACTIONS ON ESTIMATED MASS)*								USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0. 475 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.				GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.				GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)				GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)				GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing				SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.				SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).				SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).				SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.						
		SILTS & CLAYS Liquid limit less than 50	**Dry strength**	**Dilatancy**	**Toughness**				
			None to Low	Quick to slow	None			ML	SILT
			Medium to High	None	Medium			CL	CLAY
			Low to medium	Slow to very slow	Low			OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium			MH	SILT
			High	None	High			CH	CLAY
			Medium to High	None	Low to medium			OH	ORGANIC CLAY
HIGHLY ORGANIC SOIL Readily identified by colour, odour, spongy feel and frequently by fibrous texture								Pt	PEAT
• Low plasticity – Liquid Limit W_L less than 35%. • Medium plasticity – W_L between 35% and 50%.									

*After AS1726 (1993)

EXPLANATION SHEET - ROCK DESCRIPTION

DEFINITIONS

Rock Substance:
In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material may be isotropic or anisotropic.

Defect:
Discontinuity or break in the continuity of a substance or substances.

Mass:
A body of material that is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

Method:

AD/T	Auger drilling with tcbit
AD/V	Auger drilling with vbit
AS	Auger screwing
AT	Air track
B	Dozer blade
BH	Backhoe bucket
CT	Cable tool
DB	Washbore drag bit
DT	Diatube
E	Excavator
EH	Excavator with hammer
HA	Hang auger
HMLC	HMLC core barrel
HQ3	Coring 63.5mm diameter, triple tube, wireline
MZ	Mazier
N	Natural exposure
NMLC	NMLC core barrel
NQ3	Coring 45.1mm diameter, triple tube, wireline
PQ3	Coring 83.1mm diameter, triple tube, wireline
Pushed SPT	Pushed SPT
PT	Push tube
R	Ripper
RR	Rock roller
SPT	Driven SPT
WB	Washbore
X	Existing excavation

Core Quality:

TCR	Total Core Recovered (%)
RQD	Rock Quality Designation (%)

Samples and Field Tests:

B	Bulk Disturbed Sample
BLK	Block sample
C	Core sample
CBR	CBR mould sample
D	Small disturbed sample
ES	Soil sample for environmental testing
EW	Water sample for environmental testing
G	Gas sample
LB	Large bulk disturbed sample
M	Mazier type sample
P	Piston sample
SPT	Standard Penetration Test
U	Undisturbed push in sample
W	Water sample

Rock Strength:

A	Axial point load test result (Is50)
D	Diametral point load test result (Is50)

Water:

▻ Inflow
◅ Partial Loss
◄ Complete Loss

SUBSTANCE DESCRIPTIVE TERMS

Rock name:
Simple rock names are used rather than precise geological classification

Particle size (for sandstone):
Coarse - Mainly 0.6mm to 2mm
Medium - Mainly 0.2mm to 0.6mm
Fine - Mainly 0.05mm (just visible) to 0.2mm

Fabric:
Massive - No layering or penetrative fabric
Indistinct - Layering or fabric visible. Little effect on properties
Distinct - Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric

Bedding:
Thinly Laminated - <6mm
Laminated - 6 – 20mm
Very Thinly Bedded - 20 – 60mm
Thinly Bedded - 60 – 200mm
Medium Bedded - 200 – 600mm
Thickly Bedded - 600 – 2000mm
Very Thickly Bedded - >2000mm

ROCK SUBSTANCE STRENGTH

ABBR	TERM	POINT LOAD INDEX, IS50 (MPA)	FIELD GUIDE
EL	Extremely Low	≤0.03	Easily remoulded by hand to a material with soil properties
VL	Very Low	>0.03≤0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
L	Low	>0.1≤0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	>0.3≤1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
H	High	>1≤3	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.
VH	Very High	>3≤10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break; rock rings under hammer.

EXPLANATION SHEET - ROCK DESCRIPTION

CLASSIFICATION OF WEATHERING

ABBR	TERM	FIELD GUIDE
F	Fresh	Rock substance unaffected by weathering
SW	Slightly Weathered	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
MW	Moderately Weathered	The whole of the rock substance is discoloured, usually by iron staining or bleaching, to the extent that the colour of the fresh rock is no longer recognisable.
HW	Highly Weathered	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
EW	Extremely Weathered	Material is weathered to such an extent that it has soil properties, i.e.; it either disintegrates or can be remoulded in water. Original rock fabric still visible.

COMMON DEFECTS IN ROCK MASS

ABBR	TERM	FIELD GUIDE
FT	Fault	Fracture long which displacement is recognisable
SS	Shear Seam	A fracture along which movement has taken place but no displacement is recognisable. Evidence for movement may be slickensides, polishing and/or clay gouge
SZ	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
BP	Bedding Parting	Arrangement in layers of mineral grains or crystals parallel to surface of deposition along which a continuous observable parting occurs
SM	Seam	Seam of soil substance, often with gradational boundaries. Formed by weathering of the rock substance in place
IS	Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface
JT	Joint	A single fracture across which rock has little or no tensile strength and is not obviously related to rock fabric
CO	Contact	Surface between two lithologies
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
FZ	Fractured Zone	A zone of closely spaced defects (mainly joints, bedding, cleavage and/or schistosity) comprised of core lengths in the order of 50mm or less.
BSH	Bedding Shear	A shear formed along a bedding plane
DB	Drilling Break	Drilling induced break

SHAPE TERMS

ABBR	TERM	FIELD GUIDE
PR	Planar	The defect does not vary in orientation
CU	Curved	The defect has a gradual change in orientation
UN	Undulating	The defect has a wavy surface
ST	Stepped	The defect has one or more well defined steps
IR	Irregular	The defect has many sharp changes of orientation

ROUGHNESS TERMS

ABBR	TERM	FIELD GUIDE
SL	Slickensided	Grooved or striated surface, usually polished
POL	Polished	Shiny smooth surface
S	Smooth	Smooth to touch. Few or no surface irregularities
RF	Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
VR	Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS

ABBR	TERM	FIELD GUIDE
CN	Clean	No visible coating
SN	Stained	No visible coating but surfaces are discoloured
VR	Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
CT	Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (e.g., infilled seam). Thicker rock strength material is usually described as a vein

INFILLING MATERIAL

ABBR	TERM
CA	Calcite
Clay	Clay
Fe	Iron Oxide
Fe Clay	Iron Oxide Clay
KT	Chlorite
MS	Secondary Mineral
MU	Unidentified Mineral
Qz	Quartz
X	Carbonaceous
RF	Rock fragments
G	Gravel
S	Sand
Z	Silt

Borehole ID

BH01

Engineering Log - Non Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306697.0 m E 6244029.0 m N MGA94 Zone 56	Checked By:	RS

Drill Model and Mounting:	D&B 8D	Inclination:	-90°	RL Surface:	
Hole Diameter:	125 mm	Bearing:		Datum: AHD	Operator: SF

Drilling Information								***Soil Description***				***Observations***
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T			Not Encountered				1		OL	Clayey SILT: brown, low plasticity, with root fibres	D w<PL			TOPSOIL
							2		CH	CLAY: red brown mottled pale grey, high plasticity, with fine to medium shale gravel				RESIDUAL SOIL
							3			LAMINITE: pale brown, extremely weathered to highly weathered, very low strength				BEDROCK 3.10: U50 tube pushed to refusal, ground too stiff. BEDROCK
							4			Continued on cored borehole sheet				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
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
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306697.0 m E 6244029.0 m N MGA94 Zone 56	Checked By:	RS

Drill Model and Mounting: D&B 8D | Inclination: -90° | RL Surface:
Barrel Type and Length: 3 m | Bearing: | Datum: AHD | Operator: SF

Drilling Information							***Rock Substance***			***Rock Mass Defects***	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F; Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
						1					
						2					
						3					
						4		Continued from non-cored borehole sheet			
NMLC	90% Water RETURN	100	89	4.40m 1 Is(50) 2 d=0.1 a=0.3 MPa				LAMINITE: SHALE (70%): grey with orange brown staining, thinly laminated sub-horizontally. SANDSTONE (30%): fine to medium grained. Beds typically spaced at 10-20mm			CZ, 15 mm BP, 10°, CN, IR, S JT, 60°, Fe SN, PR, S BP, 5°, CN, PR, S IS, 5°, Clay, IR, S, 5 mm

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

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306697.0 m E 6244029.0 m N MGA94 Zone 56	Checked By:	RS

Drill Model and Mounting: D&B 8D | Inclination: -90° | RL Surface:
Barrel Type and Length: 3 m | Bearing: | Datum: AHD | Operator: SF

Drilling Information

Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)
NMLC	90% Water RETURN	100	89	5.35m 1 Is(50) 2 d=0.2 a=0.3 MPa		6
		100	85	6.65m 1 Is(50) 2 d=0.1 a=0.2 MPa		7
				7.25m 1 Is(50) 2 d=0.1 a=0.3 MPa		8
				8.25m 1 Is(50) 2 d=0 a=0.1 MPa		
				8.55m 1 Is(50) 2 a=0.7 MPa		9

Rock Substance

Graphic Log | Material Description (ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable) | Weathering (EW HW MW SW F) | Strength Is(50) ● - Axial ○ - Diametral (EL <0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)

LAMINITE: SHALE (70%): grey with orange brown staining, thinly laminated sub-horizontally. SANDSTONE (30%): fine to medium grained. Beds typically spaced at 10-20mm *(continued)*

SHALE: dark grey, thinly laminated sub-horizontally

Hole Terminated at 8.55 m
Target depth

Rock Mass Defects

Defect Spacing (mm) (<20, 60, 200, 600, 1000) | Defect Descriptions / Comments — Description, alpha/beta, infilling or coating, shape, roughness, thickness, other

- SM, 0°, Clay, PR, 10 mm
- BP, 5°, CN, UN, S
- BP, 0°, Fe, PR, S
- IS, 10°, RF CN, CU, 10 mm
- SM, 5°, Clay, 2 mm
- BP, 5°, CN, IR, S
- IS, 0°, RF, 5 mm
- IS, 0°, RF, 5 mm
- IS, 0°, RF, 5 mm
- BP, 5°, Fe SN, PR, S
- FZ, 15 mm
- JT, 45°, CN, PR, SL
- BP, 0°, RF, PR, S
- BP, 0°, CN, PR, S
- BP, 5°, CN, IR, S
- IS, RF, 10 mm
- SM, 15°, Clay, 10 mm
- FZ, 30 mm

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

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

See Explanatory Notes for details of abbreviations and basis of descriptions.

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

BH01 - Depth 4.05 m - 8.55 m

JBS&G 127 & 129 FLOWERDALE RD LIVERPOOL, NSW GEOTECHNICAL INVESTIGATION CORE PHOTOGRAPH	
PSM3651-004L	BH01

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Borehole ID

BH02

Engineering Log - Non Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306661.0 m E 6244021.0 m N MGA94 Zone 56	Checked By:	RS

Drill Model and Mounting:	D&B 8D	Inclination:	-90°	RL Surface:	
Hole Diameter:	125 mm	Bearing:		Datum: AHD	Operator: SF

Drilling Information								***Soil Description***				***Observations***
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description SOIL NAME: Colour, structure, plasticity, additional	Moisture Condition	Consistency / Relative Density	Hand Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T			Not Encountered				1		OL	Sandy SILT: brown, low plasticity, sand is fine grained, with root fibres	D w<PL			TOPSOIL
										Sandy GRAVEL: brown, fine to medium, angular to sub-angular, sand is fine to medium grained. Appears well compacted	D			FILL
									CH	CLAY: red brown mottled pale grey, high plasticity, with fine to medium shale gravel				RESIDUAL SOIL
							2				D w<PL			
							3							
										LAMINITE: pale brown, extremely weathered to highly weathered, very low strength				BEDROCK
							4			Continued on cored borehole sheet				

Method
AD/T - Auger drilling TC bit
AD/V - Auger drilling V bit
WB - Washbore
SPT - Standard penetration test
PT - Push tube
AS - Auger Screwing

Penetration
No resistance through to refusal

Water
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test
ES - Environmental Sample
TW - Thin Walled
LB - Large Disturbed Sample

Classification symbols and soil descriptions based on Unified Soil Classification System

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
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
C - Compact

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306661.0 m E 6244021.0 m N MGA94 Zone 56	Checked By:	RS
Drill Model and Mounting:	D&B 8D	Inclination: -90°	RL Surface:
Barrel Type and Length:	3 m	Bearing:	Datum: AHD Operator: SF

Drilling Information							Rock Substance				Rock Mass Defects	
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW HW MW SW F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) <20 60 200 600 1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
						1						
						2						
						3						
						4		Continued from non-cored borehole sheet				
NMLC	90% Water RETURN	100	79	4.45m 2 Is(50) d=0.1 a=0.2 MPa				LAMINITE: SHALE (70%): grey with orange brown staining, thinly laminated sub-horizontally. SANDSTONE (30%): fine to medium grained. Beds typically spaced at 5-20mm				FZ, 120 mm BP, 5°, CN, UN, S BSH, 0°, RF, PR, 10 mm SM, 10°, CL, 10 mm SM, 10°, CL, 10 mm

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

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

See Explanatory Notes for details of abbreviations and basis of descriptions.

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

Engineering Log - Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306661.0 m E 6244021.0 m N MGA94 Zone 56	Checked By:	RS

Drill Model and Mounting: D&B 8D | Inclination: -90° | RL Surface:
Barrel Type and Length: 3 m | Bearing: | Datum: AHD | Operator: SF

Drilling Information | **Rock Substance** | **Rock Mass Defects**

Method: NMLC
Water: 90% Water RETURN

TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)
100	79			
		5.70m 1 Is(50) 2 d=0.1 a=0.3 MPa		6
		6.25m 1 Is(50) 2 d=0.2 a=0.3 MPa		
100	97	7.20m 1 Is(50) 2 d=0.2 a=0.5 MPa		7
		8.20m 1 Is(50) 2 d=0.2 a=0.3 MPa		8
100	76	9.10m 1 Is(50) 2 d=0.2 a=0.4 MPa		9
		9.90m 1 Is(50) 21 d=0.5 a=0.5 22 MPa		

Graphic Log

Material Description
ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)

LAMINITE: SHALE (70%): grey with orange brown staining, thinly laminated sub-horizontally. SANDSTONE (30%): fine to medium grained. Beds typically spaced at 5-20mm *(continued)*

SHALE: dark grey, thinly laminated sub-horizontally

Weathering: EW | HW | MW | SW | F

Strength Is(50) ● - Axial ○ - Diametral: EL | VL | L | M | H | VH | EH (<0.03 | 0.1 | 0.3 | 1 | 3 | 10)

Defect Spacing (mm): <20 | 60 | 200 | 600 | 1000

Defect Descriptions / Comments
Description, alpha/beta, infilling or coating, shape, roughness, thickness, other

- SM, 0°, CL, 10 mm
- SM, 0°, CL, 10 mm
- SM, 0°, CL, 10 mm
- BP, 5°, CN, UN, S
- BP, 5°, CN, UN, S
- FZ, 20 mm
- BP, 10°, FE, PR, S
- BP, 10°, FE, UN, S
- CZ, 20 mm
- JT, 25°, CN, PR, S
- BSH, 0°, RF, PR
- JT, 15°, CN, PR, SL
- BP, 10°, CN, UN, S
- BP, 5°, CN, UN, S
- JT, 70°, CN, ST, RF
- JT, 65°, CN, ST, RF
- JT, 5°, CN, IR, RF
- FZ, 180 mm

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

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.

Engineering Log - Cored Borehole

Project No.: PSM3651

Client:	JBS&G	Commenced:	14/08/2018
Project Name:	127 & 129 Flowerdale Road	Completed:	14/08/2018
Hole Location:	Liverpool	Logged By:	DDC
Hole Position:	306661.0 m E 6244021.0 m N MGA94 Zone 56	Checked By:	RS

Drill Model and Mounting: D&B 8D | Inclination: -90° | RL Surface:
Barrel Type and Length: 3 m | Bearing: | Datum: AHD | Operator: SF

Drilling Information							Rock Substance																Rock Mass Defects		
Method	Water	TCR (%)	RQD (%)	SAMPLES & FIELD TESTS	RL (m)	Depth (m)	Graphic Log	Material Description ROCK TYPE: Colour, grain size, structure (texture, fabric, mineral composition, hardness, alteration, cementation, etc as applicable)	Weathering EW	HW	MW	SW	F	Strength Is(50) ● - Axial ○ - Diametral EL <0.03	VL 0.1	L 0.3	M 1	H 3	VH 10	EH	Defect Spacing (mm) <20	60	200	600	1000	Defect Descriptions / Comments Description, alpha/beta, infilling or coating, shape, roughness, thickness, other
			76																						
						11		Hole Terminated at 10.10 m Target depth																	
						12																			
						13																			
						14																			

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

Water
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
No core recovery

Weathering
EW - Extremely Weathered
HW - Highly Weathered
MW - Moderately Weathered
SW - Slightly Weathered
F - Fresh

Strength
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

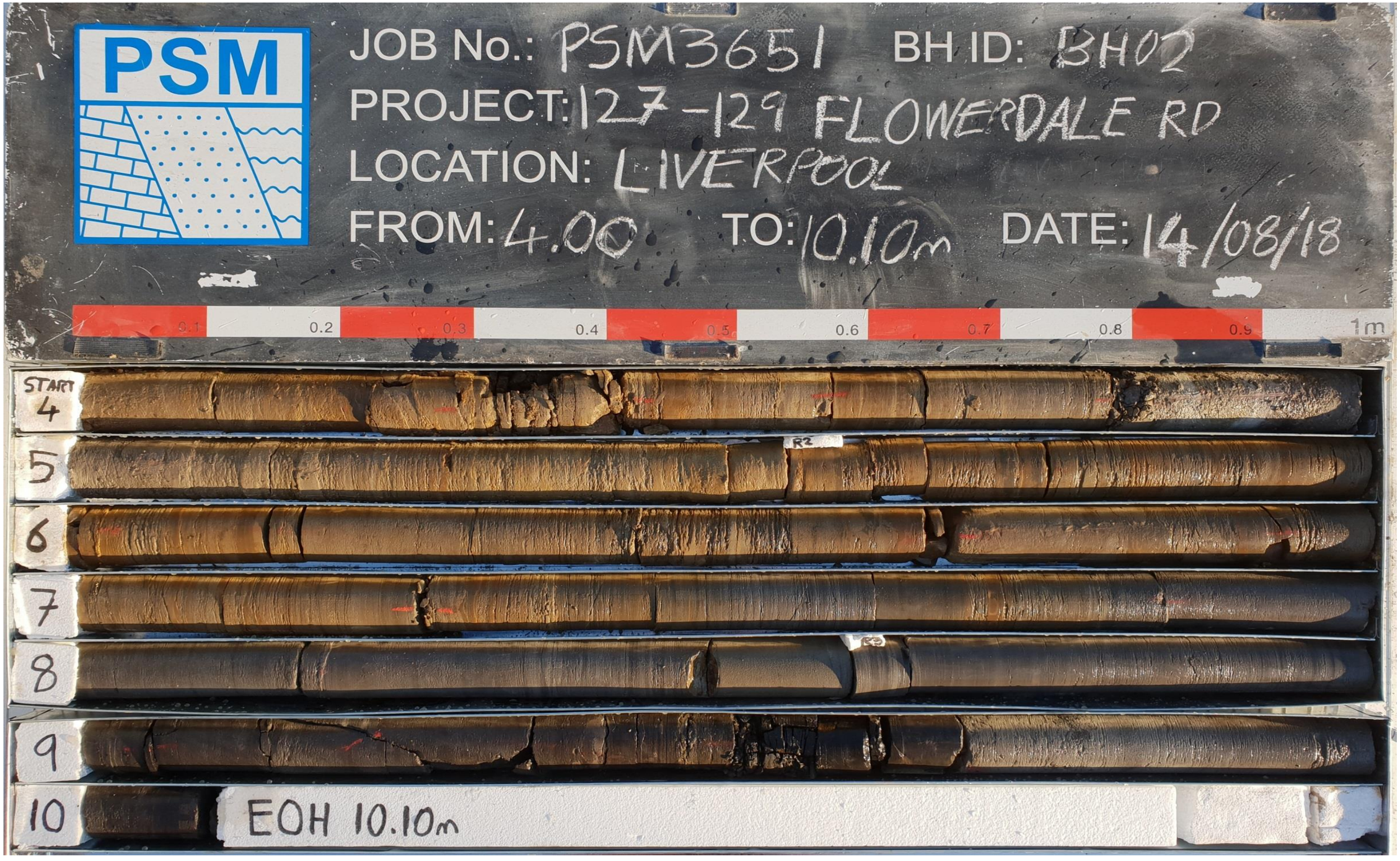
Defect Type
FT - Fault
SS - Shear Surface
SZ - Shear Zone
BP - Bedding parting
SM - Seam
IS - Infilled Seam
JT - Joint
CO - Contact
CZ - Crushed Zone
VN - Vein
FZ - Fracture Zone
BSH - Bedding Shear
DB - Drilling Break

Infilling/Coating
CN - Clean
SN - Stain
VN - Veneer
CO - Coating
RF - Rock fragments
G - Gravel
S - Sand
Z - Silt
CA - Calcite
CL - Clay
FE - Iron
QZ - Quartz
X - Carbonaceous

Roughness
SL - Slickensided
POL - Polished
S - Smooth
RF - Rough
VR - Very Rough

Shape
PR - Planar
CU - Curved
UN - Undulating
ST - Stepped
IR - Irregular

See Explanatory Notes for details of abbreviations and basis of descriptions.



BH02 - Depth 4.00 m - 10.10 m

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JBS&G	
127 & 129 FLOWERDALE RD	
LIVERPOOL, NSW	
GEOTECHNICAL INVESTIGATION CORE PHOTOGRAPH	
PSM3651-004L	BH02

ATTACHMENT B

POINT LOAD STRENGTH INDEX TEST RESULTS

Pells Sullivan Meynink

POINT LOAD STRENGTH INDEX TEST RESULTS

Job No. *PSM3651* **Sheet** 1 of 1

Project *127-129 Flowerdale Road, Liverpool*

Test Method	*AS 4133.4.1 - 1993 Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index*	Sampling Technique	*NLMC*	Sampling Date	*14/8/2018*
		Storage History	*North Ryde office indoor core storage area*	Testing Date	*22/08/2018*
Test Machine	*GSA 6510 (S/N 0311)*	Moisture Condition	*Natural*	Tested By	*RS*
Calibration Date	*16/8/2018*	Loading Rate	*< 30 seconds*		

Rock Type	Location	Depth	Diametral Tests					Axial, Block, and Irregular Lump Tests							AS 1726 Strength Class
			D	L	P	$I_{s(50)}$	Failure Mode	W	D	L	P	I_s	$I_{s(50)}$	Failure Mode	
		(m)	(mm)	(mm)	(kN)	(MPa)		(mm)	(mm)	(mm)	(kN)	(MPa)	(MPa)		
SHALE	***BH01***	***4.40***	*50*	*75*	*0.4*	***0.1***	*Through substance*	*50*	*35*		*0.6*	*0.3*	***0.3***	*Through substance*	***L***
SHALE	***BH01***	***5.35***	*50*	*100*	*0.4*	***0.2***	*Through substance*	*50*	*25*		*0.6*	*0.4*	***0.3***	*Through substance*	***L / M***
SHALE	***BH01***	***6.65***	*50*	*80*	*0.1*	***0.1***	*Through substance*	*50*	*35*		*0.6*	*0.3*	***0.2***	*Through substance*	***VL / L***
SHALE	***BH01***	***7.25***	*50*	*100*	*0.2*	***0.1***	*Through substance*	*50*	*30*		*0.6*	*0.3*	***0.3***	*Through substance*	***VL / L***
SHALE	***BH01***	***8.25***	*50*	*60*	*0.1*	***0***	*Through substance*	*50*	*30*		*0.2*	*0.1*	***0.1***	*Through substance*	***L***
SANDSTONE	***BH01***	***8.55***						*50*	*45*		*1.8*	*0.6*	***0.7***	*Through substance*	***M***
SHALE	***BH02***	***4.45***	*50*	*55*	*0.3*	***0.1***	*Through substance*	*50*	*20*		*0.3*	*0.3*	***0.2***	*Through substance*	***L***
SHALE	***BH02***	***5.70***	*50*	*90*	*0.3*	***0.1***	*Through substance*	*50*	*35*		*0.8*	*0.3*	***0.3***	*Through substance*	***L / M***
SHALE	***BH02***	***6.25***	*50*	*130*	*0.6*	***0.2***	*Through substance*	*50*	*45*		*1*	*0.3*	***0.3***	*Through substance*	***L / M***
SHALE	***BH02***	***7.20***	*50*	*75*	*0.6*	***0.2***	*Through substance*	*50*	*40*		*1.2*	*0.5*	***0.5***	*Through substance*	***L / M***
SHALE	***BH02***	***8.20***	*50*	*110*	*0.6*	***0.2***	*Through substance*	*50*	*40*		*0.9*	*0.3*	***0.3***	*Through substance*	***L / M***
SHALE	***BH02***	***9.10***	*50*	*70*	*0.6*	***0.2***	*Through substance*	*50*	*35*		*0.9*	*0.4*	***0.4***	*Through substance*	***L / M***
SHALE	***BH02***	***9.90***	*50*	*120*	*1.3*	***0.5***	*Through substance*	*50*	*40*		*1.2*	*0.5*	***0.5***	*Through substance*	***M***

By: *RS* **Checked:** **Date:** *22/8/2018*