Pells Sullivan Meynink
Engineering Consultants
Rock-Soil-Water

G3 56 Delhi Road
North Ryde NSW 2113
P: 61-2 9812 5000
F: 61-2 9812 5001
mailbox@psm.com.au
www.psm.com.au

Our Ref: PSM3333-002L

27 June 2017

FDC Construction & Fitout (NSW) Pty Ltd
22-24 Junction Street
FOREST LODGE NSW 2037

ATTENTION: KATRINA ROLLASON
By email: katrinar@fdcbuilding.com.au

Dear Katrina

RE: SITE YP, SYDNEY OLYMPIC PARK
RESULTS OF GEOTECHNICAL INVESTIGATIONS

1 INTRODUCTION

This letter presents the results of geotechnical investigations undertaken by Pells Sullivan Meynink (PSM) at Site YP, Sydney Olympic Park. The work has been undertaken in general accordance with the PSM proposal dated 23 May 2017 and accepted by Katrina Rollason of FDC on 25 May 2017.

2 BACKGROUND

Prior to undertaking the work PSM were supplied with the following document:

- Altis Architecture - *"Site YP | Sydney Olympic Park Design Competition – Design Report"*

PSM note the following about the site:

- The site is approximately 1,058 m^2 in area
- The site currently contains a paved area adjacent to Cathy Freeman Park
- The development is for a 2 storey building at least one level of basement
- The proposed footing loads are approximately 2500kN (working load)

3 FIELDWORK

The fieldwork was undertaken on 15 June 2017 during the environmental investigation being undertaken by DLA Environmental Services. The geotechnical fieldwork was completed, under the fulltime supervision of a PSM geotechnical engineer, who undertook the following tasks:

- Setting out test locations
- Preparing engineering logs

The location of each test was measured using a tape measure relative to relevant site features. Figure 1 presents the test locations.

3.1 Boreholes

A total of seven (7) augered boreholes (BH01 to BH07) were drilled using a light truck-mounted drill rig.

The boreholes were drilled to depths between 0.4 m and 7.1 m.

Tabulation of material encountered is provided for each borehole in Attachment 1.

At the completion of the fieldwork, the boreholes were backfilled with excavated spoil and reinstated concrete pavers / bricks. Figure 2 and Figure 3 present selected photos of the fieldwork.

4 SITE CONDITIONS

4.1 Geological Setting

The 1:100,000 Sydney Geological map (1983) indicates the site is underlain by man-made fill, underlain by black to dark-grey shale and laminite of the Wianamatta Group. We note that this map predates the development of the site for the Sydney Olympics in 2000.

4.2 Surface Conditions

At the time of fieldwork, the site consisted of concrete and brick paved areas. The south-eastern and south-western boundaries consisted of a concrete retaining wall. A few trees were situated along the north-eastern boundary, and some vegetation in a small area along the south-western boundary.

4.3 Subsurface Conditions

The subsurface conditions encountered within the boreholes are summarised in Table 1.

TABLE 1
SUMMARY OF INFERRED SUBSURFACE CONDITIONS ENCOUNTERED IN THE BOREHOLES

INFERRED UNIT	INFERRED TOP OF UNIT DEPTH BELOW GROUND SURFACE (m)	DESCRIPTION
PAVEMENT	0.0	CONCRETE Paver. BRICK Paver.
FILL	0.08	FILL: Gravelly SAND; medium to coarse grained, yellow-brown to pale grey, sub-rounded to sub-angular gravel up to 10 mm, dense to cemented consistency, moist. FILL: CLAY with some gravel and sand to CLAY with a trace of sand and gravel; low to medium plasticity, light brown to dark grey, sub-rounded to sub-angular gravel up to 20 mm, fine to medium grained sand, firm consistency, moist.
NATURAL SOIL	1.6 to 2.7	CLAY with some gravel and sand to Clayey SAND with some gravel; low to high plasticity, light brown to black, sub-rounded to sub-angular gravel up to 5 mm, fine to medium grained, firm to stiff consistency, moist to wet.
BEDROCK A	3.0 to 3.3	SHALE; orange-brown to grey, extremely weathered, extremely low strength.
BEDROCK B	3.5 to 3.7	SHALE; brown to grey, highly weathered, very low strength.

Table 2 shows the approximate depth to the top of the inferred geotechnical units encountered in the boreholes.

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

BOREHOLE	DEPTH TO TOP OF INFERRED GEOTECHNICAL UNITS (m)					
	PAVEMENT	FILL	NATURAL SOIL	BEDROCK A	BEDROCK B	EOH
BH01	0	0.08	N.E.	N.E.	N.E.	0.4
BH02	0	0.08	N.E.	N.E.	N.E.	0.9
BH03	0	0.08	1.6	N.E.	N.E.	3.0
BH04	0	0.08	2.7	3.0	3.5	7.1
BH05	0	0.08	2.0	N.E.	N.E.	3.0
BH06	0	0.08	1.8	3.3	3.7	7.0
BH07	0	0.08	N.E.	N.E.	N.E.	2.0

Note: EOH = End of Hole
N.E. = Not Encountered

4.4 Groundwater

Groundwater was not observed during the investigation.

5 GEOTECHNICAL DESIGN ADVICE FOR THE PROPOSED DEVELOPMENT

5.1 Site Classification

While the proposed development is out of scope of AS2870-2011 *"Residential slabs and footings"*, we assess that the characteristic surface movement, y_s, would be in the range 40 mm to 60 mm and thus would classify the site as Class H1. The civil and structural engineers should consider likely heave / settlement due to the effect of climatic factors in their designs.

We recommend that all structures and services, located on or near the surface, be detailed such that they preclude any local wetting up or drying out of the subgrade after initial equilibrium is reached following construction of the slab and that the subgrade be within specification at the time of construction of the slab. We note that normal mounding or sagging away from the perimeter of covered areas will still occur and perimeters, or open joints, will still respond to environmental changes.

For effectively sealed areas, on or near the surface, away from the perimeter, the design should allow for the following:

- Differential mound movement, y_m = 15 mm. We note that this is not the total heave or settlement but the estimated local heave or settlement due to fill variability.
- Tilts of up to approximately 1 in 300.

Mounds at perimeters or penetrations of slabs open to the environment can be taken to be as per AS2870-2011 for y_s = 45 mm.

Provided the moisture condition is retained during and after construction, the base of a basement slab should not be exposed to excessive shrinkage or swelling after construction.

5.2 Excavation conditions

Based on the geotechnical investigations and the proposed basement levels, excavation will include PAVEMENT, FILL, NATURAL SOIL and BEDROCK units. Excavation in these units should be achievable using conventional earth moving equipment (eg excavators and dozers etc).

It is our experience that excavatability is heavily dependent on both the operator and the plant used. The earthworks contractors should satisfy themselves with regard to excavatability.

5.3 Permanent and temporary batters

The batter slope angles shown in Table 1 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 1
BATTER SLOPE ANGLES

UNIT	TEMPORARY	PERMANENT
SOIL UNITS, eg. ENGINEERED FILL, NATURAL SOIL	2.0H : 1V	2.5H : 1V
BEDROCK A	1.0H : 1V	1.5H : 1V
BEDROCK B	1.0H : 1V	1.5H : 1V

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

5.4 Excavation support

Permanent cuts in the FILL, NATURAL SOIL and BEDROCK units steeper than the recommended permanent batter slopes in Table 1 will need to be supported by some form of retaining structure.

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.

The designer shall adopt the effective strength parameters in Table 2 when assessing the earth pressure on the retaining structures.

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.

5.5 Foundation

5.5.1 Shallow footings

Pad footings can be proportioned on the basis of an allowable bearing pressure (ABP) for centric vertical loads provided in Table 2. 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 soil units can be estimated using the elastic parameters provided in Table 2.

TABLE 2
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)	ELASTIC PARAMETERS	
		c' (kPa)	*ϕ'* (deg)			LONG TERM YOUNG MODULUS (MPa)	POISSON'S RATIO
SOIL UNITS, eg. ENGINEERED FILL, NATURAL SOIL	18	0	30	420[1]	150[1]	10	0.3
BEDROCK A	22	NA	NA	3,000	700	75	0.3
BEDROCK B	22	NA	NA	4,500	1,000	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 dimensions).
3. End bearing pressure to cause settlement of <1% of minimum footing dimensions.

5.6 Slab on ground

The design of slabs on ground on the ENGINEERED FILL and NATURAL SOIL units can be based on a subgrade with a long term Young's Modulus of 10 MPa. The short term Young's modulus can be taken to be 15 MPa.

We note that the environmental effects (eg. drying or wetting up of the finished surface) affecting the land prior to development should be taken into account by the various designers of any development.

We understand that the structural engineer should be able to design efficient slabs. If assessed deformation and settlement is an issue, our advice can be further refined if required.

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.

5.7 Pavements

A CBR of 2% can be adopted for subgrade at or near the current surface and on fill formed in bulk earthworks constructed in accordance with a Specification from VENM source material. Higher values, particularly in areas of significant cut, may be provided on completion of testing on the finished bulk earthworks or if, on request, the Specification is varied to obtain such higher value on fill.

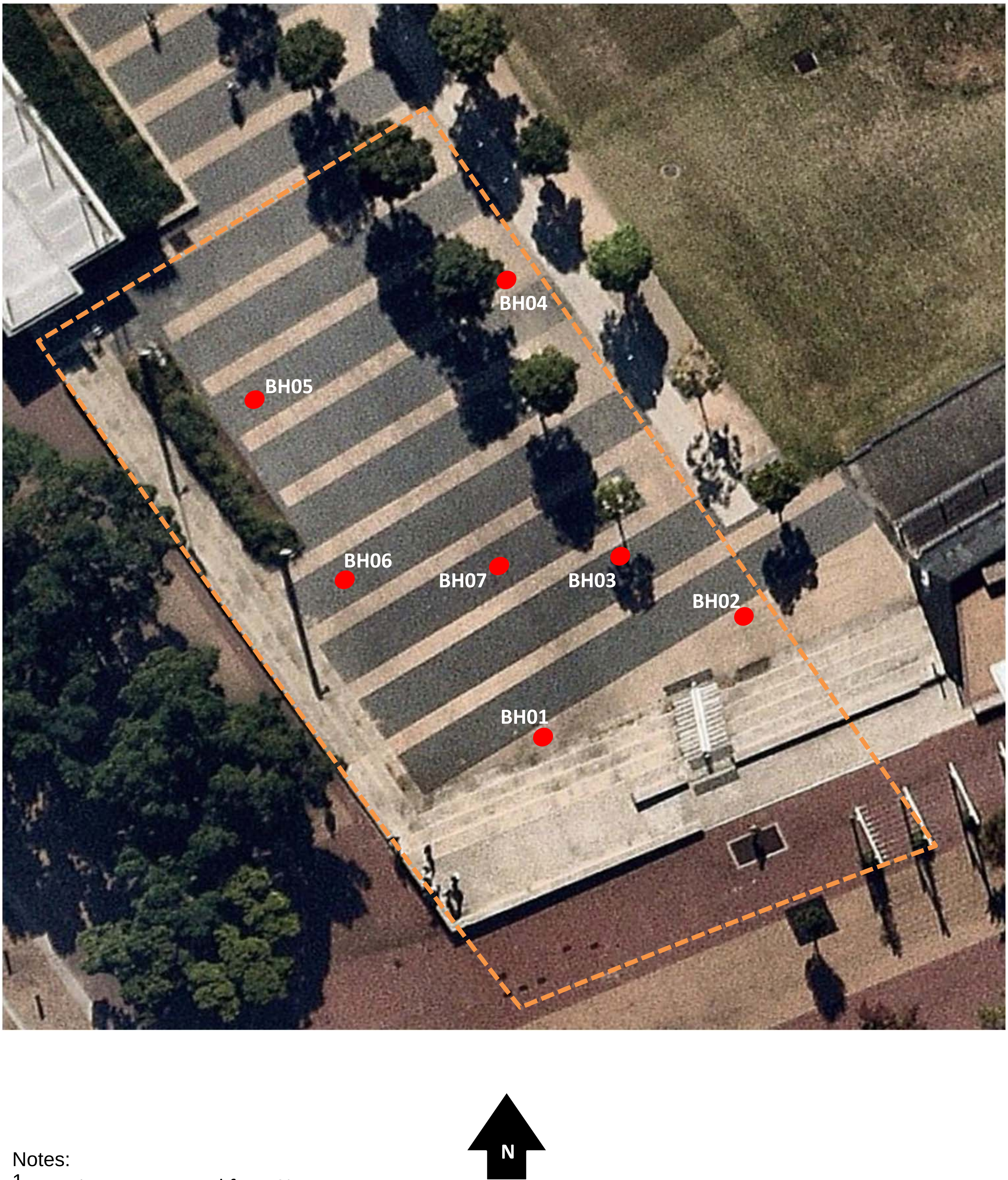
We recommend that specific CBR testing be undertaken at subgrade level when pavement layouts are finalised.

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

For and on behalf of
PELLS SULLIVAN MEYNINK

MATTHEW HAERTSCH Geotechnical Engineer	GARRY MOSTYN Principal

Encl.	Figure 1	Test Locations
	Figure 2	Selected Photos (1 of 2)
	Figure 3	Selected Photos (2 of 2)
	Attachment 1	Tabulated Borehole Logs



Notes:
1. Image extracted from Nearmap (dated 06/05/2017)

Site Boundary (Approximate)

Borehole Location

PSM

Pells Sullivan Meynink

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PSM3333-002L	**Figure 1**

Photo 1 - General site conditions

Photo 2 - FG101 drill rig used for augering each borehole

	FDC Construction & Fitout (NSW) Pty Ltd Site YP **Sydney Olympic Park** **GEOTECHNICAL INVESTIGATION** **SELECTED PHOTOGRAPHS [1 of 2]**	
PSM **Pells Sullivan Meynink**	**PSM3333-002L**	**Figure 2**

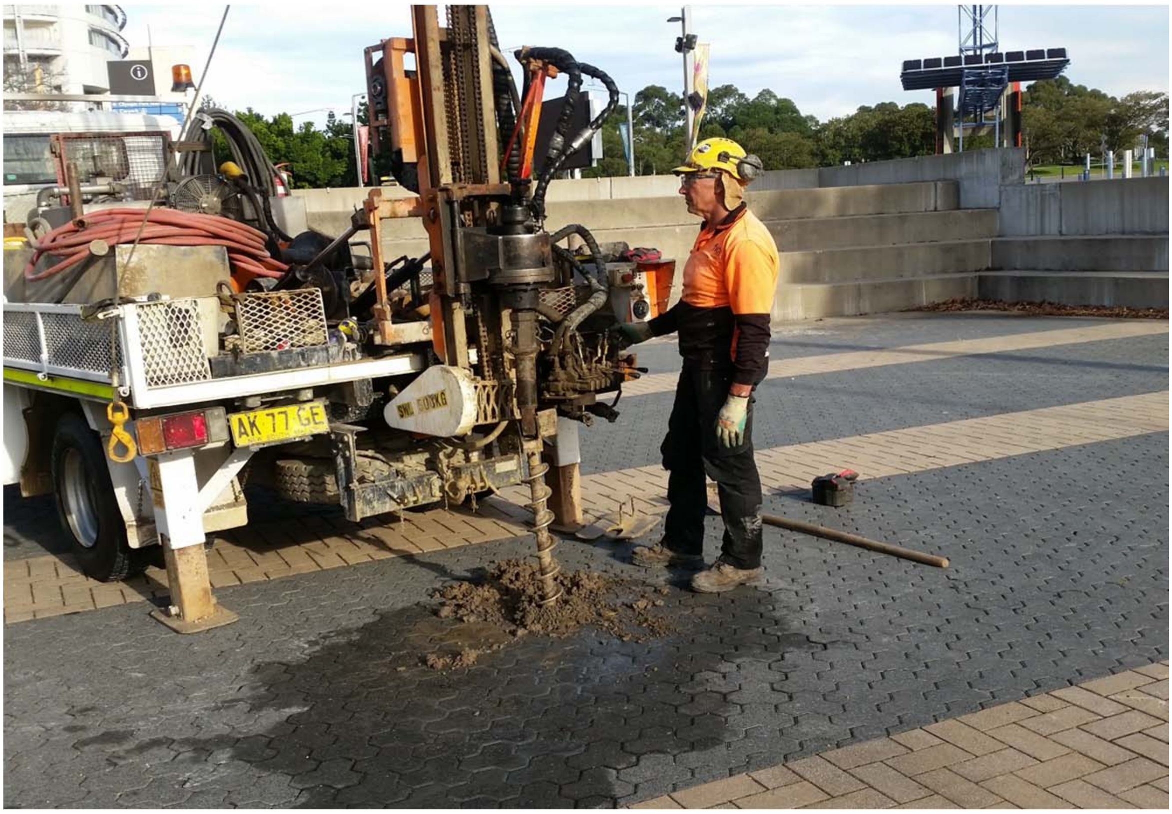

Photo 3 - Drill Rig set up at BH07 during augering

Photo 4 - Chips of weathered shale visible in auger spoil (BH04)

FDC Construction & Fitout (NSW) Pty Ltd Site YP **Sydney Olympic Park** **GEOTECHNICAL INVESTIGATION** **SELECTED PHOTOGRAPHS [2 of 2]**	
PSM3333-002L	**Figure 3**

Pells Sullivan Meynink

ATTACHMENT 1

TABULATED BOREHOLE LOGS

TABLE 1
SUMMARY OF SUBSURFACE CONDITIONS

BOREHOLE	DEPTH	MATERIAL ENCOUNTERED
BH01	0 – 0.08 m	BRICK Paver.
	0.08 – 0.3 m	FILL: Gravelly SAND; medium to coarse grained, yellow-brown to pale grey, sub-rounded to sub-angular gravel up to 3 mm, dense consistency, moist.
	0.3 – 0.4 m	FILL: CLAY with some sand and a trace of gravel; low to medium plasticity, dark brown, fine grained sand, sub-angular gravel up to 5 mm, firm consistency, moist.
	0.4 m	Hole terminated at 0.4 m*. Note: Hole terminated due to refusal on concrete steps as part of retaining wall structure.
BH02	0 – 0.08 m	BRICK Paver.
	0.08 – 0.3 m	FILL: Gravelly SAND with some clay; medium to coarse grained, yellow-brown, sub-angular gravel up to 3 mm, low plasticity clay, dense consistency, moist.
	0.3 – 0.9 m	FILL: CLAY with some gravel and sand; low to medium plasticity, dark brown to grey, sub-rounded to sub-angular gravel up to 20 mm, fine grained sand, firm consistency, moist.
	0.9 m	Hole terminated at 0.9 m*. Note: Hole terminated due to refusal on concrete steps as part of retaining wall structure.

BOREHOLE	DEPTH	MATERIAL ENCOUNTERED
BH03	0 – 0.08 m	CONCRETE Paver.
	0.08 – 0.4 m	FILL: Gravelly SAND with some clay; medium to coarse grained, yellow-brown to pale grey, sub-rounded to sub-angular gravel up to 3 mm, cemented consistency, pieces of plastic sheeting up to 50 mm in size observed.
	0.4 – 1.6 m	FILL: CLAY with some gravel and a trace of sand; medium plasticity, brown to dark grey, sub-rounded to sub-angular gravel up to 20 mm, fine grained sand, firm consistency, moist.
	1.6 – 2.0 m	CLAY with some gravel and sand; medium plasticity, dark grey to black, sub-angular gravel up to 3 mm, fine grained sand, firm consistency, moist.
	2.0 – 3.0 m	CLAY with some gravel; medium to high plasticity, grey, sub-angular gravel up to 3 mm, stiff consistency, moist.
	3.0 m	Hole terminated at 3.0 m. Refusal of auger drilling V bit; inferred top of weathered shale.

BOREHOLE	DEPTH	MATERIAL ENCOUNTERED
BH04	0 – 0.08 m	BRICK Paver.
	0.08 – 0.3 m	FILL: Gravelly SAND with some clay; medium to coarse grained, brown, sub-rounded to sub-angular gravel up to 3 mm, cemented consistency.
	0.3 – 1.3 m	FILL: CLAY with some gravel and sand; low to medium plasticity, brown to grey, sub-rounded to sub-angular gravel up to 20 mm, fine grained, firm consistency, moist.
	1.3 – 1.7 m	FILL: CLAY with a trace of sand and gravel; medium plasticity, light brown, fine grained sand, sub-rounded to sub-angular gravel up to 5 mm, firm consistency, moist.
	1.7 – 2.7 m	FILL: CLAY with some gravel and sand; low to medium plasticity, dark grey, sub-rounded to sub-angular gravel up to 10 mm, fine grained, firm consistency, moist.
	2.7 – 3.0 m	CLAY with some gravel and sand; medium plasticity, light brown, sub-angular gravel up to 3 mm, fine to medium grained sand, firm consistency, moist.
	3.0 – 7.1 m	SHALE; orange-brown, extremely low strength, extremely weathered.
	3.5 m	Becoming very low strength, highly weathered.
	4.5 m	Becoming brown.
	7.1 m	Hole terminated at 7.1 m.

BOREHOLE	DEPTH	MATERIAL ENCOUNTERED
BH05	0 – 0.08 m	CONCRETE Paver.
	0.08 – 0.3 m	FILL: Gravelly SAND; medium to coarse grained, yellow-brown, sub-rounded to sub-angular gravel up to 10 mm, cemented consistency.
	0.3 – 1.0 m	FILL: CLAY with some gravel and sand; low plasticity, brown, sub-rounded to sub-angular gravel up to 5 mm, fine grained sand, firm consistency, moist.
	1.0 – 2.0 m	FILL: CLAY with some gravel and sand; low to medium plasticity, brown to grey, sub-rounded to sub-angular gravel up to 3 mm, fine to medium grained sand, firm consistency, moist.
	2.0 – 2.6 m	CLAY with some sand; low to medium plasticity, grey, fine grained sand, firm consistency, moist.
	2.6 – 2.8 m	Sandy CLAY; medium plasticity, dark grey, fine to medium grained sand, stiff consistency, moist.
	2.8 – 3.0 m	Sandy CLAY with some gravel; medium plasticity, pale grey, medium grained sand, sub-angular gravel up to 5 mm, stiff consistency, wet.
	3.0 m	Hole terminated at 3.0 m.

BOREHOLE	DEPTH	MATERIAL ENCOUNTERED
BH06	0 – 0.08 m	CONCRETE Paver.
	0.08 – 0.3 m	FILL: Gravelly SAND; medium to coarse grained, yellow-brown to pale grey, sub-rounded to sub-angular gravel up to 3 mm, cemented consistency.
	0.3 – 1.2 m	FILL: CLAY with some sand and gravel; low to medium plasticity, grey to brown, fine to medium grained sand, sub-rounded to sub-angular gravel up to 10 mm, firm consistency, moist.
	1.2 – 1.8 m	FILL: CLAY with some gravel and a trace of sand; low to medium plasticity, grey to brown, sub-angular gravel up to 3 mm, fine grained sand, firm consistency, moist.
	1.8 – 2.2 m	Clayey SAND with some gravel; fine grained, grey, low plasticity clay, sub-angular gravel up to 3 mm, firm consistency, moist.
	2.2 – 2.6 m	Clayey SAND with a trace of gravel; fine to medium grained, grey, low plasticity clay, sub-angular gravel up to 3 mm, firm consistency, wet.
	2.6 – 3.3 m	CLAY with a trace of gravel; high plasticity, brown, sub-rounded gravel up to 3 mm, stiff consistency, moist.
	3.3 – 7.0 m	SHALE; orange-brown, extremely low strength, extremely weathered.
	3.7 m	Becoming very low strength.
	4.2 m	Becoming grey and highly weathered.
	7.0 m	Hole terminated at 7.0 m.

BOREHOLE	DEPTH	MATERIAL ENCOUNTERED
BH07	0 – 0.08 m	CONCRETE Paver.
	0.08 – 0.3 m	FILL: Gravelly SAND; medium to coarse grained, yellow-brown, sub-rounded to sub-angular gravel up to 3 mm, cemented consistency.
	0.3 – 1.2 m	FILL: CLAY with some gravel and sand; low to medium plasticity, brown, sub-rounded to sub-angular gravel up to 10 mm, fine grained, firm consistency, moist.
	1.2 – 2.0 m	FILL: CLAY with some gravel and a trace of sand; medium plasticity, light brown to grey, sub-rounded to sub-angular gravel up to 20 mm, fine grained, firm consistency, moist.
	2.0 m	Hole terminated at 2.0 m.