# Annexure 8

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# Report on

# Geotechnical Assessment

Prepared for: Woollahra Municipal Council

Address: Wilberforce Avenue & Ian Street Car Parks, Rose Bay

Job No: 23921

Date: October 2016

Accredited for compliance
With ISO/IEC 17025
NATA Accreditation No. 19226

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## 1.0 INTRODUCTION

Ideal Geotech has prepared this report to discuss the results of the geotechnical investigation undertaken for the two proposed multi storey car parks located at Ian Street and Wilberforce Avenue, Rose Bay.

Investigation was required to provide information on subsurface conditions for the purpose of:

> Earthworks procedures and guidelines including site preparation, soil profiles and excavation conditions;

> Founding conditions and allowable bearing capacities;

> Retaining wall design parameters;

> Pile design parameters;

> Comment on groundwater levels;

> Assessment of soil aggressivity to concrete and steel; and

> Special requirements for construction procedures and/or site drainage.

A Preliminary Geotechnical Assessment has been undertaken by Environmental Investigations, Report No. E22135 GA, dated 1 May 2014, and should be read in conjunction with this report.

The proposed development indicated on the architectural drawings supplied by the client comprises construction of two multi storey car parks development. Excavations for the basement portion of The Wilberforce Avenue carpark are expected to extend up to 6m And for the Ian Street Carpark is understood that up to 10m of cut will be required for the basement portion of the carpark.

## 2.0 SITE DETAILS

The following information, presented in Table 1, describes the site.

**Table 1: Summary of Site Details**

| | |
|---|---|
| **Site Address** | Ian Street and Wilberforce Avenue Car Parks, Rose Bay |
| **Client** | Woollahra Municipal Council |
| **Council Area** | Woollahra Municipal Council |

### 2.1 Geology

The 1:100,000 scale Geological Series Map of the Sydney region indicates that the subject site is underlain by Quaternary Deposits comprising of medium to fine grained marine sand with podsols. The site is close to the boundary of known Hawkesbury Sandstone and the marine sands are expected to be underlain by sandstone.

### 2.2 Site Description

The subject site at Ian Street is rectangular in shape and measures approximately 30m wide along the Dover Road frontage, approximately 40m deep and covers an area of approximately 1200m$^2$. The site is currently a Woollahra Municipal Council car park covered in asphalt with mature trees along the north, south and east boundaries. Slopes fall from north east to south west at gradients of approximately 4-5º.

The subject site at Wilberforce Avenue is irregular in shape and covers an area of approximately 2030m$^2$. The site is bound by Wilberforce Avenue to the west, Dover Road to the east and by commercial and residential buildings to the south, north and north east. The site is currently a Woollahra Municipal Council car park covered in asphalt with slopes falling towards the south west at gradients of approximately 1-2º.

## 3.0 GEOTECHNICAL INVESTIGATION

### 3.1 Field Work

Fieldwork was undertaken on 26 to 28 September 2016 and included drilling six boreholes (BH1-BH4 within the Wilberforce Avenue car park and BH5-BH6 within the Ian Street car park) using a purpose built hydraulic track mounted drill rig. The drilling methods used included solid flight augers with a TC-Bit, wash boring and NMLC coring techniques within BH5. Standard Penetration Testing (SPT) was undertaken at varying intervals within the boreholes.

Water monitoring wells were installed in BH2 and BH5.

Disturbed samples of selected materials and rock core was retrieved for laboratory assessment and testing.

All fieldwork including logging of subsurface profiles and collecting of samples was carried out by and in the presence of a Geotechnical Engineer from Ideal Geotech. The borehole locations were set out by reference to the supplied drawing and site features. The approximate locations are shown on Figure 1, attached in Appendix A.

Subsurface conditions encountered during the fieldwork are summarised in Section 4.1 and detailed in engineering logs attached in Appendix B, together with explanatory notes.

### 3.2 Laboratory Testing

Laboratory testing on selected samples comprised:

> Particle Size Distribution (PSD) on the sand soils;

> Soil Aggressivity to Buried structures; and

> Point Load Strength Index testing of rock core.

Results of laboratory testing are detailed in the reports sheets attached as Appendix C and summarised in Section 4.2 below.

## 4.0 INVESTIGATION FINDINGS

### 4.1 Subsurface Conditions

The subsurface conditions encountered in the borehole are detailed on the report log sheets, attached in Appendix B together with explanatory notes. The soil profile is summarised in Table 2 below.

**Table 2: Summary of Subsurface Conditions**

| Borehole | Depth of fill (m) | Depth to rock (m) | Depth to water (m) | Summary of sub-surface profiles |
|---|---|---|---|---|
| BH1 | 0.4 | 27.5 | 3.0 | FILL-Asphalt overlying Gravelly Sand / SAND / SANDSTONE |
| BH2 | 0.3 | NE | 2.8 | FILL-Asphalt overlying Gravelly Sand / SAND / |
| BH3 | 0.4 | NE | 2.9 | FILL-Asphalt overlying Gravelly Sand / SAND / |
| BH4 | 0.4 | NE | 3.0 | FILL-Asphalt overlying Gravelly Sand / SAND / |
| BH5 | 0.3 | 11.0 | 5.8 | FILL-Asphalt overlying Gravelly Sand / SAND / SANDSTONE |
| BH6 | 0.3 | 9.9 | 9.0 | FILL-Asphalt overlying Gravelly Sand / SAND / SANDSTONE |

*NE Not Encountered*

During drilling ground water was encountered in all boreholes. The piezometers installed in BH2 and Bh5 were backfilled with a 5 mm sand filter pack to a level above the screened section and then sealed with bentonite to a depth of approximately 0.5m from natural surface levels with the remaining backfill comprising sand spoil. The Piezos were covered with gattic covers cemented in place.

### 4.2 Laboratory Test Results

The laboratory test results are detailed in report sheets attached in Appendix C and summarised in the tables below.

**Table 3: Summary of PSD Test Results**

| Borehole | Depth (m) | Soil Type | % Passing | | |
|---|---|---|---|---|---|
| | | | 1.18mm | 0.425mm | 0.075mm |
| BH1 | 6.0 | SAND | 100 | 64 | 7 |
| BH2 | 7.5 | SAND | 100 | 70 | 4 |
| BH2 | 12.0 | SAND | 100 | 66 | 2 |
| BH2 | 18.0 | SAND | 100 | 100 | 15 |
| BH5 | 9.0 | SAND | 100 | 75 | 5 |
| BH6 | 7.0 | SAND | 100 | 62 | 4 |

**Table 4: Summary of Aggressivity Test Results**

| Borehole | Depth (m) | Soil Type | Cl (mg/kg) | $SO_4$ (mg/kg) | pH | EC (µS/cm) |
|---|---|---|---|---|---|---|
| BH2 | 9.0 | SAND | 20 | 29 | 5.2 | 60 |
| BH2 | 15.0 | SAND | 9.5 | 21 | 7.3 | 110 |
| BH3 | 9.0 | SAND | 9.8 | 50 | 5.4 | 72 |
| BH4 | 6.0 | SAND | 30 | 15 | 4.9 | 62 |
| BH4 | 12.0 | SAND | 14 | 35 | 4.7 | 63 |
| BH5 | 9.0 | SAND | 8.5 | 32 | 5.3 | 50 |
| BH6 | 6.0 | SAND | 9.6 | 13 | 5.4 | 36 |

**Table 5: Summary of Point Load Index Test Results**

| Borehole | Depth (m) | Rock Type | Range of Is (50) | Strength |
|---|---|---|---|---|
| BH5 | 11.7 | Sandstone | 0.7 – 0.9 | Medium |
| BH5 | 12.0 | Sandstone | 0.8 – 0.8 | Medium |
| BH5 | 12.7 | Sandstone | 0.5 – 0.8 | Medium |

## 5.0 COMMENTS AND RECOMMENDATIONS

### 5.1 Summary of Ground Conditions

The subsurface profile encountered at the Wilberforce carpark comprised marine sands to a depth of 27.5m below ground level, overlying sandstone at the western part of the site. Based on a previous report the depth to rock is expected to decrease towards the east to depths of approximately 21m.

The subsurface profile encountered at the Ian Street carpark comprised Aeolian sands overlying marine sands to varying depths, and underlain by sandstone. Sandstone rock was encountered at a depth of 11m in BH5 and 9.9m in BH6. The depth to sandstone rock decreases from west to east due to the site topography.

### 5.2 Site Classification

This site is classified as **Class A** in accordance with AS2870 – 2011:

As defined in AS 2870-2011, Table 2.1 and section 2.2.3, this site will be classified as **Class A**

based on geology and natural soil profile as encountered on this investigation. The site is expected to have some movement due to settlement.

### 5.3 Earthworks

In the event fill is to be placed Ideal Geotech recommends the placement of engineered fill be carried out in accordance with AS3798-2007 "Guidelines on Earthworks for commercial and residential developments".

In summary, engineered fill should comprise the following:

> Prior to filling, any soft material and vegetation should be removed down to a firm base.

> Suitable fill material shall be placed in loose horizontal layers not exceeding 250mm in thickness.

> The fill shall be compacted to a Dry Density Ratio of at least 98% Standard (AS1289: 5.1.1, 5.4.1 or 5.7.1);

> The fill should be compacted to within +/-2% of the soils optimum moisture content

> The fill material shall not contain greater than 20%, by volume, of particles coarser than 37.5mm and no particle over 200mm in any dimension.

> Under no circumstances should any additional fill contain significant amount of organic matter or be a mixture of greatly different particle sizes.

### 5.4 Excavation Conditions and Retaining Walls

As the subsurface material mainly consists of stiff silty and sandy clays overlying medium dense sand and sandy gravel, excavation can be achieved using conventional earthmoving equipment such as backhoes and excavators.

Excavations in the sand could not be expected to stand for any significant length of time, especially below the groundwater level, and should be appropriately supported. Excavations require dewatering as the groundwater table is higher than the proposed excavation depths.

All structural retaining walls should be engineer designed. Design of retaining walls should:

> Consider surcharge loading from slopes and structures above the wall;

> Take into account loading from any proposed compaction of fill behind the wall;

> Provide adequate surface and subsurface drainage behind retaining walls;

> Utilise materials that are not susceptible to deterioration;

> Ensure walls are founded in materials appropriate for the loading conditions.

**Table 6: Geotechnical Design Parameters**

| Material | Bulk Unit Weight (kN/m³) | Angle of Friction (°) | Young's Modulus (MPa) |
|---|---|---|---|
| Loose Sand | 16 | 27 | 15 |
| Medium Dense Sand | 18 | 30 | 30 |
| Dense Sand | 19 | 34 | 50 |
| Sandstone | 22 | 32 | 10,000 |

It is anticipated that a fully tanked secant pile wall or diaphragm walls will be required to support the basement excavations.

### 5.5 Groundwater

Groundwater was encountered during the fieldwork in all boreholes up to depths of at depths of 2.8m to 3m within the Wilberforce car park area and 5.8m to 9m below ground level within the Ian Street car park area. It is anticipated that dewatering and support of excavations will be required at excavation beyond this depth.

The best option for the control of groundwater during construction would be the installation of spear points prior to construction. Drawdown effects of the surrounding area will need to be considered during the planning of the dewatering method to be used.

It should be noted that prior to the construction a licence will be required for dewatering. Prior to the commencement of construction the groundwater wells should be sampled to determine base line conditions of the groundwater.

### 5.6 Footings - Allowable Bearing Capacity

All footings should be founded below any uncontrolled fill or deleterious materials. All footings for the same structure should be founded on strata of similar stiffness and reactivity to minimise the risk of differential movements.

All footing excavations should be inspected prior to installation of structural steel by Ideal Geotech or a suitably experienced engineer or geotechnical consultant to confirm that the founding conditions are as described in this report. All loose material should be cleared from the footing excavations before concrete is poured.

#### 5.6.1 High Level Footings

High-level footing alternatives could be expected to comprise slabs-on-ground with edge beams or pad footings for the support of concentrated loads. Such footings designed in accordance with engineering principles and founded in medium dense sands may be proportioned on an allowable bearing capacity of 100kPa and founded in the slightly weathered sandstone in the Ian Street car park may be proportioned on an allowable bearing capacity of 1000kPa. The founding conditions should be assessed by a geotechnical consultant or experienced engineer to confirm suitable conditions.

### 5.6.2 Piered Footings

Piered footings are considered as an alternative to deep edge beams or high level footings. Piered footings, founded in the medium dense to dense sand could be proportioned on an end bearing pressure of 200kPa and founded in the sandstone in the Ian Street car park could be proportioned on an end bearing pressure of 1000kPa.

The potential for volume change in the subsurface profile should be considered by the designer as the piered footing may move with the soil and undergo differential settlement or heaving.

Options for piered footings include:

> CFA and cased bored piles;

> Franki Piles;

> Screw Piers; and

> Driven Piles.

## 5.7 Aggressiveness to Steel and Concrete

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of pH and types of salts present. In order to determine the degree of aggressiveness, the test values obtained are compared to tables 6.4.2 (C) and 6.5.2 (C) in AS2159 Piling - Design and Installation and tables 5.1 to 5.4 in AS2870-2011 “Residential Slabs and Footings”. The following testing suite was undertaken with results summarised within table 4 below;

> pH;

> Electrical Conductivity (EC µS/cm);

> Chloride (Cl);

> Sulphate ($SO_4$); and

> Resistivity (ohm.cm).

Based on test results detailed in Table 4 the soil conditions are considered to be mild to moderately aggressive to concrete and mild to moderately aggressive to steel in high permeability soils. An exposure classification of B1 for concrete has been determined.

## 6.0 LIMITATIONS

This type of investigation (as per our commission) is not designed or capable of locating all ground conditions, which can vary even over short distances. The advice given in this report is based on the assumption that the test results are representative of the overall ground conditions. However, it should be noted that actual conditions in some parts of the site might differ from those found. If excavations reveal ground conditions significantly different from those shown in our findings, Ideal Geotech must be consulted.

The scope and the period of Ideal Geotech services are described in the report and are subject to restrictions and limitations. Ideal Geotech did not perform a complete assessment of all possible conditions or circumstances that may exist at the Site. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Ideal Geotech in regards to it.

Where data has been supplied by the client or a third party, it is assumed that the information is correct unless otherwise stated. No responsibility is accepted by Ideal Geotech for incomplete or inaccurate data supplied by others.

Any drawings or figures presented in this report should be considered only as pictorial evidence of our work. Therefore, unless otherwise stated, any dimensions should not be used for accurate calculations or dimensioning.

## 6.0 REFERENCES


- *Geological Series Sheet 9130, Map of the Sydney region, scale 1:100,000*
- *AS2870-2011 Residential Slabs and Footings*
- *AS2159-2009 Piling Design and Installation*
- *AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments*

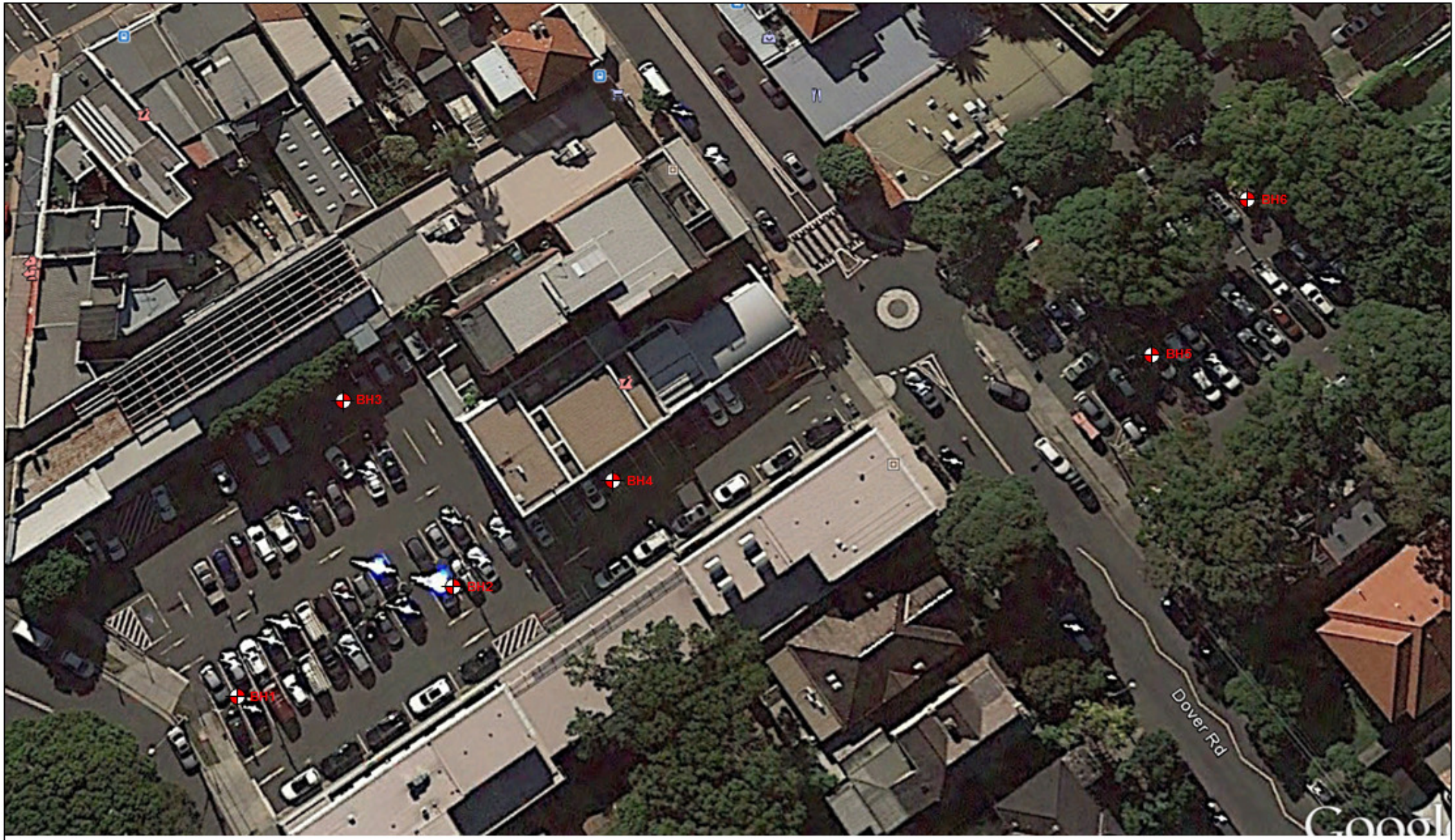

For and on behalf of
**Ideal Geotech**

**Dane Dwyer**
*Geotechnical Engineer*

MuraliPamu
*Geotechnical Engineer*

# APPENDIX A

# FIGURES

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| | |
|---|---|
| DRAWING TITLE: | BOREHOLE LOCATION PLAN |
| PROJECT NAME: | GEOTECHNICAL INVESTIGATION |
| SITE LOCATION: | WILBERFORCE AVENUE & IAN STREET CAR PARKS, ROSE BAY |

| | |
|---|---|
| CLIENT: | Woollahra Municipal Council |
| PROJECT NO: | 23921 |
| DRAWING NO: | 1 |
| FILE REF: | Figure 1 |

| | |
|---|---|
| DRAWN BY: | DD |
| CHECKED BY: | MP |
| DATE: | October 2016 |
| OFFICE: | |

NORTH

# APPENDIX B

# BOREHOLE LOGS

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 1

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| ADT | ▼ | | | 0 | | Fill, Gravelly SAND, fine to medium grained, brown, fine to medium gravel | M | | 0.1m of asphalt overlying fill |
| | | | | | | SAND, fine to medium grained, yellow | M | L | |
| | | | | 1 | | pale grey | | | |
| | | | | 2 | | | | | |
| | | | | 3 | | | W | | |
| WB | | SPT 3.0m 2,3,4 N=7 | | | | pale brown | | | |
| | | | | 4 | | | | | |
| | | | | 5 | | | | | |
| | | | | | | SAND, trace silt, fine to medium grained, pale grey-pale brown | W | L-MD | |
| | | | | 6 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

**Density**
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

**Consistency**
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

**Moisture**
PL - Plastic Limit
D - Dry
M - Moist
W - Wet

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 1

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 6.0m 6,9,11 N=20 | | 6 | | *Continued* - SAND, trace silt, fine to medium grained, pale grey-pale brown | W | MD | |
| | | | | 7 | | SAND, fine to medium grained, pale brown-yellow | W | MD | |
| | | SPT 9.0m 6,11,15 N=25 | | 9 | | pale grey-pale brown | | | |
| | | | | 12 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

## BORE HOLE NO. 1

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 12.0m 11,18,20 N=38 | | 12 | | *Continued* - SAND, fine to medium grained, pale grey-white | W | D | |
| | | | | 13 | | | | | |
| | | | | 14 | | | | | |
| | | | | 15 | | | | | |
| | | | | 16 | | pale grey-yellow | | | |
| | | | | 17 | | | | | |
| | | | | 18 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

## BORE HOLE NO. 1

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 18.0m 9,13,18 N=31 | | 18 | | *Continued* - SAND, fine to medium grained, pale grey-white | W | D | |
| | | | | 19 | | dark grey | | | |
| | | | | 20 | | | | | |
| | | | | 21 | | | | | |
| | | | | 22 | | | | | |
| | | | | 23 | | | | | |
| | | | | 24 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

Density
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Consistency
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

Moisture
PL - Plastic Limit
D - Dry
M - Moist
W - Wet

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 1

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 24.0m 9,16,22 N=38 | | 24 | | *Continued* - SAND, fine to medium grained, dark grey | W | D | |
| | | | | 25 | | | | | |
| | | | | 26 | | | | | |
| | | | | 27 | | | | | |
| | | | | 28 | | Borehole terminated at 27.5m due to refusal on sandstone | | | |
| | | | | 29 | | | | | |
| | | | | 30 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 2

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| ADT | | | | 0 | | Fill, Gravelly SAND, fine to medium grained, brown, fine to medium gravel | M | | 0.08m of asphalt overlying fill |
| | | | | | | SAND, fine to medium grained, yellow | M | L | |
| | | | | 1 | | white-pale grey | | | |
| | | SPT 1.5m 2,3,3 N=6 | | | | | | | |
| | | | | 2 | | | | | |
| | ▼ | | | | | | W | | |
| WB | | SPT 3.0m 3,3,3 N=6 | | 3 | | | | | |
| | | | | 4 | | grey-pale brown | | | |
| | | SPT 4.5m 1,3,5 N=8 | | | | | | | |
| | | | | 5 | | Silty SAND, fine to medium grained, grey-pale brown | W | L-MD | |
| | | | | 6 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 2

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 6.0m 2,4,5 N=9 | | 6 | | SAND, fine to coarse grained, pale brown | W | MD | |
| | | | | 7 | | | | | |
| | | SPT 7.5m 3,7,7 N=14 | | | | SAND, trace silt, fine to medium grained, pale brown-pale grey | W | MD | |
| | | | | 8 | | | | | |
| | | SPT 9.0m 6,10,14 N=24 | | 9 | | SAND, fine to medium grained, pale grey | W | MD | |
| | | | | 10 | | | | | |
| | | | | 11 | | | | | |
| | | | | 12 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

## BORE HOLE NO. 2

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 12.0m 9,16,18 N=34 | | 12 | | *Continued* - SAND, fine to medium grained, pale grey-white | W | D | |
| | | | | 13 | | | | | |
| | | | | 14 | | | | | |
| | | SPT 15.0m 6,10,14 N=24 | | 15 | | yellow-pale grey | | | |
| | | | | 16 | | | | | |
| | | | | 17 | | | | | |
| | | | | 18 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

## BORE HOLE NO. 2

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 18.0m 7,10,10 N=20 | | 18 | | *Continued* - SAND, fine to medium grained, grey | W | MD | |
| | | | | | | Borehole terminated at 18.5m | | | |
| | | | | 19 | | | | | |
| | | | | 20 | | | | | |
| | | | | 21 | | | | | |
| | | | | 22 | | | | | |
| | | | | 23 | | | | | |
| | | | | 24 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 26/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 3

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| ADT | | | | 0 | | Fill, Gravelly SAND, fine to coarse grained, brown, fine to medium gravel | M | | 0.1m of asphalt overlying fill |
| | | | | | | SAND, fine to medium grained, yellow | | L | |
| | | | | 1 | | pale brown-pale grey | | | |
| | | | | 2 | | | | | |
| | ▼ | | | | | | W | | |
| WB | | SPT 3.0m 1,2,3 N=5 | | 3 | | | | | |
| | | | | 4 | | | | | |
| | | SPT 4.5m 2,3,5 N=8 | | 5 | | | | | |
| | | | | 6 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 3

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 6.0m 3,6,8 N=14 | | 6 | | *Continued* - SAND, fine to medium grained, yellow | W | D | |
| | | | | 7 | | | | | |
| | | SPT 7.5m 3,8,7 N=17 | | 8 | | | | | |
| | | SPT 9.0m 9,16,21 N=37 | | 9 | | pale grey | | | |
| | | | | 10 | | | | | |
| | | | | 11 | | | | | |
| | | | | 12 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

Density
VL - Very loose
L - Loose
MD - Medium dense
D - Dense
VD - Very dense

Consistency
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard

Moisture
PL - Plastic Limit
D - Dry
M - Moist
W - Wet

## BORE HOLE NO. 3

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 12.0m 8,15,22 N=39 | | 12 | | *Continued* - SAND, fine to medium grained, pale grey-pale yellow | W | D | |
| | | | | 13 | | | | | |
| | | | | 14 | | | | | |
| | | SPT 15.0m 14,26,30R N=>50 | | 15 | | | | VD | |
| | | | | | | Borehole terminated at 15.45m | | | |
| | | | | 16 | | | | | |
| | | | | 17 | | | | | |
| | | | | 18 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 4

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| ADT | ▼ | | | 0 | | Fill, Gravelly SAND, fine to medium grained, brown, fine to medium gravel | M | | 0.1m of asphalt overlying fill |
| | | | | 1 | | SAND, fine to medium grained, yellow | | | |
| | | | | 2 | | | | | |
| | | | | 3 | | | W | | |
| WB | | SPT 3.0m 3,3,3 N=6 | | | | white-pale grey | | | |
| | | | | 4 | | | | | |
| | | SPT 4.5m 1,3,4 N=7 | | | | | | | |
| | | | | 5 | | Silty SAND, fine to medium grained, grey-pale brown | W | L | |
| | | | | 6 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

## BORE HOLE NO. 4

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 6.0m 2,3,3 N=6 | | 6 | | *Continued* - SAND, fine to medium grained, pale grey | W | L | |
| | | | | 7 | | | | | |
| | | SPT 7.5m 4,7,8 N=15 | | | | | | MD | |
| | | | | 8 | | | | | |
| | | SPT 9.0m 6,9,14 N=23 | | 9 | | | | | |
| | | | | 10 | | | | | |
| | | | | 11 | | pale brown-pale grey | | | |
| | | | | 12 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 4

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 12.0m 5,9,9 N=18 | | 12 | | *Continued* - SAND, fine to medium grained, pale brown-pale grey | W | D | |
| | | | | 13 | | | | | |
| | | | | 14 | | | | | |
| | | SPT 15.0m 6,9,15 N=25 | | 15 | | | | | |
| | | | | 16 | | | | | |
| | | | | 17 | | | | | |
| | | | | 18 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 4

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 18.0m 4,13,14 N=27 | | 18 | | *Continued* - SAND, fine to medium grained, pale grey | W | MD | |
| | | | | | | Borehole terminated at 18.5m | | | |
| | | | | 19 | | | | | |
| | | | | 20 | | | | | |
| | | | | 21 | | | | | |
| | | | | 22 | | | | | |
| | | | | 23 | | | | | |
| | | | | 24 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 27/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 5

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| ADT | | | | | | Fill, Gravelly SAND, fine to medium grained, brown, fine to medium gravel | M | | 0.05m of asphalt overlying fill |
| | | | | | | SAND, fine to medium grained, yellow-pale brown | M | L | |
| | | | | 1 | | | | | |
| | | | | 2 | | | | | |
| | | SPT 3.0m 2,3,3 N=6 | | 3 | | | | | |
| | | | | 4 | | | | | |
| | | | | 5 | | | | | |
| | | | | | | Clayey SAND, fine to coarse grained, grey-orange | W | MD | |
| | | | | 6 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 28/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

## BORE HOLE NO. 5

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 6.0m 3,7,8 N=15 | | 6 | | *Continued* - Clayey SAND, fine to coarse grained, pale brown-yellow | W | MD | |
| | | | | 7 | | | | | |
| | | | | 8 | | | | | |
| | | SPT 9.0m 9,13,14 N=27 | | 9 | | pale brown-orange | | | |
| | | | | 10 | | | | | |
| | | | | 11 | | Continued as cored borehole | | | |
| | | | | 12 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 28/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 5

| Method | WATER | Tests | RQD | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Rock Strength | REMARKS and DEFECT DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 11 | | Start coring at 11.0m | | | |
| NMLC | | | 100% | 11.5 | | Quartz SANDSTONE, fine to medium grained, pale orange-pale grey | DW | H | |
| | | | | 12 | | pale grey | FR | H | |
| | | | | 12.5 | | Borehole terminated at 12.11m | | | |
| | | | | 13 | | | | | |
| | | | | 13.5 | | | | | |
| | | | | 14 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 28/01/2016
*Logged by:* DD

| Consistency | Rock strength | Rock Weathering |
|---|---|---|
| S - Soft | VL - Very Low | XW - Extremely Weathered |
| F - Firm | L - Low | DW - Distinctly Weathered |
| St - Stiff | M - Medium | SW - Slightly Weathered |
| VSt - Very Stiff | H - High | FR - Fresh |
| H - Hard | VH - Very High | |

**Core Photograph: 23921 – Ian Street Car Park, Rose Bay**

**BH5 11.0m – 12.11m**

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

# BORE HOLE NO. 6

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| ADT | ▼ | SPT 3.0m 2,2,2 N=4 | | 1<br>2<br>3<br>4<br>5<br>6 | | Fill, Gravelly SAND, fine to medium grained, brown, fine to medium gravel | M-D | | 0.08m of asphalt overlying fill |
| | | | | | | SAND, fine to medium grained, yellow- pale brown | M-D | L | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 28/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

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**SITE LOCATION:** Wilberforce Avenue Carpark, Rose Bay 

## BORE HOLE NO. 6

| Method | WATER | Tests/ Samples | PP | DEPTH (m) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION (*SOIL TYPE, COLOUR, MOISTURE, CONSISTENCY*) | Moisture/ Weathering | Consistency/ Density | REMARKS and OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|
| WB | | SPT 6.0m 2,3,3 N=6 | | 6 | | *tinued* - SAND, fine to medium grained, yellow-brown | M-D | L | |
| | | | | 7 | | | | | |
| | | | | 8 | | | | | |
| | ▼ | SPT 9.0m 3,9,12 N=21 | | 9 | | | W | MD | |
| | | | | 10 | | Borehole terminated at 9.9m due to refusal on sandstone | | | |
| | | | | 11 | | | | | |
| | | | | 12 | | | | | |

*Equipment:* Track mounted drilling rig
*Date of Drilling:* 28/9/2016
*Logged by:* *DD*

| Density | Consistency | Moisture |
|---|---|---|
| VL - Very loose | S - Soft | PL - Plastic Limit |
| L - Loose | F - Firm | D - Dry |
| MD - Medium dense | St - Stiff | M - Moist |
| D - Dense | VSt - Very Stiff | W - Wet |
| VD - Very dense | H - Hard | |

# APPENDIX C

## LABORATORY TEST RESULTS

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deal orp t td t as
d
1 1 1
14 ooper Street Smth eld S 14
ox 14 etheril ar S 14
h ax 4

# [illegible]

| | | | | | |
|---|---|---|---|---|---|
| est Method | S 41 4.1 | Sampln ate | Suppl ed l ent | o o | 1 |
| l ent | deal eotech | Stora e stor | | est n ate | 1 1 |
| ro ect | es dent al evelopment | Mo sture ondt on | | eport o | 1 1 |
| | | oad n ate | | | |

| oc pe | ocat on | epth m | ametral ests | | | | | xal loc and rre ular ump ests | | | | | | | Stren th lass cat on |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mm | mm | | s M a | a lure Mode | mm | mm | mm | | s M a | s M a | a lure Mode | |
| Sandstone | n no n | 11. | 1 | 1. | | | | | 1. | | 4.1 | | | | Med um |
| Sandstone | n no n | 1 . | 1. | 11 | | | | | 1. | | | | | | Med um |
| Sandstone | n no n | 1 . | 1 | 1. | | | | | 1 | 1 1 | 4.4 | | | | Med um |

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Ideal Corp Pty Ltd t/as
Ideal Geotech
ABN 15 132 337 190
14 Cooper Street Smithfield NSW 2164
PO Box 6147 Wetherill Park NSW 2164
Ph: (02) 9725 5522 Fax: (02) 9756 5724

# *Sieve Analysis Report*

Project: Residential Development
Project No.: DE [illegible]153
Client: Ideal Geotech
Report No.: DE [illegible]153_1
Address: Supplied by Client
Report Date: 28/[illegible]0/[illegible]6
Test Method: AS1289.3.6.1
Page: 1 of 1

Sampling Proceedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

| Sample No. | L1 | L2 | L3 | L4 | L[illegible] | L6 |
|---|---|---|---|---|---|---|
| Sample Location | BH1 | BH2 | BH2 | BH[illegible] | BH5 | BH6 |
| Material Description | Brown Sand trace of Silt/Clay | Brown Sand trace of Silt/Clay | Brown Sand trace of Silt/Clay | Brown Sand some of Silt/Clay | Brown Sand trace of Silt/Clay | Brown Sand trace of Silt/Clay |
| Depth (m) | 6.0m | 7.5m | 12.0m | 18.0m | 9.0m | 7.0m |
| Sample Date | Supplied by Client | Supplied by Client | Supplied by Client | Supplied by Client | Supplied by Client | Supplied by Client |
| Test Type | Wash | Wash | Wash | Wash | Wash | Wash |
| Sieve Size | Percent Passing (%) | | | | | |
| | | | | | | |
| 100 | | | | | | |
| 75 | | | | | | |
| 53 | | | | | | |
| 37.5 | | | | | | |
| 26.5 | | | | | | |
| 19 | | | | | | |
| 13.2 | | | | | | |
| 9.5 | | | | | | |
| [illegible].[illegible] | | | | | | |
| 4.75 | | | | | | |
| 2.36 | | | | | | |
| 1.18 | | | | | 100 | |
| 0.6 | 100 | 100 | 100 | | 9[illegible] | 100 |
| 0.425 | [illegible]4 | 70 | 66 | 100 | 7[illegible] | 62 |
| 0.3 | 3[illegible] | 40 | 45 | 66 | 5[illegible] | 38 |
| 0.15 | 1[illegible] | 15 | 28 | 41 | 1[illegible] | 10 |
| 0.075 | 7 | 4 | 2 | 15 | 5 | 4 |

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Accredited for compliance with ISO/IEC 17025

Accreditation No. 19788

Signatory: N.Smith

N smith

Date: 28 10-[illegible]016

# ANALYTICAL REPORT

Accreditation No. 2562

| CLIENT DETAILS | | LABORATORY DETAILS | |
|---|---|---|---|
| Contact | Dane Dwyer | Manager | Huong Crawford |
| Client | IDEALCORP PTY LTD | Laboratory | SGS Alexandria Environmental |
| Address | PO BOX 2270<br>SMITHFIELD NSW 2164 | Address | Unit 16, 33 Maddox St<br>Alexandria NSW 2015 |
| Telephone | 61 2 97255522 | Telephone | +61 2 8594 0400 |
| Facsimile | 61 2 87866300 | Facsimile | +61 2 8594 0499 |
| Email | orders@idealfoundations.com.au | Email | au.environmental.sydney@sgs.com |
| Project | **23921** | SGS Reference | **SE157667 R0** |
| Order Number | (Not specified) | Date Received | 30 Sep 2016 |
| Samples | 11 | Date Reported | 07 Oct 2016 |

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Andy Sutton
Senior Organic Chemist

Dong Liang
Metals/Inorganics Team Leader

| Parameter | Units | LOR | Sample Number<br>Sample Matrix<br>Sample Date<br>Sample Name<br>SE157667.001<br>Soil<br>26 Sep 2016<br>BH2 - 1.5m | SE157667.002<br>Soil<br>26 Sep 2016<br>BH2 - 3.0m | SE157667.003<br>Soil<br>26 Sep 2016<br>BH2 - 9.0m | SE157667.004<br>Soil<br>26 Sep 2016<br>BH2 - 15.0m |
|---|---|---|---|---|---|---|
| **Field pH for Acid Sulphate Soil Method: AN104 Tested: 6/10/2016** | | | | | | |
| pHf | pH Units | - | **6.9** | **6.6** | **6.1** | - |
| pHfox | pH Units | - | **6.8** | **6.3** | **4.5** | - |
| Reaction* | No unit | - | x | x | x | - |
| pH Difference* | pH Units | -10 | **0.2** | **0.3** | **1.6** | - |
| **pH in soil (1:2) Method: AN101 Tested: 4/10/2016** | | | | | | |
| pH (1:2) | pH Units | - | - | - | **5.2** | **7.3** |
| **Conductivity (1:2) in soil Method: AN106 Tested: 4/10/2016** | | | | | | |
| Conductivity (1:2) @25 C* | µS/cm | 1 | - | - | **60** | **110** |
| Resistivity (1:2)* | ohm cm | - | - | - | **17000** | **9300** |
| **Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 5/10/2016** | | | | | | |
| Chloride | mg/kg | 0.25 | - | - | **20** | **9.5** |
| Sulphate | mg/kg | 0.5 | - | - | **29** | **21** |
| **Moisture Content Method: AN002 Tested: 5/10/2016** | | | | | | |
| % Moisture | %w/w | 0.5 | - | - | **20.4** | **20.6** |

| Parameter | Units | LOR | Sample Number: SE157667.005<br>Sample Matrix: Soil<br>Sample Date: 27 Sep 2016<br>Sample Name: BH3 - 9.0m | SE157667.006<br>Soil<br>27 Sep 2016<br>BH4 - 6.0 | SE157667.007<br>Soil<br>27 Sep 2016<br>BH4 - 12.0m | SE157667.008<br>Soil<br>28 Sep 2016<br>BH5 - 1.5m |
|---|---|---|---|---|---|---|
| **Field pH for Acid Sulphate Soil Method: AN104 Tested: 6/10/2016** | | | | | | |
| pHf | pH Units | - | - | **5.1** | - | **7.5** |
| pHfox | pH Units | - | - | **4.9** | - | **6.9** |
| Reaction* | No unit | - | - | x | - | x x x x |
| pH Difference* | pH Units | -10 | - | **0.2** | - | **0.5** |
| **pH in soil (1:2) Method: AN101 Tested: 4/10/2016** | | | | | | |
| pH (1:2) | pH Units | - | **5.4** | **4.9** | **4.7** | - |
| **Conductivity (1:2) in soil Method: AN106 Tested: 4/10/2016** | | | | | | |
| Conductivity (1:2) @25 C* | µS/cm | 1 | **72** | **62** | **63** | - |
| Resistivity (1:2)* | ohm cm | - | **14000** | **16000** | **16000** | - |
| **Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 5/10/2016** | | | | | | |
| Chloride | mg/kg | 0.25 | **9.8** | **30** | **14** | - |
| Sulphate | mg/kg | 0.5 | **50** | **15** | **35** | - |
| **Moisture Content Method: AN002 Tested: 5/10/2016** | | | | | | |
| % Moisture | %w/w | 0.5 | **17.7** | **17.5** | **17.5** | - |

| Parameter | Units | LOR | Sample Number<br>Sample Matrix<br>Sample Date<br>Sample Name | SE157667.009<br>Soil<br>28 Sep 2016<br>BH5 - 6.0m | SE157667.010<br>Soil<br>28 Sep 2016<br>BH5 - 9.0m | SE157667.011<br>Soil<br>28 Sep 2016<br>BH6 - 6.0m |
|---|---|---|---|---|---|---|
| **Field pH for Acid Sulphate Soil Method: AN104 Tested: 6/10/2016** | | | | | | |
| pHf | pH Units | - | | **5.3** | - | - |
| pHfox | pH Units | - | | **4.7** | - | - |
| Reaction* | No unit | - | | x | - | - |
| pH Difference* | pH Units | -10 | | **0.6** | - | - |
| **pH in soil (1:2) Method: AN101 Tested: 4/10/2016** | | | | | | |
| pH (1:2) | pH Units | - | | - | **5.3** | **5.4** |
| **Conductivity (1:2) in soil Method: AN106 Tested: 4/10/2016** | | | | | | |
| Conductivity (1:2) @25 C* | µS/cm | 1 | | - | **50** | **36** |
| Resistivity (1:2)* | ohm cm | - | | - | **20000** | **28000** |
| **Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 5/10/2016** | | | | | | |
| Chloride | mg/kg | 0.25 | | - | **8.5** | **9.6** |
| Sulphate | mg/kg | 0.5 | | - | **32** | **13** |
| **Moisture Content Method: AN002 Tested: 5/10/2016** | | | | | | |
| % Moisture | %w/w | 0.5 | | - | **19.9** | **2.5** |

# QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

## Conductivity (1:2) in soil  Method: ME-(AU)-[ENV]AN106

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery |
|---|---|---|---|---|---|---|
| Conductivity (1:2) @25 C* | LB110974 | µS/cm | 1 | <1 | 9% | 99% |
| Resistivity (1:2)* | LB110974 | ohm cm | - | | 9% | NA |

## Field pH for Acid Sulphate Soil  Method: ME-(AU)-[ENV]AN104

| Parameter | QC Reference | Units | LOR | DUP %RPD | LCS %Recovery |
|---|---|---|---|---|---|
| pHf | LB111100 | pH Units | - | 0% | NA |
| pHfox | LB111100 | pH Units | - | 1 - 2% | NA |

## Moisture Content  Method: ME-(AU)-[ENV]AN002

| Parameter | QC Reference | Units | LOR | DUP %RPD |
|---|---|---|---|---|
| % Moisture | LB111089 | %w/w | 0.5 | 0 - 4% |

## pH in soil (1:2)  Method: ME-(AU)-[ENV]AN101

| Parameter | QC Reference | Units | LOR | DUP %RPD | LCS %Recovery |
|---|---|---|---|---|---|
| pH (1:2) | LB110974 | pH Units | - | 1% | 99% |

## Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography  Method: ME-(AU)-[ENV]AN245

| Parameter | QC Reference | Units | LOR | MB | DUP %RPD | LCS %Recovery |
|---|---|---|---|---|---|---|
| Chloride | LB110984 | mg/kg | 0.25 | <0.25 | 22% | 100% |
| Sulphate | LB110984 | mg/kg | 0.5 | <0.5 | 24% | 99% |

# METHOD SUMMARY

| METHOD | METHODOLOGY SUMMARY |
|---|---|
| AN002 | The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water. |
| AN101 | pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+. |
| AN104 | pHF is determined on an extract of approximately 2g of as received sample in approximately 10 mL of deionised water with pH determined after standing 30 minutes. |
| AN104 | pHFox is determined on an extract of approximately 2g of as received sample with a few mLs of 30% hydrogen peroxide (adjusted to pH 4.5 to 5.5) with the extract reaction being rated from slight to extreme, with pH determined after reaction is complete and extract has cooled. Referenced to ASS Laboratory Methods Guidelines, method 23Af-Bf, 2004.<br><br>X Slight Reaction<br>XX Moderate Reaction<br>XXX Strong/High Reaction<br>XXXX Extreme/Vigorous Reaction (gas evolution and heat generation) |
| AN106 | Conductivity : Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:2 and the EC determined and reported on the extract basis after the 1 hour extraction (EC(1:2)) or after the 1 hour extraction and overnight aging (EC(1:2) aged). Reference APHA 2510 B. |
| AN106 | Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis. |
| AN245 | Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B |

FOOTNOTES

| | | | |
|---|---|---|---|
| IS | Insufficient sample for analysis. | LOR | Limit of Reporting |
| LNR | Sample listed, but not received. | ↑↓ | Raised or Lowered Limit of Reporting |
| * | NATA accreditation does not cover the performance of this service. | QFH | QC result is above the upper tolerance |
| | | QFL | QC result is below the lower tolerance |
| ** | Indicative data, theoretical holding time exceeded. | - | The sample was not analysed for this analyte |
| | | NVL | Not Validated |

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf