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Doc: GE2.1.1

GEOTECHNICAL INVESTIGATION

For: Phoenix Contracting

Project Address: #26 Ford Street, Woodbridge

Project Number: D236397

Job Number: J345419

Revision Number: 0

Date: 24/4/2020

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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

1. PROJECT DETAILS

1.1. Introduction

At the request of Brad Snell of Phoenix Contracting, Structerre Consulting (Structerre) have conducted a Geotechnical Investigation at #26 Ford Street, Woodbridge. The purpose of the investigation was to provide the following for residential subdivision purposes:

- An assessment of subsurface soil profile and groundwater conditions across the proposed area of development;
- Site classification in accordance with AS 2870-2011 Residential Slabs and Footings;
- Wind Classification in accordance with AS 4055-2012 Wind Loads for Housing;
- Recommendations for stormwater drainage design;
- Recommendations on earthworks and site preparation; and
- Provision of a footing detail considering anticipated surface movement and sand pad thickness.

Structerre were provided with a site plan prepared by Alan McLean Engineering Pty Ltd showing surface contours, the proposed subdivision and the location in relation to the site boundaries.

1.2. Site Description

The site is located at #26 Ford Street, Woodbridge, City of Swan. Ford Street lies to the southwest of the site with Ray Marshall Park to the northeast and residential properties to the east and west.

The site slopes down towards the rear section. At the time of the field investigation, the site was vacant and covered in vegetation.

1.3. Field Investigation – Scope of Works

The field investigation was carried out on 15 April 2020 and comprised:

- 6 x Sample Retrieval Probes (SRP) to a depth of 2.5m over the site for material assessment and soil profiling.

The borehole test locations are shown on the attached site plan in Appendix 1.

Suitably qualified geotechnical personnel from Structerre supervised the fieldwork and all fieldwork, interpretation and terminology used in this report are in accordance with the guidelines presented in AS1726-2017 Geotechnical Site Investigations.

2. DESK STUDY

2.1. Geological Setting

The Perth sheet 1: 50,000 Environmental Geology Series (Part Sheets 2034 III and 2134 III, 1986) prepared by the Geological Survey of Western Australia indicates that the following geological layers underlie the site:

- Pebbly SILT (Mgs1) – strong brown silt with common, fine to occasionally coarse-grained, sub-rounded laterite quartz, heavily weathered granite pebble, some fine to medium-grained quartz sand, of alluvial origin (Guildford Formation Qpa).

2.2. Ground Surface and Groundwater Level

The Perth Groundwater Atlas (Waters & Rivers Commission) indicates the ground surface level at this site was approximately 3.0m – 12.5m Australian Height Datum (AHD). This is consistent with the survey data provided by the Client.

The May 2003 groundwater level at the site was approximately 1.0m AHD. It should be noted that the groundwater levels can vary significantly due to seasonal variation and the data from the recorded maximum levels should be used only as a guide.

2.3. Earthquake Coefficient

In accordance with AS 1170.4-2007 Structural Design Actions the site is located within an area with an earthquake acceleration coefficient of between 0.09 and 0.10.

2.4. Wind Classification

In accordance with AS 4055-2012 Wind Loads for Housing, wind classification of this site falls within the non-cyclonic "N2" category.

3. RESULTS OF THE INVESTIGATION

3.1. Subsurface Soil Profile

The subsurface soil profile presented below was determined from the ground conditions encountered within the boreholes:

Table 1 – Subsurface Soil Profile

Depth to Base of Strata (m)	Material Description
0.1	Topsoil
0.2 – 1.8 (Ave. 0.7)	FILL: SAND (fine to medium grained), non-plastic, trace building rubble
0.6 – 1.2 (Ave. 0.8)	NATURAL: Clayey SAND (fine to medium grained), low to medium plasticity
Not Penetrated (>2.5m)	NATURAL: CLAY (fine to medium grained), medium plasticity, with gravel, with sand

The soils encountered are consistent with the expected site conditions as predicted from the Environmental Geology Map. It is important to note that there may be pockets of fill on site that are deeper than that encountered by the investigation boreholes. The subsurface soil conditions encountered are presented in the bore logs, within Appendix 3.

3.2. Groundwater

Groundwater was not encountered in any of the boreholes during or immediately after drilling. However, based on the Perth Groundwater Atlas, the groundwater is expected to be encountered approximately 2.0m – 11.5m below the existing ground level or perched between 0.2m and 1.8m, above the more cohesive materials.

3.3. Laboratory Test Results

Selected soil samples were tested for Atterberg Limits.

3.3.1. Atterberg Limits

Atterberg Limits were tested by Structerre's in-house NATA accredited laboratory. Results of the testing are summarised below:

Table 2 – Atterberg Limit Test Results

Sample	Test Hole	Depth (m)	Soil Description	Liquid Limit % AS1289 3.1.2	Plastic Limit % AS1289 3.2.1	Plasticity Index % AS1289 3.3.1	Linear Shrinkage % AS1289 3.4.1
1	BH5	1.2-1.6	CLAY with gravel, with sand	43	19	24	8

Test results indicate that the natural CLAY has moderate shrink swell capacity or degree of expansion.

A copy of the result is presented in Appendix 4.

4. GEOTECHNICAL CONSTRUCTION CONSIDERATIONS

4.1. Site Classification

AS 2870-2011 Residential Slabs and Footings provides guidance on site classification for residential slabs and footing design based on the expected ground surface movement and depth of expected moisture changes.

Table 2 – Classification Based on Site Reactivity

AS 2870-2011 Residential Slabs and Footings - Clause 2.1.2 Table 2.1	
Class	**Foundation**
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes (0<ys≤20mm)
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes (20<ys≤40mm)
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes (40<ys≤60mm)
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes (60<ys≤75mm)
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes (ys>75mm)
Clause 2.1.3 Classification of other Sites	
P	Sites which include soft or unstable foundations such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils and soils subject to erosion, reactive sites subject to abnormal moisture conditions and site that cannot be classified in accordance to Table 2.1

The site in its current condition is classified as Class “P” due to the uncontrolled fill encountered. Based on results of this investigation.

Option 1: The site can be upgraded to a Class “S” in accordance with AS 2870-2011 provided that all unsuitable materials are removed and replaced with engineer-controlled sand fill materials in accordance with the earthwork recommendations outlined in Section 4.3 of this report.

Footings suitable for this site should be adopted to accommodate expected ground surface movements of approximately y_s = 5mm associated with the presence of moderately reactive CLAY with sand deposits within the building site.

Option 2: The site can be upgraded to a Class "A" in accordance with AS 2870-2011 provided that all unsuitable materials are removed and replaced with a minimum of 1.8m of engineer-controlled sand fill materials in accordance with the earthwork recommendations outlined in Section 4.3 of this report.

4.2. Drainage

The existing ground conditions are not suitable for on-site disposal of stormwater runoff through the use of soakwells. It is recommended that all stormwater from roofed, paved and driveway areas be collected and detained to reduce peak flow rates prior to discharging off site as per council requirements. Sub soil drainage may be required at this site to control ground water perching in the upper soil layers.

4.3. Earthworks

All earthworks shall be undertaken in accordance with AS 3798-2007 Guidelines on earthworks for commercial and residential developments and are to include the following:

- All unsuitable materials to be stripped and removed from the site. Unsuitable materials include topsoil, uncontrolled fill, deleterious and organic materials.
- It is considered that the FILL requires improvement. Fill was encountered between 0.2-1.8m below the existing surface. Therefore, it is proposed to excavate and stockpile the materials for reuse, provided it is free from clay/silt (i.e. <5%), deleterious and organic materials. The depth of excavation may vary depending on conditions encountered and is subject to inspection.
- Excavation should not be greater than 2.0m and/or undermine the surrounding structures. A 1V: 2H slope should be maintained for temporary excavations. If excavation is required closer than the 1V: 2H slope would allow or deeper, it is recommended that this office be contacted for retaining system design.
- Proof compact the exposed base. The compaction requirements are set out in the table below, as per AS 3798-2007:

Table 3 – Compaction Requirements

Item	Application	Minimum relative compaction, %	
		Minimum density ratio (Standard Compaction Effort) (Cohesive soils)	Minimum density index (Cohesionless soils)
1	Residential - lot, fill, house, sites	95	70

- After excavation and proof compaction, the excavated base is to be inspected and approved by a representative from this office prior to backfilling. At this stage it can be assessed whether any further materials need to be removed or whether further compaction of the base is required.

- Option 1: A minimum of 0.9m sand cover is to be maintained above the reactive material in order to achieve a Class "S" site with y_s = 5mm.
- Option 2: A minimum of 1.8m sand cover is to be maintained above the reactive material in order to achieve a Class "A" site.
- The ground level should be built up to design levels with the stockpiled sand FILL and/or imported fill, if required. The imported fill should consist of free draining sand with not more than 5% passing a 75µm sieve and be free of organic matter and other deleterious materials. The fill materials should be placed in layers not exceeding 300mm loose thickness and compacted to achieve a minimum 8 PSP blows over the interval 150 – 450mm, 9 PSP blows over the interval 450 – 750mm and 11 PSP blows over the interval 750 -1050mm.
- After remedial earthworks have been completed, the earthworks should be inspected and approved by a representative from this office.

5. CONCLUSIONS

A site investigation has been carried out at the site of the proposed residential development to assess the geotechnical conditions. Parameter and design recommendations are incorporated in the body of the report. The following conclusions have been drawn from the site investigation:

- The average subsurface soil profile encountered comprised topsoil to 0.1m, sand FILL up to 1.8m, clayey SAND to 0.8m and underlain by CLAY with gravel, with sand to the investigated depth of 2.5m.
- Groundwater or perched water was not encountered across the site to the depth of 2.5m.
- It is considered that the site is not suitable for on-site drainage.
- Option 1: The site can be classified as Class "S" in accordance with AS 2870-2011 due to presence of moderately reactive CLAY with sand deposits within the building site, provided that the recommended earthworks are undertaken.
- Option 2: The site can be classified as Class "A" in accordance with AS 2870-2011 provided that the recommended earthworks are undertaken.
- The full scope of the recommended earthworks is presented in Section 4.3, but generally comprises:
    - Stripping of topsoil and unsuitable materials
    - Proof compaction of the base
    - Placement of sand fill to required level
    - Compaction to final level

6. LIMITATION OF FIELD INVESTIGATIONS

This report has been prepared in accordance with generally accepted consulting practice for Phoenix Contracting using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

The conclusions and recommendations in this report are based on the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that actually exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions.

If ground conditions encountered during construction are different to that described in this report, this office should be notified immediately.

For and behalf of

STRUCTERRE CONSULTING

Margie Mortera
Geotechnical Assistant

Checked By: David Harding
Employee Title: Geotechnical Supervisor

Authorised By: Mel Castle
Employee Title: Division Manager - Geotechnical

Disclaimer
This report is at the request of the addressee and no liability is accepted by Structerre Consulting to any third person reading or relying upon the report, not withstanding any rule of law and/or equity to the contrary and that this report is strictly confidential and intended to be read and relied upon only be the addressee.

Job #	Revision	Authored	Checked	Authorised
J345419	0	MM	DH	MC

7. REFERENCES

Department of Water – Perth Groundwater Atlas

Geological Survey of Western Australia 1:50,000 Environmental Geology Series

AS 1170.4-2007 Structural design actions – Earthquake actions in Australia

AS 1289.3.1.2-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the liquid limit of a soil

AS 1289.3.2.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the plastic limit of a soil

AS 1289.3.3.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Calculation of the plasticity index of a soil

AS 1289.3.4.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the linear shrinkage of a soil

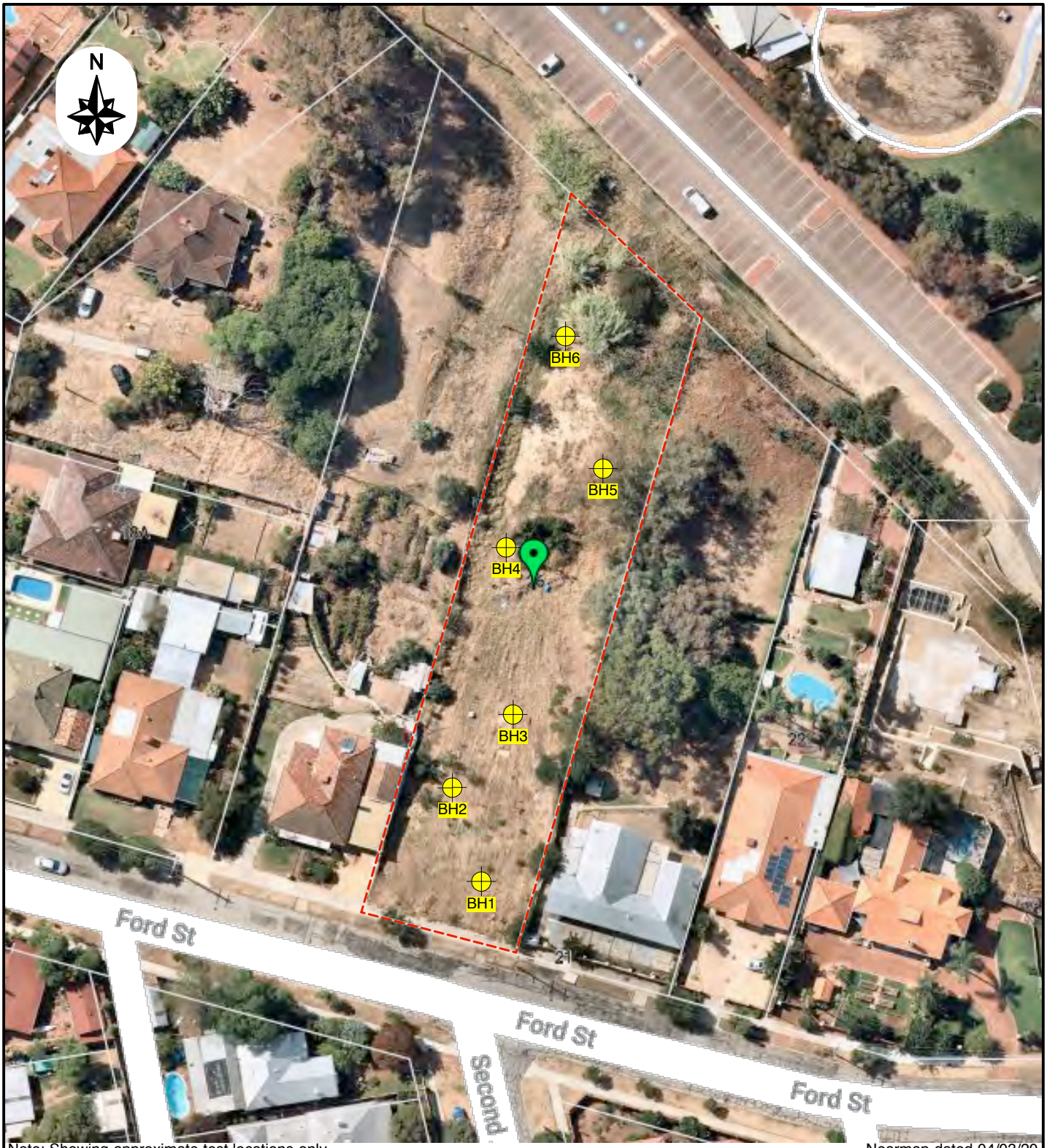
AS 1726-2017 Geotechnical site investigation

AS 2870-2011 Residential slabs and footings

AS 3798-2007 Guidelines on earthworks for commercial and residential developments

AS 4055-2012 Wind loads for housing

APPENDIX 1 – SITE LOCATION MAP



Note: Showing approximate test locations only

Nearmap dated 04/03/20

LEGEND

BH Borehole

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PROJECT:	#26 Ford Street, Woodbridge
PROJECT #:	D236397
JOB #:	J345419
CLIENT:	**Pheonix Contractors**
SCALE:	NTS
TITLE:	Geotechnical Investigation Site Plan
DATE:	14 Apr '20
DRAWN BY:	MM
CHECKED BY:	DH

DOC: GE:3.001

APPENDIX 2 – SITE PHOTOS

PHOTO 1

PHOTO 2

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PROJECT #:	D236397
JOB #:	J345419
CLIENT:	**Pheonix Contractors**
SCALE:	NTS
TITLE:	Site Photographs
DATE:	14 Apr '20
DRAWN BY:	MM
CHECKED BY:	DH

APPENDIX 3 – BORELOGS

STRUCterre consulting engineers

Project #26 Ford Street, Woodbridge

Client Pheonix Contractors

Test No. **BH01**

Project No.	D236397	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404600
Job No.	J345419	**Date**	14/04/2020	**Hole Dia.**	65mm	**Northing**	6471348

Depth	Graphic	Stratum Description	Consistency	DCP Blows/150mm (5 10 15 20)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, trace building rubble, brown (FILL)						
		SC: Clayey SAND: fine to medium grained, low to medium plasticity, brown (Alluvium)						
1		CI: CLAY: fine to medium grained, medium plasticity, with gravel, with sand, brown						
		Terminated at 1.00 m						
2								
3								

Remarks

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project #26 Ford Street, Woodbridge

Client Pheonix Contractors

Test No.

BH02

Project No.	D236397	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404617
Job No.	J345419	**Date**	14/04/2020	**Hole Dia.**	65mm	**Northing**	6471344

Depth	Graphic	Stratum Description	Consistency	DCP Blows/150mm (5 10 15 20)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, trace building rubble, brown (FILL)						
1		SC: Clayey SAND: fine to medium grained, low to medium plasticity, brown (Alluvium)						
		Terminated at 1.20 m						
2								
3								

Remarks

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project #26 Ford Street, Woodbridge

Client Pheonix Contractors

Test No.

BH03

Project No.	D236397	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404617
Job No.	J345419	**Date**	14/04/2020	**Hole Dia.**	65mm	**Northing**	6471344

Depth	Graphic	Stratum Description	Consistency	DCP Blows/150mm (5 10 15 20)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, trace building rubble, brown (FILL)						
		SC: Clayey SAND: fine to medium grained, low to medium plasticity, brown (Alluvium)						
		Terminated at 0.60 m						
1								
2								
3								

Remarks

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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STRUCterre consulting engineers

Project #26 Ford Street, Woodbridge

Client Pheonix Contractors

Test No.

BH04

Project No.	D236397	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404633
Job No.	J345419	**Date**	14/04/2020	**Hole Dia.**	65mm	**Northing**	6471348

Depth	Graphic	Stratum Description	Consistency	DCP Blows/150mm (5 10 15 20)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, trace building rubble, brown (FILL)						
		SC: Clayey SAND: fine to medium grained, low to medium plasticity, brown (Alluvium)						
		Terminated at 0.60 m						
1								
2								
3								

Remarks

1. Termination reason: Refusal - interpreted on stiff clay
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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STRUCterre consulting engineers

Project #26 Ford Street, Woodbridge

Client Pheonix Contractors

Test No.

BH05

Project No.	D236397	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404627
Job No.	J345419	**Date**	14/04/2020	**Hole Dia.**	65mm	**Northing**	6471404

Depth	Graphic	Stratum Description	Consistency	DCP Blows/150mm (5 10 15 20)	Samples Depth	Samples Type	Moisture	Water Level
		SP: SAND: fine to medium grained, non-plastic, pale brown (FILL)			0.0 - 2.5	T		
1								
		Cl: CLAY: fine to medium grained, medium plasticity, with gravel, with sand, brown (Alluvium)						
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability:
3. Samples taken: As indicated
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project #26 Ford Street, Woodbridge

Client Pheonix Contractors

Test No. **BH06**

Project No.	D236397	**Logged By**	Tony Broadway	**Machine**	Soil Retrieval Probe	**Easting**	404622
Job No.	J345419	**Date**	14/04/2020	**Hole Dia.**	65mm	**Northing**	6471378

Depth	Graphic	Stratum Description	Consistency	DCP Blows/150mm (5 10 15 20)	Samples Depth	Samples Type	Moisture	Water Level
0		SP: SAND: fine to medium grained, non-plastic, pale brown (FILL)						
1								
2		CI: CLAY: fine to medium grained, medium plasticity, with gravel, with sand, brown (Alluvium)						
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability:
3. Samples taken: None
4. Co-ordinate system: WGS 84

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APPENDIX 4 – LABORATORY TEST RESULTS

Sample No.	**33560**	**Client**	Geotechnical
Job No.	J345419	**Project**	#26 Ford St,, Woodbridge

Laboratory testing carried out at Balcatta Laboratory 1 Erindale Rd, Balcatta WA 6021

SAMPLE DETAILS

BH No. / Depth : BH5 1.2-1.6m
Sample History : 50°C Oven Dried

Sampling Method Client
Sample Preparation AS 1289 1.1

ATTERBERG LIMITS

Description	Method	Result (%)
Liquid Limit	AS 1289.3.1.2	43
Plastic Limit	AS 1289.3.2.1	19
Plasticity Index	AS 1289.3.3.1	24
Linear Shrinkage	AS 1289.3.4.1	8
Nature of Shrinkage		Flat

PARTICLE SIZE DISTRIBUTION

Method: AS 1289.3.6.1
Description: Particle size distribution by sieve analysis

Sieve Size (mm)	% Passing
19.0	100
2.36	77
0.425	69
0.075	57

AS 1726:2017 Clause 6.1
Material Description: CLAY with gravel, with sand
AS Group Symbol: CI or OI

Accredited for compliance with ISO/IEC 17025
NATA
WORLD RECOGNISED ACCREDITATION
STRUCTERRE CONSULTING ENGINEERS BALCATTA LABORATORY ACCREDITATION NUMBER 18742

Wayne Rozmianiec
Laboratory Manager

Date: 23-Apr-20

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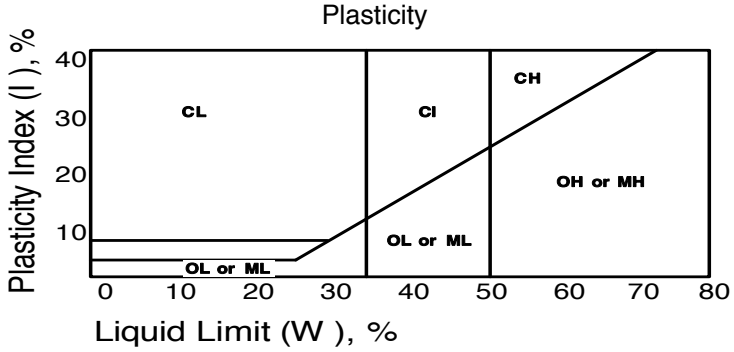
APPENDIX 5 – BORELOG TERMINOLOGY

BOREHOLE TERMINOLOGY

Particle Size Distribution

Major Division	Subdivision	Size
Boulders		>200mm
Cobbles		200 - 63mm
Gravel	Coarse	63 - 20mm
	Medium	20- 6mm
	Fine	6 - 2.36mm
Sand	Coarse	2.36 - 0.6mm
	Medium	0.6 - 0.2mm
	Fine	0.2 - 0.075mm

Plasticity



Consistency of Cohesive Soils

Term	Undrained Strength Su (kPa)	Field Guide
Very Soft	< 12	Exudes between the fingers when squeezed in hand
Soft	12 - 25	Can be moulded by light finger pressure
Firm	25 - 50	Can be moulded by strong finger pressure
Stiff	50 - 100	Cannot be moulded by Fingers. Can be indented by thumb.
Very Stiff	100 - 200	Can be indented by thumb nail
Hard	> 200	Can be indented with difficulty by thumb nail.
Friable	-	Crumbles or powders when scraped by thumbnail

Consistency/Density of Non-Cohesive Soils

Term	Density Index (%)	SPT "N" Value Comparison
Very Loose	< 15	0 - 4
Loose	15 - 35	4 - 10
Medium Dense	35 - 65	10 - 30
Dense	65 - 85	30 - 50
Very Dense	> 85	> 50

Moisture Content

D	Dry
M	Moist
W	Wet
S	Saturated

Minor Components

Term	Assessment Guide	Proportion of Minor Component In:
Trace	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	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 Legend

FILL	CLAY	GRAVEL	CONCRETE
TOPSOIL	SILT	LIMESTONE	COMBINATIONS
PEAT	SAND	BEDROCK	eg: Clay, Silty, Sandy

USCS

GW	Well graded gravel	SC	Clayey sand	OL	Organic low plasticity silt	CL	Low plasticity clay
GP	Poorly graded gravel	SM	Silty sand	ML	Low plasticity silt	CI	Intermediate plasticity clay
SW	Well graded sand			MH	High plasticity silt	CH	High plasticity clay
SP	Poorly graded sand			OH	Organic high plasticity silt	PT	Peat

DOC:GE:3.003

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