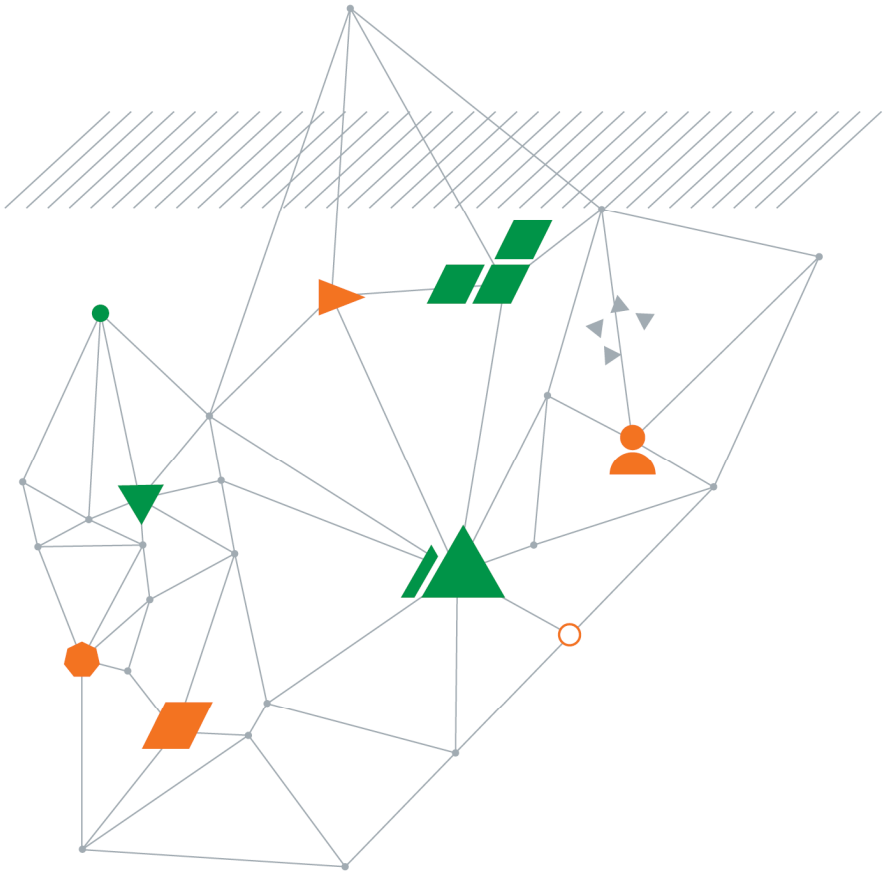
Rustrum Pty Ltd C/- Sterlings

Proposed Development - 216-232 Main Road, Toukley

Geotechnical Report

23 September 2014



Real
potential
is uncovered
only when
you scratch
beneath
the surface

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Proposed Development - 216-232 Main Road, Toukley

Prepared for
Rustrum Pty Ltd C/- Sterlings

Prepared by
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23 September 2014

Document authorisation

Our ref: GEOTWARA22382AA-ABrev1

For and on behalf of Coffey

Arthur Love
Principal Geotechnical Engineer

Quality information

Revision history

Revision	Description	Date	Author	Reviewer	Signatory
V2	Rev 1	23 Sep 2014	SGB	RK	ABL

Distribution

Report Status	No. of copies	Format	Distributed to	Date
V2	1	PDF	Terry Roche, Trevor Clack	23 Sept 2014

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1. Introduction

Coffey was commissioned by Sterlings Pty Ltd on behalf of Rustrum Pty Ltd to undertake a geotechnical assessment of the proposed development site at 216-232 Main Road in Toukley. The commission was made following acceptance of Coffey Proposal GEOTWARA22382AA-AA, dated 12 August 2014.

Sterlings Pty Ltd is planning a multi-storey residential and commercial building on the lake shore at 216-232 Main Road in Toukley. The development will comprise an 11-storey building (including 2 basement car parking levels) on the upper portion of the site with two level units on the northern side of the tower extending towards the lake shore..

Geotechnical work will focus on excavation ability, temporary and permanent support, foundation (and pile) capacity and lateral earth pressures with a special focus on the following.

- A 6m high excavation (potentially up to 8.5m deep) to construct the basement;
- The lift pit is likely to be 1.5m below the lowest floor level;
- Lowest basement slab is proposed to be slab on ground;
- Building frames with column loads at the basement level in the order of 3,500kN (working) around the perimeter of the tower increasing to 5000kN in the central area;
- Building may require piles to resist uplift under the lift and stairs.

The report presents the findings of the geotechnical investigation and provides recommendations for the following:

- Footing design;
- Retaining structures;
- Excavation conditions;
- Geotechnical Hazards and Opportunities to development.

In preparation of this report we have referred to the Geotechnical Brief, written by Northrop Consulting Engineers, dated 8 August 2014 and to Architectural sketch plans provided by DWP Suters, dated 10 July 2014.

2. Field Work

Field work was undertaken primarily on 18 August and 21 August 2014 and comprised four boreholes. Boreholes (BHC01) on 18 August were drilled using a truck mounted drilling rig provided by FICO. Subsequent boreholes (BHC02 BHC03 and BHC04) were completed using a tracked Geoprobe rig provided by Terratest. Details of each borehole are as follows:

- Borehole BHC01 drilled to a depth of 14.5m. A Groundwater monitoring well was installed with a response zone from 1.5m to 4.5m depth;
- Borehole BHC02 terminated at 1m and relocated. BHC02B drilled to a depth of 14.35m;
- Borehole BHC03 drilled to a depth of 5.95m; and
- Borehole BHC04 drilled to a depth of 5.9m

Holes were located using hand held GPS (GDA94 system) and a location plan is presented in Figure 1. Reduced levels were estimated using a detailed survey provided by Sterlings and are presented in mAHD. Borehole logs along with Explanation sheets are presented in Appendix A. Existing borehole logs completed by Network Geotechnics are presented in Appendix B.

Data loggers have been installed in three groundwater monitoring wells on site. Loggers were installed on 9 September 2014 and set to take readings at 1 hour intervals.

3. Laboratory Testing

Samples obtained were returned to our NATA accredited Newcastle laboratory for testing. The results of the testing are presented in Appendix C and are summarised in Table 1. The testing comprised of:

- Two particle size distribution tests;
- One Atterberg classification test;
- One aggressive soil suite of testing (Chloride content, sulphide content, pH and resistivity).

Table 1: Summary of Laboratory Testing

BOREHOLE	SAMPLE DEPTH (m)	MATERIAL	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LINEAR SHRINKAGE (%)
BHC02B	8.5-8.95	XW Claystone	24.7	52	29	10.5

Laboratory testing undertaken by Network Geotechnics in 2008 reported Plasticity Index results ranging from 24% to 28% and Liquid Limit results ranging from 37% to 47%.

Table 2: Summary of Particle Size Distribution Tests

HOLE ID	DEPTH (m)	% PASSING BY DRY WEIGHT								
		13.2mm	4.75mm	2.36mm	1.18mm	600µm	425µm	300µm	150µm	75µm
BHC02B	2.5-2.95	100	96	88	79	67	57	46	37	35
BHC02B	5.5-5.7	99	96	91	85	69	53	41	27	23

These data show that the material tested comprised Clayey SAND with some gravel.

Table 3: Summary of Aggressive Soil Results

HOLE ID	DEPTH	SOIL SULPHATE SO4 (mg/kg)	SOIL CHLORIDE (mg/kg)	RESISTIVITY (ohm.cm)	pH	EXPOSURE CLASSIFICATION - CONCRETE PILES*	EXPOSURE CLASSIFICATION - STEEL PILES*
BHC02B	13.0-13.45	<30	27	180	8.1	Mild	Non-aggressive
*NOTE: *Based on procedure set out in Australian Standard AS2159-2009*							

Aggressiveness to buried elements depends on soil pH, soluble sulphate and chloride content (with respect to concrete) and also resistivity in the soil (with respect to steel).

Australian Standard AS2159-2009 provides an indication of aggressiveness of soils based on laboratory derived values and provides advice on durability design.

The soils and weathered rocks on site are generally of low permeability and a ‘mild’ exposure classification as defined in the standard may be assumed for concrete in the clayey sand residual soil and ‘non-aggressive’ for steel piles.

4. Ground Model

4.1. Surface Conditions

The site is located on a promontory of land that lies between two lakes; Budgewoi Lake to the north and Tuggerah Lake to the south. The area is typically low lying, ranging from approximately RL10mAHD to RL0.5m AHD at lake level. The site itself slopes down to the north towards the lake and also, less steeply, towards the west.

4.2. Geology

With reference to the 1:100,000 scale geological map of Gosford the site is anticipated to be underlain by bedrock of the Tuggerah Formation, part of the Narrabeen Group. Bedrock has been found to comprise interbedded sandstone, siltstone, and claystone.

4.3. Subsurface Conditions

The subsurface profiles encountered in existing and recent boreholes suggest that a ground model for the site is likely to comprise soil and rock profile as presented in Table 4.

Table 4: Summary of Geotechnical Model

Geological Unit / Soil Type	Material Description
REWORKED TOPSOIL – Clayey SAND	Fine to medium grained, dark brown with a trace of fine angular gravel of sandstone
ALLUVIUM – SAND	Coarse grained, orange brown with trace of fine grained gravel
RESIDUAL SOIL – CLAY / Sandy CLAY / Clayey SAND	High plasticity, grey to pale grey, trace of fine grained sand and fine grained sub-angular gravel
EXTREMELY TO HIGHLY WEATHERED SANDSTONE	Extremely weathered sandstone, recovered as clayey sand
EXTREMELY WEATHERED SILTSTONE / CLAYSTONE	Extremely weathered siltstone and claystone, recovered as sandy clay
EXTREMELY TO HIGHLY WEATHERED SILTSTONE / CLAYSTONE	Extremely to highly weathered siltstone and claystone, recovered as sandy clay

The groundwater table has been encountered during previous investigations and is expected to be at depths varying from about 2.0m to 2.5m below existing surface levels. Groundwater monitoring is being undertaken and will be reported under separate cover.

Alluvium was only encountered in borehole BHC04 and comprised a 0.5m thick layer. BHC04 was located relatively close to the lake edge. Alluvium is not expected to be encountered further up the slope (to the south).

Residual soil typically comprised sand and clay of varying fractions. The soils have been derived from weathering of the underlying parent rock. Where encountered, clay was reported to be stiff to very hard in consistency and high plasticity. Sand was reported to be dense to very dense and typically fine grained.

Rock was found to comprise of extremely to highly weathered sandstone, towards the crest of the slope in boreholes BHC01 and BHC02.The weathered sandstone underlain in BHC01 and BHC02 by extremely to highly weathered interbedded layers of siltstone and claystone. extremely to highly weathered interbedded layers of siltstone and claystone was encountered in boreholes BHC03 and BHC04, closer to the lake

Rock was typically very low to low strength and no rock core was able to be recovered.

Two slope sections are presented showing an interpretation of the ground model. The location of the sections is shown in Figure 1. The ground models are shown in Figure 2 and 3 respectively.

5. Discussion and Recommendations

5.1. General

The concept design for the developments indicates a nine storey tower complex over a two level carpark extending over the majority of the southern, upper portion of the lot. The lower basement level at about RL 3.0m AHD will involve extensive excavations up to 6m to 7m deep. The tower is located towards the top of the ridge with two storey units on the northern side of the carpark extending towards the lake.

The 11-storey building is proposed to be constructed as a concrete frame, with column loads at the basement level expected to be in the order of 3,500kN around the perimeter of the tower with internal column loads up to about 5000kN. The buildings could be supported on pad footings or piles founded in the weathered rock and soils below general excavation level.

5.2. Geotechnical Hazards and Opportunities

The key issue in relation to the design of footings and retaining structures on the site are:

- Founding conditions typically comprise extremely to highly weathered rock. The material can be considered to behave as either a dense or hard soil, or a very low strength rock. The weathered rock should provide reasonable bearing parameters for foundations;
- Groundwater has been encountered at a depth of 2m to 3m in borehole BHC01 and will need to be controlled if deep excavation are made;
- Retaining structures should provide suitable drainage measures to reduce the potential for build-up of pore-water pressures behind the wall.
- The rock and soils will be relatively easy to excavate;
- The carpark slabs will provide permanent support for the perimeter walls of the basement levels but temporary retention of the excavation will be required during construction;
- The excavation could be supported by cantilever pile walls or soil nail walls or a combination of both.
- With suitable designed soil nail reinforcement the need for heavily reinforced retaining structures could be minimised;
- Soil nails reduce the necessity for deep cantilever retaining structures, specifically the design of soil nails to assist with temporary retention of contiguous pile walls for basements;
- The excavations extend below the water table and some inflow during excavations should be expected compromising the trafficability of the site especially during wet weather.

The footing solution adopted for the proposed development elements will depend on both the imposed ground loading conditions and the tolerance of the structure to settlement. Shallow or deep footings may be suitable.

5.3. Building Foundation Design Parameters

The excavation for the two level basement down to about RL3.0m will result in removal of the majority of the soil and extremely weathered rock to expose reasonably competent sandstone over most of the area of the tower. The weathering may become deeper further to the east where it was not possible to locate boreholes due to property constraints. Further investigation boreholes will be required to allow for a confident tendering environment.

The tower could be supported on pad footings founded in the sandstone below basement level. The parameters for pad footings for the tower and the remainder of the site are provided in Table 5.

Table 5: Pad Design Parameters

Founding Unit for Pad Footing	Ultimate Base Bearing Pressure (kPa)	Serviceability Base Bearing Pressure (kPa)	Elastic Modulus (MPa)
Extremely to Highly Weathered sandstone	5,500	2,000	240
Extremely Weathered Siltstone / Claystone	1,900	700	100
Extremely to Highly Weathered Siltstone / Claystone	2,700	1,000	150
Residual Clays	600	200	40

Additional investigations and/ or testing during construction will be required to check at least one footing width of the same foundation material underlies foundation level particularly in the eastern section where investigations were not possible. All footings bases should be immediately covered (same day) with a layer of blinding concrete to protect the surface from deterioration from groundwater inflows or exposure to weather. The exposed footing excavation soil should be viewed by an appropriately qualified person who is able to advise on the adequate quality of the foundation material.

Where soils are present the structures may be supported on piles. Due to the soil / weathered rock profile, the structure may be supported on non-displacement piles such as bored piles, or CFA piles.

Limit state Ultimate Strength and Serviceability Design Parameters in accordance with the guidelines presented in AS2159–1995 *Piling Design and Installation and Pells (1998)*, are as shown in Table 6.

Table 6: Pile Design Parameters

Founding Unit	Ultimate End Bearing Pressure (kPa)	Ultimate Side Adhesion (kPa)	Serviceability End Bearing Pressure (kPa)	Serviceability Side Adhesion (kPa)	Elastic Modulus (MPa)
Extremely to Highly Weathered Sandstone	8,200	300	3,000	165	240
Extremely Weathered Siltstone / Claystone	2,700	100	1,000	55	100
Extremely to Highly Weathered Siltstone / Claystone	5,000	150	1,500	82.5	150
Residual Clays	900	150	300	82.5	40
*NOTE: * - No shaft adhesion to be allowed for in design using non-displacement steel screw piles.*					

The above parameters assume that piles are installed without disturbing the surrounding material and have a wall socket roughness of R2 or better.

A geotechnical reduction factor ($Ø_g$) should be applied to ultimate capacities to obtain design geotechnical strength parameters for limit state design. A value of 0.55 is recommended for $Ø_g$ at this stage. AS2159-2009 allows for less conservative factors under certain conditions.

The settlement of footings proportioned as recommended above should not exceed 1% of maximum width or pile diameter. In accordance with Pells et al a modulus reduction factor of 0.5 has been applied to the moduli provided in the above tables.

5.4. Shallow Footings

5.4.1. Site Classification

On the basis of the soil profiles encountered during the field investigations, laboratory testing and calculations, the natural soil profile on the site is classified in accordance with AS2870-2011 *'Residential Slabs and Footings'*, as Moderately Reactive (Class M) in the upper section of the site and Highly Reactive (Class H1) in the lower part of the site below RL3.0m.

The effects of changes to the soil profile by additional cutting and filling and the effects of past and future trees should be considered in selection of the design value for differential movement. Footings for the proposed development should be designed and constructed in accordance with the requirements of AS2870 *'Residential Slabs and Footings'*.
The classification presented above assumes that:

- The performance expectations set out in AS2870-2011 *'Residential Slabs and Footings'* are acceptable;
- Earthworks for building pads are constructed in accordance with the relevant clauses in AS2870-2011. Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 'Guidelines for Earthworks for Commercial and Residential Developments'.
- The construction and architectural requirements for reactive clay sites set out in AS2870-2011 are followed.

- Service trenches backfilled with uncontrolled fill do not extend below a line extending out and down at 45°from the ground surface at the edge of build ings;
- Site maintenance complies with the provisions of CSIRO Sheet BTF 18, *Foundation Maintenance and Footing Performance: A Homeowner's Guide*, a copy of which is attached;

This classification is for the site in its current condition. Following clearing, stripping and regrade, the classification should be reviewed by the geotechnical authority and amended if necessary.

5.5. Earthquake Classification

The site is interpreted to be a shallow soil site in accordance with AS1170.4-2007 'Earthquake Actions in Australia'. The site is therefore considered to be Class C_e.

5.6. Retaining Structures

Table 7 presents selected values of lateral earth pressure parameters for use in analysis and design. The material encountered in boreholes BHC01 and BHC02 is expected to be representative of material that will require retaining especially adjacent to property boundaries and existing structures.

Retained material is expected to comprise sandy soil, therefore active earth pressure values have been offered for this material. Passive resistance is expected to be provided from residually derived sandy clay soil.

Table 7: Lateral Earth Pressure Parameters for On Site Materials

Material	Effective Internal Angle of Fiction, φ'	Effective Cohesion c' kPa	Bulk Density of Soil, γ_b	Coefficient of Earth Pressure at Rest, K_o	Coefficient of Earth Pressure Active, K_a	Coefficient of Earth Pressure Passive, K_p
Extremely to Highly Weathered Sandstone	36°	7	20 kN/m^3	0.45	0.26	3.9
Extremely Weathered Siltstone / Claystone	30°	5	20 kN/m^3	0.50	0.33	3
Extremely to Highly Weathered Siltstone / Claystone	30°	5	20 kN/m^3	0.50	0.33	3
Residual Soils	28°	5	19kN/m^3	0.5	0.36	2.8

5.7. Temporary and Permanent Slopes

Temporary excavations in the cohesive residual soil / weathered rock above the water table may be cut at an angle of 1V:1H. Where granular soils are encountered and inflow of water is noted (such as in boreholes BHC01) it is recommended to install temporary stability measures such as concrete block or rockfill berms.

As mentioned above the basement excavations may be supported during construction with an engineered designed soil nail wall which may later be incorporated into the permanent retention system. Coffey can assist with the design of the soil nail wall to protect the adjacent properties and infrastructure.

Permanent cut slopes within alluvium or residual soils are recommended to be cut at a slope of 1V:2H or flatter and protected against erosion to reduce the risk of shallow slope failures over the design life of the property. Permanent cut slopes within extremely to highly weathered rock may reasonable to be cut to 1V:2H and protected against erosion.

5.8. Excavation and Groundwater Conditions

Excavatability varies with material properties and equipment. A conventional bulldozer blade, backhoe or excavator bucket can generally be used in soils and some softer rocks.

The materials encountered in the boreholes comprised extremely to highly weathered rock, often recovered as clay or sandy soil. It is expected that the soils encountered within the extent of our investigation may be excavated using standard plant and equipment.

The excavated surface will have poor trafficability particularly with groundwater inflows and wet weather and construction of access roads and working platforms will be required to provide access around the site. Construction of defensive drains will help control water issues. An erosion and sediment management plan will be required to manage runoff.

Materials excavated on site may be suitable for general fill or landscaping requirements. Material is not expected to be suitable for specific use, such as road base or drainage material..

Excavations will extend beneath the water table and some inflows can be expected. The rate of inflow is expected to be low and can be expected to reduce with time. The permeability and the rate of inflow could be evaluated by carrying out slug tests or inflow tests on the piezometer installed on site. Until this test is carried out a permeability of 1x10E-6 m/sec may be assumed for preliminary design purposes. The geological profile consists of weathered sandstone overlying less permeable siltstone and claystone which will tend to limit upward flows of groundwater. Groundwater flows will be mainly due to horizontal flows from surrounding areas. It is suggested that inflows could be handled by a series of perimeter drains and cross drains around and beneath the basement slab with gravity outlet to the north.

Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 '*Guidelines for Earthworks for Commercial and Residential Developments'*.

5.9. Aggressive Soil

Aggressive soil is assessed in accordance with *AS2159–1995 Piling Design and Installation* exposure classification. Based on the ground conditions encountered, a preliminary classification of mildly aggressive to concrete piles may be appropriate and non-aggressive for steel piles.

6. Closure

Some uncertainty remains with regards to the distribution of extremely to highly weathered Sandstone material and the strength profile of the weathered rocks. To assist with reducing geotechnical uncertainty, some additional investigation before or at construction stage may be prudent.

Further discussion on the uses and limitations of this report are presented in the attached document *'Important Information about Your Coffey Report'*.

For and on behalf of Coffey

Arthur Love
Principal Geotechnical Engineer

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Important information about your **Coffey** Report

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction,
speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures

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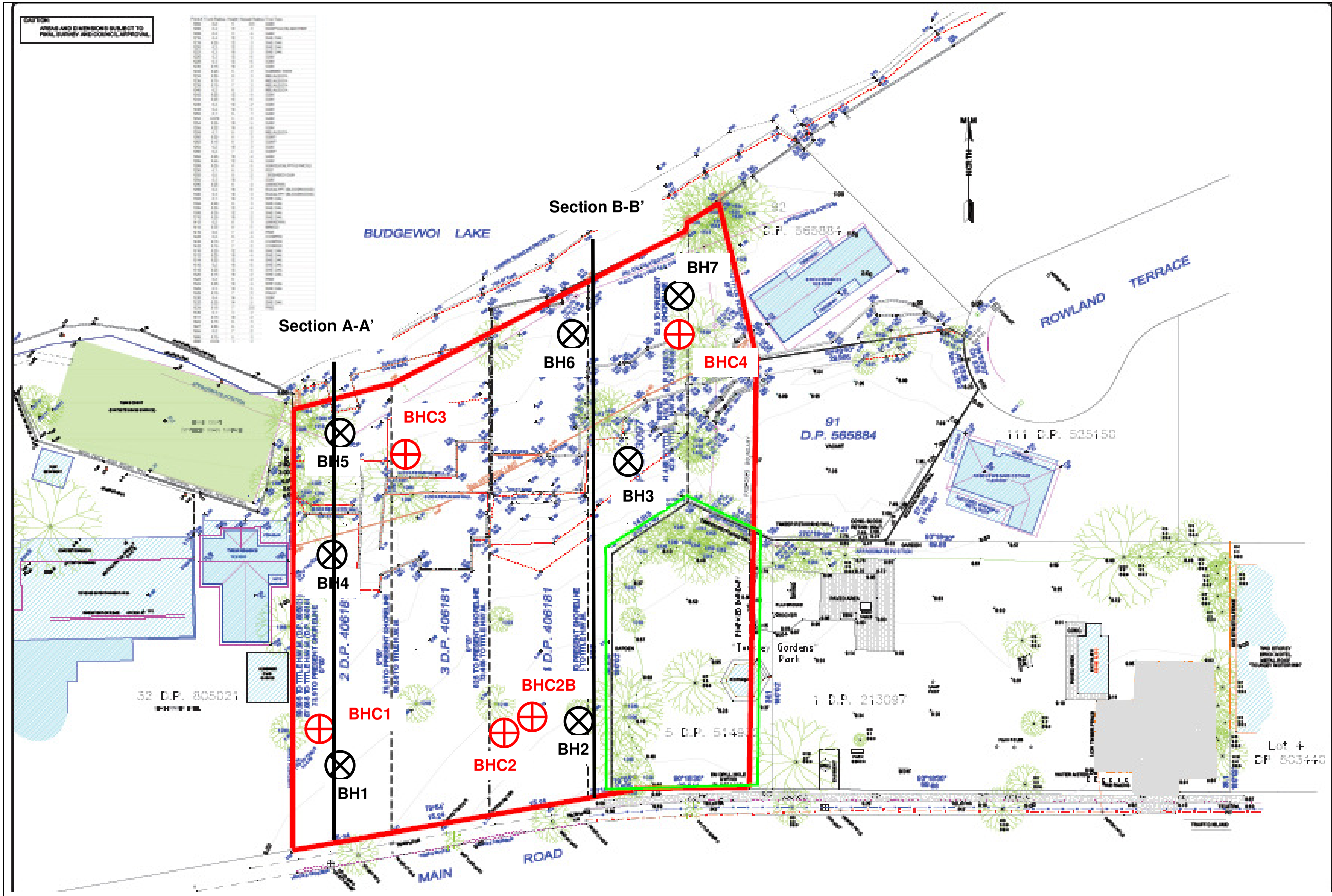

revision	description	drawn	approved	date

drawn	SGB
approved	IT
date	3 SEPT 2014
scale	NTS
original size	A3

coffey

client: **RUSTRUM PTY LTD C/O STERLINGS**

project: **PROPOSED DEVELOPMENT 216-232 MAIN ROAD TOUKLEY**

title: **TEST LOCATION PLAN**

project no: GEOTWARA22382AA

figure no: **FIGURE 1**

coffey

Computations

project no: GW22382AA

sheet 1 of 2

client: Sterlings

office: Warabrook

principal: Rustrum

date: 9/9/14

project: 216-232 Main Road, Toukley

by: SAB

location: Section A-A'

checked:

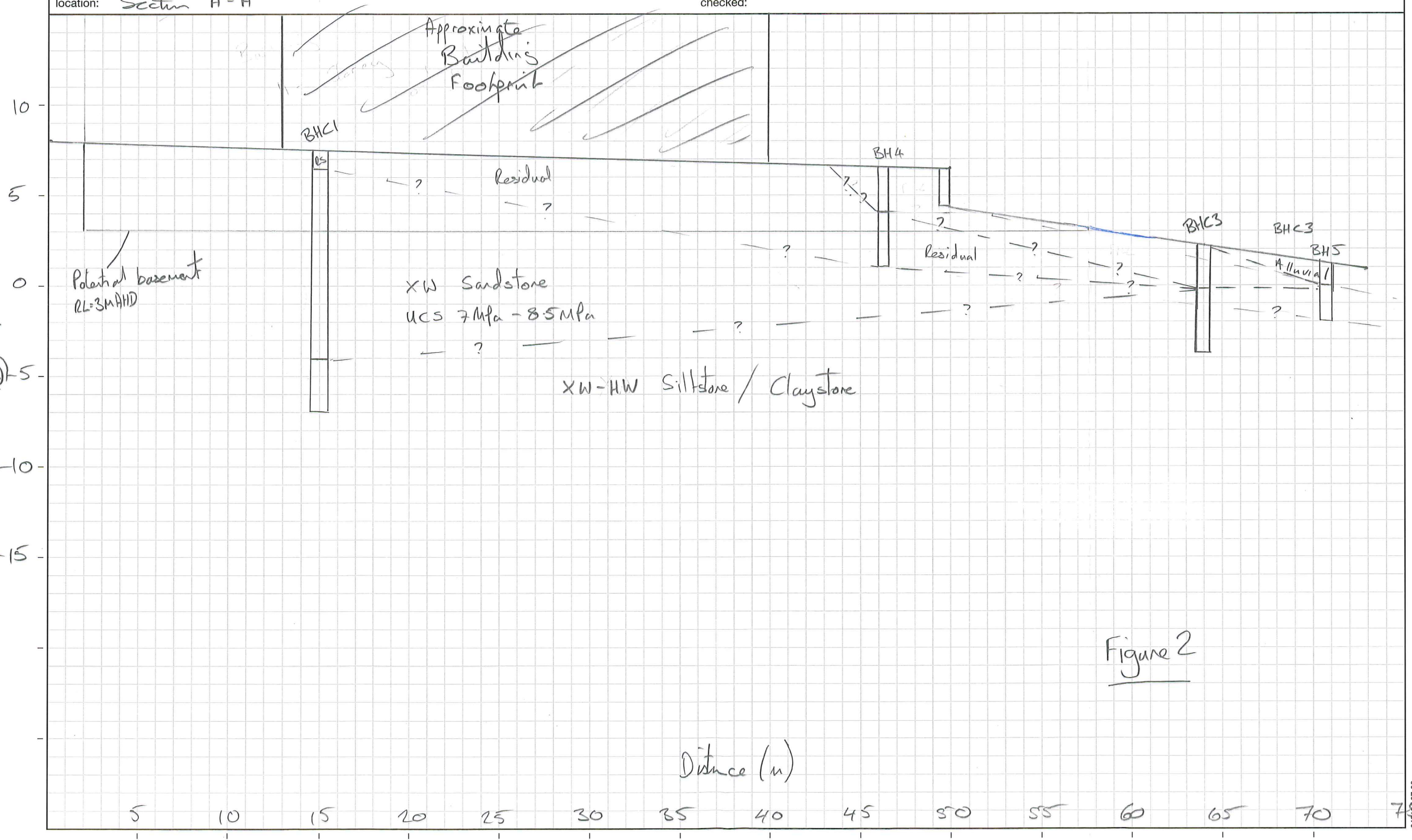

Figure 2

coffey

Computations

project no: GW22382AA

sheet 2 of 2

client: Sterlings

office: Warabrook

principal: Rustrum

date: 9/9/14

project: 216-232 Main Road, Toukley

by: SGB

location: Section B-B'

checked:

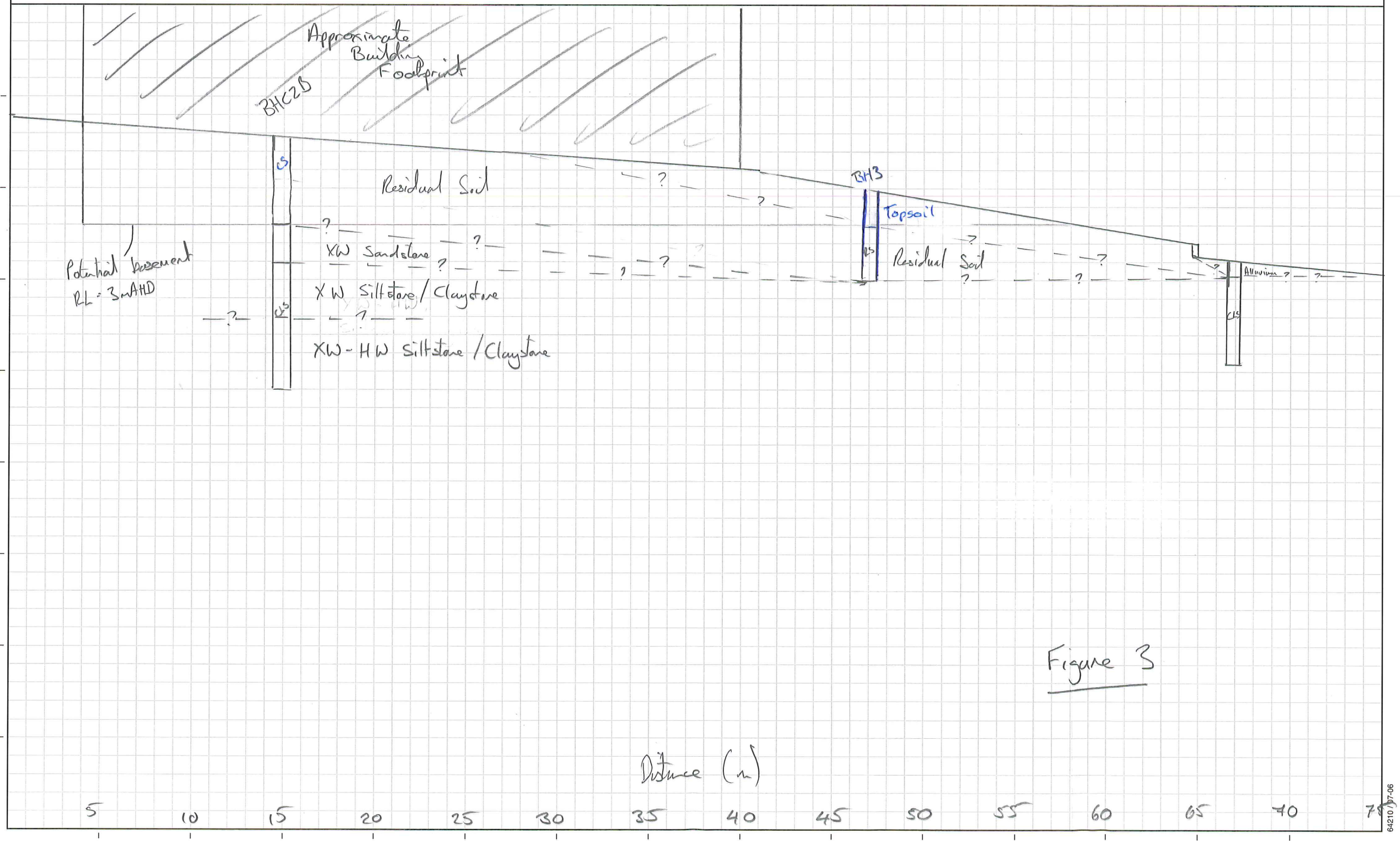

Figure 3

Appendix A - Engineering Logs

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Soil Description Explanation Sheet (1 of 2)

DEFINITION:

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

CLASSIFICATION SYMBOL & SOIL NAME

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

PARTICLE SIZE DESCRIPTIVE TERMS

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

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

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

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

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

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material — Structure and fabric of parent rock visible.

Residual soil — Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil — Deposited by wind.

Alluvial soil — Deposited by streams and rivers.

Colluvial soil — Deposited on slopes (transported downslope by gravity).

Fill — Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.

Lacustrine soil — Deposited by lakes.

Marine soil — Deposited in ocean basins, bays, beaches and estuaries.

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Soil Description Explanation Sheet (2 of 2)

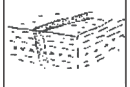
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAIINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
		SILTS & CLAYS Liquid limit less than 50	**DRY STRENGTH**	**DILATANCY**	**TOUGHNESS**			
			None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Medium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME	Simple rock names are used rather than precise geological classification.
PARTICLE SIZE	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
FABRIC	Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	**RS**	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbrev-iation	Point Load Index, $I_{s(50)}$ (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index $I_{s(50)}$. The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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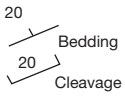
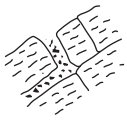
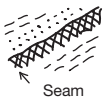
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

DEFECT SHAPE TERMS	
Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS	
Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS	
Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS	
Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

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Engineering Log - Borehole

Borehole ID.	***BHC01***
sheet:	1 of 2
project no.	***GEOTWARA22382AA***
client: ***STERLINGS PTY LTD***	date started: ***18 Aug 2014***
principal:	date completed: ***18 Aug 2014***
project: ***PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT***	logged by: ***AWJ***
location: ***216-232 MAIN ROAD, TOUKLEY***	checked by: ***SGB***

position: E: 363681; N: 6318592 (MGA94) | surface elevation: 7.70 m (AHD) | angle from horizontal: 90°

drill model: FG101, Truck mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/V				7				**TOPSOIL: Sandy CLAY**: low plasticity, dark brown, fine grained sand, some roots, some glass and rubbish at surface.	>Wp			**TOPSOIL**
			SPT 3, 25/130mm N*=R		1.0		CH	**CLAY**: high plasticity, pale grey and pale brown, trace of fine grained sand, trace of roots.	Wp	St		**RESIDUAL SOIL**
				6	2.0			**SANDSTONE**: fine - medium grained, pale grey. Trace fragments of tuff recovered by auger, very low strength. Recovered as Clayey Sand. Becoming orange-red.	D	VD		**EXTREMELY WEATHERED ROCK**
		21/08/14	SPT 31/115mm N*=R	5	3.0			**SANDSTONE**: fine - medium grained, orange red, some fine subrounded gravel, very low strength. Recovered as Clayey Sand.	M			
AD/T			SPT 50 N*=R	4	4.0			**SANDSTONE**: fine - medium grained, orange, red and pale grey, very low strength. Recovered as Clayey Sand.	M - W			
				3	5.0				W			
			SPT 30 N*=R	2	6.0			**SANDSTONE**: high plasticity, pale grey and pale brown, very low strength. Recovered as Clayey Sand.		VSt		
			SPT 30 N*=R	1	7.0			**SANDSTONE**: medium - coarse grained, subrounded grains, orange brown, some clay, very low strength. Recovered as Clayey Sand.		VD		
N				0								

CDF_0_9_04BB_MW LOGS.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 09/09/2014 16:21

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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Engineering Log - Borehole

Borehole ID.	**BHC01**
sheet:	2 of 2
project no.	**GEOTWARA22382AA**
client:	**STERLINGS PTY LTD**
date started:	**18 Aug 2014**
principal:	
date completed:	**18 Aug 2014**
project:	**PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT**
logged by:	**AWJ**
location:	**216-232 MAIN ROAD, TOUKLEY**
checked by:	**SGB**

position: E: 363681; N: 6318592 (MGA94) surface elevation: 7.70 m (AHD) angle from horizontal: 90°

drill model: FG101, Truck mounted hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T, N			SPT 9, 25, 30/105mm N*=R	-1	9.0			**SANDSTONE**: medium - coarse grained, subrounded grains, orange brown, some clay, very low strength. Recovered as Clayey Sand. *(continued)*	W	VD		**EXTREMELY WEATHERED ROCK**
								CLAYSTONE: grey, XW, very low strength, remoulds to CLAY, high plasticity, H-Fb.				
			SPT 22, 30/105mm N*=R	-2	10.0							
				-3	11.0							
			SPT 17, 30/105mm N*=R	-4	12.0			**SILTSTONE**: dark grey, XW-HW, estimated very low strength, remoulds to CLAY.				**EXTREMELY TO HIGHLY WEATHERED ROCK**
				-5	13.0							
			SPT 14, 30/50mm N*=R	-6	14.0			**CLAYSTONE**: pale grey, remoulds to clay.				
			SPT 30/60mm N*=R	-7	15.0			Borehole BHC01 terminated at 14.5 m				
				-8								

CDF_0_9_04BB_MW LOGS.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 09/09/2014 16:21

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remoulded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Piezometer Installation Log

Hole ID.	***BHC01***
sheet:	1 of 1
project no.	***GEOTWARA22382AA***
client: ***STERLINGS PTY LTD***	date started: ***18 Aug 2014***
principal:	date completed: ***18 Aug 2014***
project: ***PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT***	logged by: ***AWJ***
location: ***216-232 MAIN ROAD, TOUKLEY***	checked by: ***SGB***

position: E: 363681; N: 6318592 (MGA94) surface elevation: 7.70 m (AHD) angle from horizontal: 90°

equipment type: FG101, Truck mounted hole diameter : 100 mm

drilling information | **material substance** | **piezometer construction details**

method & support	water	RL (m)	depth (m)	graphic log	material name
AD/V		8	0		
			1		TOPSOIL: Sandy CLAY
					CLAY
		6	2		SANDSTONE
	21/08/14		3		
		4	4		
			5		
		2	6		
			7		
AD/T		0	8		
			9		CLAYSTONE
		-2	10		
			11		
		-4	12		SILTSTONE
			13		CLAYSTONE
		-6	14		
			15		Borehole BHC01 terminated at 14.50 m
		-8			

N

BH1

bore construction license:
drilling company:
driller:
driller's permit no.:

1.50 m

4.50 m

Cuttings

Sand

Cuttings

method & support
see engineering log for details

water
10-Oct-12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

ID	type	stick up & RL	tip depth & RL	install. date	water level
BH1	standpipe piezo.	0.00 m 7.70 m AHD	4.50 m 3.20 m AHD		

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Engineering Log - Borehole

Borehole ID.	***BHC02***
sheet:	1 of 1
project no.	***GEOTWARA22382AA***
client: ***STERLINGS PTY LTD***	date started: ***19 Aug 2014***
principal:	date completed: ***19 Aug 2014***
project: ***PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT***	logged by: ***AWJ***
location: ***216-232 MAIN ROAD, TOUKLEY***	checked by: ***SGB***

position: E: 363712; N: 6318588 (MGA94) surface elevation: 3.60 m (AHD) angle from horizontal: 90°

drill model: FG101, Truck mounted hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/V, N				3				**TOPSOIL: SILT**: medium to high, dark brown, some coarse grained sand and fine grained.	W			**TOPSOIL**
							SC	**Clayey SAND** fine to medium grained, pale grey, orange and red, some fine subrounded gravel.	<Wp	VD		**RESIDUAL SOIL**
			SPT 16, 24/110mm N*=R	-1	1.0			Borehole BHC02 terminated at 1.0 m				
				-2	2.0							
				-3	3.0							
				-4	4.0							
				-5	5.0							
				-6	6.0							
				-7	7.0							

CDF_0_9_04BB_MW LOGS.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 09/09/2014 16:21

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Borehole

Borehole ID.	**BHC02B**
sheet:	1 of 2
project no.	**GEOTWARA22382AA**
client:	**STERLINGS PTY LTD**
date started:	**21 Aug 2014**
principal:	
date completed:	**21 Aug 2014**
project:	**PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT**
logged by:	**AWJ**
location:	**216-232 MAIN ROAD, TOUKLEY**
checked by:	**SGB**

position: E: 363714; N: 6318588 (MGA94) | surface elevation: 8.60 m (AHD) | angle from horizontal: 90°

drill model: FG101, Truck mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T				8				**TOPSOIL: Sandy SILT**: medium to high, dark brown, fine grained sand, some fine grained gravel, some roots.	M			**TOPSOIL**
			SPT 7, 14, 7 N*=21	7	1.0		SC	**Clayey SAND**: fine to coarse grained, pale grey-white, orange and red, some fine grained subrounded gravel.	D	D		**RESIDUAL SOIL**
			SPT 4, 6, 6 N*=12	6	2.0				<Wp	MD		
			SPT 4, 5, 10 N*=15	5	3.0			3.6-4.0m Becoming dark red.	>Wp			
			SPT 18, 25/100mm N*=R	4	4.0			**SANDSTONE**: medium to coarse grained, pale grey and red, very low strength, remoulds to CLAYEY SAND, medium to coarse grained, some fine gravel.		VD		**EXTREMELY WEATHERED ROCK**
			SPT 30, 17/120mm HB N*=R	3	5.0			At 7.0m, becoming pale brown-yellow.	W			Auger bringing up water.
N				2	6.0			**CLAYSTONE**: pale grey, some red, very low strength, easily remoulds to CLAY, low plasticity.	<Wp	H		
				1	7.0							

CDF_0_9_04BB_MW LOGS.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 09/09/2014 16:21

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey

Engineering Log - Borehole

Borehole ID.	**BHC02B**
sheet:	2 of 2
project no.	**GEOTWARA22382AA**
client: **STERLINGS PTY LTD**	date started: **21 Aug 2014**
principal:	date completed: **21 Aug 2014**
project: **PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT**	logged by: **AWJ**
location: **216-232 MAIN ROAD, TOUKLEY**	checked by: **SGB**

position: E: 363714; N: 6318588 (MGA94) | surface elevation: 8.60 m (AHD) | angle from horizontal: 90°

drill model: FG101, Truck mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T								**CLAYSTONE**: pale grey, some red, very low strength, easily remoulds to CLAY, low plasticity. *(continued)*	<Wp	H		**EXTREMELY WEATHERED ROCK**
			SPT 7, 16, 24 N*=40	0	9.0							
				-1								
			SPT 8, 13, 21 N*=34		10.0							
				-2				**CLAYSTONE**: grey-brown, highly weathered, very low strength, can be remoulded to CLAY.				**HIGHLY WEATHERED ROCK**
N			SPT 8, 12, 20 N*=32	-3	11.0							
					12.0			At 12.0m, becoming pale grey, moderately to sightly weathered.				
				-4								
R			SPT 6, 11, 18 N*=29		13.0							
			D	-5								
			D		14.0							
				-6				Borehole BHC02B terminated at 14.35 m				SPT splits base.
					15.0							
				-7								

CDF_0_9_04BB_MW LOGS.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 09/09/2014 16:21

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3
no resistance
ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey

Engineering Log - Borehole

Borehole ID.	***BHC03***
sheet:	1 of 1
project no.	***GEOTWARA22382AA***
client: ***STERLINGS PTY LTD***	date started: ***21 Aug 2014***
principal:	date completed: ***21 Aug 2014***
project: ***PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT***	logged by: ***AWJ***
location: ***216-232 MAIN ROAD, TOUKLEY***	checked by: ***SGB***

position: E: 363693; N: 6318633 (MGA94) surface elevation : 2.20m (AHD) angle from horizontal: 90°

drill model: FG101 mounting: Truck hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T				2				**TOPSOIL: Clayey SAND** fine - medium grained, dark brown, trace fine angular gravel of siltstone, some silt fines.	M			**TOPSOIL**
			SPT 1, 2, 2 N*=4	1	1.0		SC	**Clayey SAND** fine - medium grained, dark brown, some silt fines, trace roots.	W	L		
N				0	2.0							
			SPT 6, 11, 6 N*=17	-1	3.0			**SILTSTONE**: yellow-pale brown, extremely to high weathered, very low strength, some 40° joints visible, can be remoulded to silt.				**EXTREMELY TO HIGHLY WEATHERED ROCK**
			SPT 6, 10, 13 N*=23	-2	4.0			**CLAYSTONE**: purple grey and pale grey, extremely to highly weathered, very low strength, can be remoulded to clay.				
			SPT 7, 12, 21 N*=33	-3	5.0			At 5.5m, becoming highly weathered.				
				-4	6.0			Borehole BHC03 terminated at 5.95 m				
				-5	7.0							

CDF_0_9_04BA.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 24/09/2014 10:53

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey

Engineering Log - Borehole

Borehole ID.	***BHC04***
sheet:	1 of 1
project no.	***GEOTWARA22382AA***
client: ***STERLINGS PTY LTD***	date started: ***21 Aug 2014***
principal:	date completed: ***21 Aug 2014***
project: ***PROPOSED COMMERCIAL AND RESIDENTIAL DEVELOPMENT***	logged by: ***AWJ***
location: ***216-232 MAIN ROAD, TOUKLEY***	checked by: ***SGB***

position: E: 363726; N: 6318645 (MGA94) | surface elevation: 1.40 m (AHD) | angle from horizontal: 90°

drill model: FG101, Truck mounted | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T, N				1			SM	**Silty SAND**: fine - medium grained, dark grey.	M	VL - L		**ALLUVIUM / TOPSOIL**
							SP	**Gravelly SAND**: fine - coarse grained, grey, subangular gravel, trace fines.				**ALLUVIUM**
					1.0		SP	**SAND**: coarse grained, orange-brown, trace fine gravel, some fines.	W			
			SPT 2, 5, 7 N*=12	0				**CLAYSTONE**: pale grey, some orange, extremely to highly weathered, very low strength, can be remoulded to clay.	D	VSt		**EXTREMELY TO HIGHLY WEATHERED ROCK**
				-1	2.0							
			SPT 5, 9, 14 N*=23					**CLAYSTONE**: purple grey, some pale grey, highly weathered, very low strength.				
				-2								
			SPT 5, 7, 14 N*=21		4.0			At 4.2m, becoming pale grey, moderately to slightly weathered.				
				-3								
					5.0							
			SPT 11, 19, 25/130mm N*=R	-4								
					6.0			Borehole BHC04 terminated at 5.9 m				
				-5								
					7.0							
				-6								

CDF_0_9_04BB_MW LOGS.GLB Log COF BOREHOLE: NON CORED GEOTWARA22382AA.GPJ <<DrawingFile>> 09/09/2014 16:21

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3
no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Appendix B - Existing Borehole Logs

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BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 089 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH1
Sheet:	PAGE 1 / 1
Started:	01/10/08
Finished:	01/10/08
Logged:	TR
Checked:	RJK
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: TRUCK MOUNTED EZI PROBE

Borehole Diameter: -mm (I.D.)60mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments, notes, structure, and additional observations
Macro	None Encountered					ML	Sandy SILT, dark brown, fine to medium sand, trace of rootlets	D-M	-	TOPSOIL
						GP-GM / CL/CH	Sandy Silty GRAVEL, fine to medium gravel, dark brown, fine to medium sand			
							Silty Sandy CLAY, medium to high plasticity, pale grey mottled orange brown, fine to medium sand	>Wp	-	RESIDUAL
				1.0						
Macro						-	SANDSTONE, extremely weathered, pale grey, fine to medium grained	D-M	-	
							BH1 Terminated at 1.5 m			Macro refusal at 1.5m depth
				2.0						
				3.0						
				4.0						
				5.0						
				6.0						

BOREHOLE LOG G08221.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 13/10/08

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd

ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH2
Sheet:	PAGE 1 / 1
Started:	30/09/08
Finished:	30/09/08
Logged:	TR
Checked:	RJK
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: TRUCK MOUNTED EZI PROBE

Borehole Diameter: -mm (I.D.)60mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments, notes, structure, and additional observations
DT						ML	Sandy SILT, dark brown, fine to medium grained, some fine to medium gravel	M	-	TOPSOIL/FILL
						CL	Sandy CLAY, medium plasticity, pale grey mottled orange brown, fine to medium sand	>Wp		RESIDUAL
DT			15+	1.0		SC	Clayey SAND, fine to coarse grained, pale grey mottled orange/red, low plasticity, trace of fine gravel	M	VD	15/75mm
DT			15+	2.0		CL-CH	Sandy CLAY, medium to high plasticity, pale grey, fine to medium sand	>Wp	-	15/100mm
DT			9 11 15+	3.0		CH	Clayey SAND, fine to coarse grained, pale grey becoming orange/red at 3.2m depth, low plasticity, trace of fine gravel	M	D	15/50mm
DT	▽		20	4.0		CL-CH	CLAY medium to high plasticity, pale grey, some fine to medium sand	>Wp	VSt	
DT						SC	Clayey SAND, fine to coarse grained, pale grey mottled red brown, low plasticity, trace of fine gravel	M	S	15/50mm
ADV				5.0						15/75mm
				6.0			BH2 Terminated at 6 m			

BOREHOLE LOG G08221.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 13/10/08

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 089 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH3
Sheet:	PAGE 1 / 1
Started:	30/09/08
Finished:	30/09/08
Logged:	DS
Checked:	TR
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: TRUCK MOUNTED EZI PROBE

Borehole Diameter: -mm (I.D.)100mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADV	▽					GP-GM	Sandy Silty GRAVEL, fine to medium gravel, grey, fine to medium sand	D-M	-	FILL
						ML	Sandy SILT, brown, fine to medium sand, some fine to medium gravel, traces of low to medium plastic fines	M		
						CL	Gravelly Sandy CLAY, low to medium plasticity, pale orange brown becoming pale grey at 1.2m depth, fine to medium gravel, fine to medium sand	>Wp	St	
			8	1.0						
		D	5							
			15							
				2.0						
		D				CL/SC	Sandy CLAY/Clayey SAND, medium plasticity, pale grey, fine to medium sand	>Wp to (M)	VSt	RESIDUAL
			11							
			15							
			15	3.0						
				4.0		SC	Clayey SAND, fine to coarse gravel, pale grey, low to medium plasticity, trace of fine to medium gravel	W-S	D-VD	
			30							
		D		5.0						
						CL	CLAY, medium plasticity, pale yellow brown, trace of fine to medium gravel	>Wp	(VSt/H)	
		D								
			22				BH3 Terminated at 5.5 m			
				6.0						

BOREHOLE LOG G08221.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 13/10/08

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 089 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH4
Sheet:	PAGE 1 / 1
Started:	30/09/08
Finished:	30/09/08
Logged:	DS
Checked:	TR
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: TRUCK MOUNTED EZI PROBE

Borehole Diameter: -mm (I.D.)100mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments, notes, structure, and additional observations
ADV	▽					SM	Silty SAND, fine to medium grained, dark brown	D-M	-	TOPSOIL/FILL
				1.0		SP	Gravelly Clayey SAND, fine to coarse grained, pale grey, fine to medium gravel, low to medium plasticity	M		FILL
			15/50			GP	Sandy GRAVEL, fine to medium, pale orange brown, fine to medium sand, trace of low to medium plastic fines	M	MD-D	(+15/50mm @1.0m)
				2.0						
			+20			SP	Gravelly SAND, fine to medium grained, pale grey, fine to medium gravel, slightly low to medium plastic fines	M	D-VD	(+20/100mm)
				3.0		SP	Gravelly Clayey SAND, low to medium plasticity, fine to medium grained, yellow brown, fine to medium gravel	M-W		RESIDUAL
						CL	Sandy CLAY, low to medium plasticity, yellow brown, fine to medium sand, some fine to medium gravel	>Wp to (Sat)	VSt-H	
				4.0						
			24							
				5.0						
			+35				BH4 Terminated at 5.5 m			(35+/100mm)
				6.0						

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH5
Sheet:	PAGE 1 / 1
Started:	01/10/08
Finished:	01/10/08
Logged:	TR
Checked:	RJK
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: SKID STEER DINGO

Borehole Diameter: -mm (I.D.)100mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments, notes, structure, and additional observations
ADV	▽	D		1.0		SM	Silty SAND, fine to coarse grained, dark brown, trace of fine gravel	D-M	(L)	ALLUVIAL
		D				SM/SC	Silty Clayey SAND, fine to coarse grained, dark brown, low plasticity	M-W		
		D				SP/SM	Gravelly Silty SAND, fine tto coarse grained, dark brown, fine gravel	W-S		
		D		2.0		CH	CLAY, high plasticity, grey mottled orange brown, trace of fine to medium sand, trace of fine to medium gravel	»Wp to W	(St-VSt)	RESIDUAL
		D		3.0			BH5 Terminated at 3 m			
				4.0						
				5.0						
				6.0						

BOREHOLE LOG G08221.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 1/12/08

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH6
Sheet:	PAGE 1 / 1
Started:	01/10/08
Finished:	01/10/08
Logged:	TR
Checked:	RJK
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: SKID STEER DINGO

Borehole Diameter: -mm (I.D.)100mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments, notes, structure, and additional observations
ADV	▽	D				SM/SC	Silty Clayey SAND, fine to coarse grained, dark brown, low plasticity, trace of fine to medium gravel	M	(L)	ALLUVIAL
		D		1.0		CL	Sandy CLAY, medium plasticity, grey mottled orange brown, fine to coarse sand, trace of fine to medium gravel	>Wp	F	
			3			SC	Clayey SAND, fine to coarse grained, grey, low to medium plasticity	M-W	F-St	
		D	3							
			4							
			6			CL/CH	CLAY, medium to high plasticity, grey mottled red brown, some fine to medium sand	≥Wp	VSt	RESIDUAL
		D		2.0						
			11							
			12							
		D	15+							15/100mm
						CH	CLAY, high plasticity, grey mottled brown	>Wp	H	
		D		3.0						
			23				BH6 Terminated at 3 m			Near V Bit refusal at 3.0m depth
			25							
				4.0						
				5.0						
				6.0						

BOREHOLE LOG G08221.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 1/12/08

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G08/221
Hole No:	BH7
Sheet:	PAGE 1 / 1
Started:	01/10/08
Finished:	01/10/08
Logged:	TR
Checked:	RJK
RL Surface:	-
Datum:	-

Client: STERLINGS PTY LTD

Project: PROPOSED SENIORS LIVING

Location: 222 MAIN ROAD, TOUKLEY
GPS (-)

Equipment Type: SKID STEER DINGO

Borehole Diameter: -mm (I.D.)100mm(O.D.) Inclination: Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments (notes, structure, and additional observations)
LB						SC	Clayey SAND, fine to medium grained, pale grey, low to medium plasticity, trace of fine to medium gravel	M	-	FILL
LB		D				SM	Silty SAND, fine to coarse grained, dark grey, trace of fine gravel	M-W	(L)	ALLUVIAL
						SP	SAND, fine to coarse grained, pale grey, trace of fine gravel	W		
LB	▽	D		1.0		SP	Gravelly SAND, fine to coarse grained, pale grey, fine gravel		-	
LB		D				CH	CLAY, high plasticity, pale grey	»Wp	(Vst)	RESIDUAL
				2.0			BH7 Terminated at 1.8 m			
				3.0						
				4.0						
				5.0						
				6.0						

BOREHOLE LOG G08221.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 1/12/08

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Appendix C - Laboratory Test Reports

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Warabrook, Newcastle Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
19 Warabrook Boulevard
Warabrook NSW 2304

Phone: +61 2 4016 2300
Fax: +61 2 4016 2380

Material Test Report

Report No: WARA14S-10806-1
Issue No: 1

Client:	Coffey Geotechnics Pty Ltd (Warabrook) 19 Warabrook Boulevard Warabrook NSW 2304
Principal:	
Project No.:	INFOWARA01807AA
Project Name:	GEOTWARA22382AA - Proposed Development Main Road Toukley
Lot No.:	- TRN: -

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Greg Eveleigh
(Geotechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 9/09/2014

Sample Details

Sample ID:	WARA14S-10806
Client Sample:	-
Date Sampled:	26/08/2014
Source:	On-Site
Material:	Existing Ground
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	NSW
Sample Location:	BH2B 8.50 - 8.95m

Other Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	24.7	
Date Tested		1/09/2014	
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.5	
Mould Length (mm)		150.5	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	52	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	23	
Plasticity Index (%)	AS 1289.3.3.1	29	
Date Tested		4/09/2014	

Particle Size Distribution

Chart

Comments

N/A

Warabrook, Newcastle Laboratory

Coffey Testing Pty Ltd
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Warabrook NSW 2304

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Fax: +61 2 4016 2380

Material Test Report

Report No: WARA14S-10805-1
Issue No: 2
This report replaces all previous issues of report no 'WARA14S-10805-1'.

Client:	Coffey Geotechnics Pty Ltd (Warabrook) 19 Warabrook Boulevard Warabrook NSW 2304
Principal:	
Project No.:	INFOWARA01807AA
Project Name:	GEOTWARA22382AA - Proposed Development Main Road Toukley
Lot No.:	- TRN: -

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Joey Smith
(Senior Technician)
NATA Accredited Laboratory Number:431
Date of Issue: 4/09/2014

Sample Details

Sample ID:	WARA14S-10805
Client Sample:	-
Date Sampled:	26/08/2014
Source:	On-Site
Material:	Existing Ground
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	NSW
Sample Location:	BH2B 5.50 - 5.70m

Other Test Results

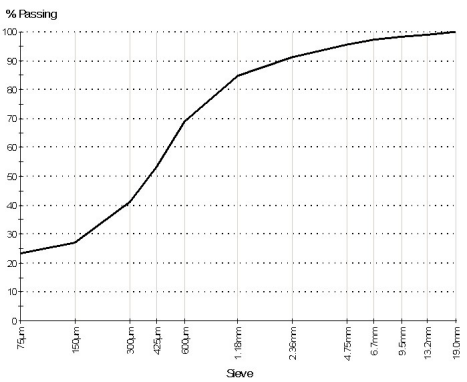
Description	Method	Result	Limits

Particle Size Distribution

Method:	AS 1289.3.6.1
Drying by:	Oven
Date Tested:	2/09/2014
Note:	Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	99	
9.5mm	98	
6.7mm	97	
4.75mm	96	
2.36mm	91	
1.18mm	85	
600µm	69	
425µm	53	
300µm	41	
150µm	27	
75µm	23	

Chart



Comments

N/A

Warabrook, Newcastle Laboratory

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Warabrook NSW 2304

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Material Test Report

Report No: WARA14S-10804-1
Issue No: 2
This report replaces all previous issues of report no 'WARA14S-10804-1'.

Client:	Coffey Geotechnics Pty Ltd (Warabrook) 19 Warabrook Boulevard Warabrook NSW 2304
Principal:	
Project No.:	INFOWARA01807AA
Project Name:	GEOTWARA22382AA - Proposed Development Main Road Toukley
Lot No.:	- TRN: -

Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Joey Smith
(Senior Technician)
NATA Accredited Laboratory Number:431
Date of Issue: 4/09/2014

Sample Details

Sample ID:	WARA14S-10804
Client Sample:	-
Date Sampled:	26/08/2014
Source:	On-Site
Material:	Existing Ground
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	NSW
Sample Location:	BH2B 2.50 - 2.95m

Other Test Results

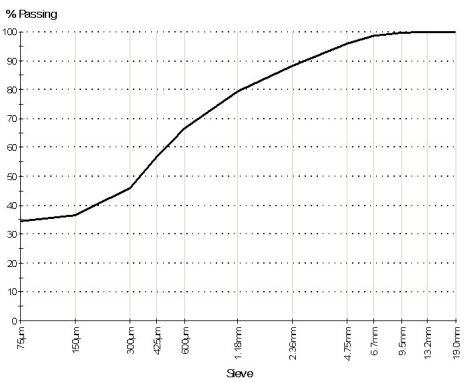
Description	Method	Result	Limits

Particle Size Distribution

Method:	AS 1289.3.6.1
Drying by:	Oven
Date Tested:	2/09/2014
Note:	Sample Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	100	
9.5mm	100	
6.7mm	99	
4.75mm	96	
2.36mm	88	
1.18mm	79	
600µm	67	
425µm	57	
300µm	46	
150µm	37	
75µm	35	

Chart



Comments

N/A